Tuesday, October 28, 2025, 6:00 PM
Council Chambers
One DesCombes Drive
Broomfield, CO 80020

View Correspondence
View Presentations

1. Meeting Commencement

1.A. Pledge of Allegiance

1.B. Review and Approval of Agenda

2. Petitions and Communications

3. Councilmember Reports

4. Public Comment

5. Reports

5.A. Expense Report for Elected Officials- 3rd Quarter 2025

6. Consent Items

6.A. Minutes for Approval

6.B. Resolution - Mile High Water License Approval

— Resolution No. 2025-146 approving the Issuance of a Water License to Mile High Water Company

6.C. Resolution - Assignment of 2025 Private Activity Bonds (PAB) to the Broomfield Housing Alliance (BHA)

— Resolution 2025-149 transferring Broomfield’s 2025 Private Activity Bond Allocation to the Broomfield Housing Alliance

6.D. Resolution - Board of Equalization (BOE) - Appointing Daisy Glassburn as an Arbitrator

— Resolution 2025-147-BOE appointing Daisy Glassburn as an arbitrator to conduct property valuation appeal hearings

6.E. Executive Session Request for Legal Advice Related to a Conservation Easement

7. Action Items

7.A. Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

— Item 7A thru 7F will be heard concurrently

— Resolution No. 2025-141 approving the 2nd Amendment to the 2025 Broomfield Budget

— Resolution No. 2025-142 approving the 2026 Broomfield Budget

7.B. Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

(Broomfield Urban Renewal Authority - BURA)

— Item 7A thru 7F will be heard concurrently

— Resolution No. 2025-143-UR approving the 2nd Amendment to the 2025 BURA Budget

— Resolution No. 2025-144-UR approving the 2026 BURA Budget

7.C. Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

(Arista Local Improvement District)

— Item 7A thru 7F will be heard concurrently

— Resolution No. 2025-145-AID approving the 2026 Arista Local Improvement District (ALID) Budget

7.D. Public Hearing - Ordinance Second Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

— Item 7A thru 7F will be heard concurrently

— Ordinance No. 2286 amending Title 13 of the Broomfield Municipal Code to change water, wastewater, reclaimed wastewater, and stormwater fees and service charges

7.E. Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

— Item 7A thru 7F will be heard concurrently

— Ordinance No. 2288 for Enterprise Revenue Bond (Water)

— Ordinance No. 2289 for Enterprise Revenue Bond (Sewer)

— Ordinance No. 2290 for Police Building Certificate of Participation

7.F. Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

— Item 7A thru 7F will be heard concurrently

— Resolution No. 2025-153 approving the Continuation of the Utility Rate Assistance Fund (URAF) Program

— Resolution No. 2025-154 approving the Continuation of the Partial Property Tax Refund (PPTR) Program

7.G. Resolution - Water Tanks Construction Agreement

— Resolution No. 2025-131 authorizing the Guaranteed Maximum Price (GMP) to the Construction Agreement with Garney Construction

— Resolution No. 2025-137 authorizing the Consulting Agreement with Burns & McDonnell Engineering, Inc.

— Resolution No. 2025-152 expressing the intent of the City and County of Broomfield to be reimbursed for certain expenses relating to the construction of water improvements

7.H. Public Hearing - Ordinance Second Reading - Water and Sewer License Purchase and Refund Requirements and Timing

— Ordinance No 2287 amending Chapter 13-02 Water License and Chapter 13-08 Sewer Licenses

7.I. Resolution - Broomfield Business Center (BBC) Metropolitan District Service Plan Amendment — Resolution No. 2025-148 approving an Amendment to the First Amended and Restated Service Plan for Broomfield Business Center (BBC) Metropolitan District

8. Mayor and Councilmember Requests for Future Action

8.A. Councilmember Ward's Request for Future Action for City Council to Adopt a Resolution Demanding RTD Reserve FISA Funds for FasTracks Completion and Seek Alternative Funding for Bus Replacements

9. Adjournment

The City and County of Broomfield operates without regard to race, color, national origin, ethnicity, citizenship, immigration status, gender, age, sex, sexual orientation, gender identity, gender expression, marital status, source of income, military status, or disability in all programs and activities.
Individuals with disabilities requiring accommodation or persons needing a language interpreter must submit such a request to the City Clerk no later than noon on Thursday prior to the scheduled Council meeting to allow adequate time to make arrangements. Please call 303.438.6332 or TDD 303.465.5411 or write cityclerk@broomfield.org to make your request.
During the meeting, individuals can click the “CC” button on Live Council meeting video feeds to view closed captioning. Auxiliary hearing aid equipment can be requested on the night of the meeting with our AV team located at the back of the Council Chambers.

Date Posted: October 22, 2025

City and County of Broomfield

City Council Regular Meeting

A. Expense Report for Elected Officials- 3rd Quarter 2025

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Reports Item: 5A.

Presented By
Ashandra Corman

Community Goals

Overview

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The 3rd quarter report for Council's 2025 training and travel expenses and community relations events.

Attachments

Expense Report for Elected Officials - 3rd Quarter 2025.pdf
2025 EXPENSE REPORT FOR ELECTED OFFICIALS - 2025.pdf

Summary

View Correspondence
View Presentation

Sections 3.10(b) of the City Council's Expense Policy for Elected Officials states that after attending a training or travel event, each elected official shall provide a written or oral report.

If a Councilmember submitted a written report regarding conferences and travel, they are available on Broomfield's website.

Section 3.10(c) of the City Council's Expense Policy for Elected Officials requires quarterly reports by the finance department regarding current expenses for training and travel, and community relations activities.

Attached is the third quarter report for Council's 2025 training and travel expenses and community relations events.

It should be noted that the Mayor and Councilmembers may share allocations with other Councilmembers not to exceed the overall budgeted amount ($76,000); transfers between Councilmembers are captured under Budget Transfers/Adjustments.

In this quarter, $3,775.58 of the Travel and Training Budget was used with the Council's permission and pursuant to their policies. These expenditures did not cause the Council to exceed the overall budget of $76,000.

Quarter 1 (January 1 - March 31, 2025): $23,392.95 used
Quarter 2 (April 1 - June 30, 2025) $11,043.83 used
Quarter 3 (July 1 - September 30, 2025) $3,775.58 used
Quarter 4 (October 1 - December 31, 2025)

Total used Year to Date: $38,212.36 with a remaining balance of $37,787.64

Financial Considerations

The total 2025 budget for the Mayor's and Council's Training & Travel and Community Relations expenses is $76,000, as broken down below:

Annual Training & Travel Allowance for the Mayor	$10,000.00
Annual Training & Travel Allowance for 10 Councilmembers ($6,000 per Councilmember)	$60,000.00
Annual Community Relations Allowance for the Mayor	$1,000.00
Annual Community Relations Allowance for 10 Councilmembers ($500 per Councilmember)	$5,000.00
Annual Total	**$76,000.00**

It is important to note that in the Expense Policy, these line items are not provided but for tracking purposes; Training & Travel and Community Relations expenses are tracked separately due to IRS policies for

training and travel expenses.

Prior Council or Other Entity Actions

The City Council approved Resolution No. 2008-133, adopting an Expense Policy for Elected Officials on July 8, 2008.

The City Council approved Resolution No. 2010-92, revising the Expense Policy for Elected Officials on July 13, 2010.

The City Council approved Resolution No. 2018-181, revising the Expense Policy for Elected Officials on December 11, 2018.

The City Council approved Resolution No. 2025-09, revising the Expense Policy for Elected Officials on January 14, 2025.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

N/A - Information Only

Alternatives

N/A

2025 EXPENSE REPORT FOR ELECTED OFFICIALS 01-11100-53210 - Project Code (for Travel and Training)	Mayor CCC2303	Anderson CCC2305	Cohen CCC2308	Delgadillo CCC2312	Henkel CCC2304	Nguyen CCC2313	Leslie CCC2309	Lim CCC2306	Marsh-Holschen CCC2310	Shaff CCC2301	Ward CCC2311	TOTAL
Meetings and Community Relations Total	**$2,270.40**	**$0.00**	**$0.00**	**$164.54**	**$1,430.65**	**$185.16**	**$0.00**	**$46.53**	**$0.00**	**$98.36**	**$0.00**	**$4,195.64**
Travel and Training Total	**$5,022.20**	**$1,052.10**	**$0.00**	**$2,157.87**	**$5,928.68**	**$1,328.15**	**$0.00**	**$4,908.67**	**$7,734.97**	**$0.00**	**$5,884.08**	**$34,016.72**
Total Spent	**$7,292.60**	**$1,052.10**	**$0.00**	**$2,322.41**	**$7,359.33**	**$1,513.31**	**$0.00**	**$4,955.20**	**$7,734.97**	**$98.36**	**$5,884.08**	**$38,212.36**
Budget Transfers/Adjustments												
CML Annual Conference			**-$295.91**		**$295.91**	**-$475.57**			**$475.57**			
CML Executive Board Retreat							**-$759.40**		**$759.40**			
Monthly Mileage and Parking			**-$385.09**		**$385.09**							
Meeting with Brad Rothman			**-$6.68**		**$6.68**							
Event Food			**-$86.65**		**$86.65**							
EmpoweHer Chamber Event			**-$85.00**		**$85.00**							
Total Transfers	**$0.00**	**$0.00**	**-$859.33**	**$0.00**	**$859.33**	**-$475.57**	**-$759.40**	**$0.00**	**$1,234.97**	**$0.00**	**$0.00**	
Remaining Balance	**$3,707.40**	**$5,447.90**	**$5,640.67**	**$4,177.59**	**$0.00**	**$4,511.12**	**$5,740.60**	**$1,544.80**	**$0.00**	**$6,401.64**	**$615.92**	**$37,787.64**
Meetings and Community Relations Expenses												
Parking for Metro Mayors Executive Briefing on Housing	$30.00											**$30.00**
Mayor Meeting with Ward 5 CM's	$50.99											**$50.99**
Meeting with former Senator Terry Phillips regarding the Property Tax commission	$50.74											**$50.74**
January Mileage and Parking	$94.74				$126.67			$46.53				**$267.94**
2025 Business Awards, Broomfield Area Chamber	$65.00				$75.00							**$140.00**
Chamber Event					$6.30							**$6.30**
Chamber Event	$65.00											**$65.00**
February Mileage	$52.53				$121.67							**$174.20**
Meeting with Kyle Harris and Andrew Sorenson					$7.43							**$7.43**
Meeting with CM Ward	$43.62											**$43.62**
March Mileage and Parking	$46.91				$99.95							**$146.86**
Meeting with CM Cohen and Pat Quinn					$42.11							**$42.11**
Meeting with Heidi Williams					$76.00							**$76.00**
Parking for CBCA Awards	$17.00											**$17.00**
Meeting with Kelly Shaughnessy					$55.79							**$55.79**
Meeting with CM Anderson	$46.85											**$46.85**
Meeting with Ward 2 Resident	$36.84											**$36.84**
April Mileage	$107.47				$188.99							**$296.46**
Meeting with CM Cohen and CM Henkel	$57.59											**$57.59**
Meeting with John Dulles and Barb Gregory					$67.32							**$67.32**
Meeting with CM Marsh-Holschen	$70.37											**$70.37**
Chamber Event	$35.00			$35.00								**$70.00**

May Mileage	$121.26				$111.77							**$233.03**
Metro Area County Commissioners Meeting Parking and Mileage						$23.83						**$23.83**
June Mileage	$117.65				$56.95	$12.59						**$187.19**
February and March Mileage and Parking										$98.36		**$98.36**
Meeting with Stan Jezierski	$31.16											**$31.16**
Meeting with Jack Castellano	$29.28											**$29.28**
July Mileage and Parking	$144.24				$111.15	$70.88						**$326.27**
Meeting with Mark Braman And Sherry Burkhard	$39.08											**$39.08**
A Precious Child Luncheon and Fashion Show Ticket				$129.54								**$129.54**
Meeting with Brad Rothman					$6.68							**$6.68**
Event Food					$86.65							**$86.65**
August Mileage	$81.21				$105.22	$77.86						**$264.29**
Meeting with Reverend Broderick Greer from Holy Comforter Church	$44.40											**$44.40**
Meeting with Asta Clemson	$41.47											**$41.47**
Scouting Colorado Vale La Pena Sponsorship	$500.00											**$500.00**
Rocky Mountain Equality Teen Program Sponsorship	$250.00											**$250.00**
EmpoweHer Chamber Event					$85.00							**$85.00**
Total	**$2,270.40**	**$0.00**	**$0.00**	**$164.54**	**$1,430.65**	**$185.16**	**$0.00**	**$46.53**	**$0.00**	**$98.36**	**$0.00**	**$4,195.64**
Training and Travel Expenses												
NACo Legislative Conference March 1-4, 2025 - Washington D.C.												
Registration					$590.00				$530.00		$530.00	**$1,650.00**
Hotel					$1,362.40				$1,594.31		$1,502.66	**$4,459.37**
Air/Transport.					$551.36				$536.96		$424.07	**$1,512.39**
Mileage					$40.07							**$40.07**
Meal / Per Diem					$409.00				$337.00		$337.00	**$1,083.00**
Misc./Ride Share					$164.90							**$164.90**
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$3,117.73**	**$0.00**	**$0.00**	**$0.00**	**$2,998.27**	**$0.00**	**$2,793.73**	**$8,909.73**
NLC Congressional City Conference March 10-12, 2025 - Washington D.C.												
Registration	$870.00							$780.00	$670.00		$745.00	**$3,065.00**
Hotel	$1,525.92							$1,525.92	$1,525.92		$2,023.35	**$6,601.11**
Air/Transport.	$655.49							$393.96				**$1,049.45**
Mileage												**$0.00**

Meal / Per Diem	$261.00							$322.00	$322.00		$322.00	**$1,227.00**
Misc./Ride Share & Airport Parking	$328.64											**$328.64**
Total	**$3,641.05**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$3,021.88**	**$2,517.92**	**$0.00**	**$3,090.35**	**$12,271.20**
CCI Foundation June 2-4, 2025 - Summit County												
Registration					$455.78							**$455.78**
Hotel					$679.89							**$679.89**
Air/Transport.												**$0.00**
Mileage					$117.52							**$117.52**
Meal / Per Diem					$113.00							**$113.00**
Misc.												**$0.00**
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$1,366.19**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$1,366.19**
CML Annual Conference June 24-27, 2025 - Breckenridge, Co												
Registration	$435.00				$345.00	$100.00			$140.00			**$1,020.00**
Hotel	$577.29				$735.00	$896.76			$1,006.83			**$3,215.88**
Air/Transport.												**$0.00**
Mileage	$127.43				$126.76	$119.39			$123.55			**$497.13**
Meal / Per Diem	$189.00				$238.00	$212.00			$189.00			**$828.00**
Misc./Parking	$52.43											**$52.43**
Total	**$1,381.15**	**$0.00**	**$0.00**	**$0.00**	**$1,444.76**	**$1,328.15**	**$0.00**	**$0.00**	**$1,459.38**	**$0.00**	**$0.00**	**$5,613.44**
NALEO Annual Conference July 22-24, 2025 - Atlanta, Ga												
Registration				$800.00								**$800.00**
Hotel				$785.30								**$785.30**
Air/Transport.				$428.57								**$428.57**
Mileage												**$0.00**
Meal / Per Diem				$144.00								**$144.00**
Misc.												**$0.00**
Total	**$0.00**	**$0.00**	**$0.00**	**$2,157.87**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$2,157.87**
CC4CA Annual Meeting June 11-13, 2025 - Vail, CO												
Registration		$250.00						$325.00				**$575.00**
Hotel		$648.00						$992.00				**$1,640.00**
Air/Transport.								$25.50				**$25.50**
Mileage		$154.10										**$154.10**
Meal / Per Diem												**$0.00**
Misc.												**$0.00**
Total	**$0.00**	**$1,052.10**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$1,342.50**	**$0.00**	**$0.00**	**$0.00**	**$2,394.60**
CML Executive Board Retreat July 10-12, 2025- Grand Junction, CO												
Registration												**$0.00**
Hotel									$392.00			**$392.00**

Air/Transport.												$0.00
Mileage									$348.40			$348.40
Meal / Per Diem									$19.00			$19.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$759.40**	**$0.00**	**$0.00**	**$759.40**
CCAT Summer Retreat August 7-8, 2025- Avon, CO												
Registration								$106.23				$106.23
Hotel								$322.56				$322.56
Air/Transport.								$28.50				$28.50
Mileage												$0.00
Meal / Per Diem								$87.00				$87.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$544.29**	**$0.00**	**$0.00**	**$0.00**	**$544.29**
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00
Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00
Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00
Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00

Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00
Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**	**$0.00**
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00
Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total												$0.00
Registration												$0.00
Hotel												$0.00
Air/Transport.												$0.00
Mileage												$0.00
Meal / Per Diem												$0.00
Misc.												$0.00
Total												$0.00

City and County of Broomfield

City Council Regular Meeting

A. Minutes for Approval

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Consent Items Item: 6A.

Presented By
Crystal Clemens, City Clerk

Community Goals

Overview

View Presentation

Approval of Minutes for the Regular City Council Meeting of October 14, 2025.

Attachments

Minutes of October 14 2025.pdf

Minutes for the City Council Regular Meeting

One DesCombes Drive, Broomfield, CO 80020

October 14, 2025, 6:00 PM - October 14, 2025, 9:29 PM

Roll Call: *(The following members were in attendance)*

- **Guyleen Castriotta,** Mayor
- **James Marsh-Holschen,** Ward 1
- **Kenny Van Nguyen,** Ward 1
- **Paloma Delgadillo,** Ward 2
- **Austin Ward,** Ward 2
- **Jean Lim,** Ward 3
- **Deven Shaff,** Mayor Pro Tem, Ward 3
- **Laurie Anderson,** Ward 4
- **Bruce Leslie,** Ward 4
- **Heidi Henkel,** Ward 5
- **Todd Cohen,** Ward 5
- **Lori Goldstein,** Authority Member - BURA (remote)

Also Present:

- Jennifer Hoffman, City and County Manager
- Anna Bertenzetti, Deputy City and County Manager
- Dan Casey, Deputy City and County Manager
- Nancy Rodgers, City and County Attorney
- Michelle Parker, Deputy City and County Clerk
- And various staff members

The Mayor called a recess at 7:53 p.m. The meeting reconvened at 8:03 p.m.

1. Meeting Commencement

1.A. Pledge of Allegiance- 6:03 PM

1.B. Review and Approval of Agenda- 6:03 PM

2. Petitions and Communications

2.A. Proclamation - 2026 Anniversary Year: U.S., Colorado, City & County of Broomfield- 6:03 PM

3. Councilmember Reports

4. Public Comment

5. Reports

5.A. Master Services Agreement Quarterly Report - September 2025- 6:39 PM

6. Consent Items

Councilmember Marsh-Holschen moved to approve Consent Items 6A - 6D. The motion was seconded by Councilmember Ward, and passed 10-0.

6.A. Minutes for Approval- 6:41 PM

6.B. Resolution - The Trails at Westlake Development Proposal - Findings of Denial - 6:41 PM

6.C. Ordinance - First Reading - Water and Sewer License Purchase and Refund Requirements and Timing - 6:41 PM

6.D. Request for Executive Session Request Related Eagle Trace Golf Course- 6:41 PM

7. Action Items

7.A. Public Hearing - 2026 Operating and Capital Budgets- 6:48 PM
Public Hearing was opened at 6:49 PM and closed at 7:26 PM

7.B. Ordinance - First Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees - 7:26 PM

Mayor Pro Tem Shaff moved to approve on first reading and order published in full Ordinance No. 2286 Amending Title 13 of the Broomfield Municipal Code to change water, wastewater, reclaimed wastewater, and stormwater fees and service charges. The motion was seconded by Councilmember Leslie. The motion passed 7-3, with Councilmembers Marsh-Holschen, Cohen, and Henkel voting no.

7.C. Ordinances - First Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation- 9:21 PM

Councilmember Leslie moved to approve on first reading and order published in full Ordinance No. 2288 authorizing the issuance of the City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026. The motion was seconded by Councilmember Ward and passed 10-0.

Councilmember Nguyen moved to approve on first reading and order published in full Ordinance No. 2289 authorizing the issuance of the City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026. The motion was seconded by Councilmember Leslie and passed 10-0.

Councilmember Henkel moved to approve on first reading and order published in full Ordinance No. 2290 concerning the financing of police and courts buildings and approving the execution and delivery of a Site Lease Agreement, Lease Purchase Agreement, and related documents. The motion was seconded by Councilmember Leslie and passed 10-0.

7.D. Public Hearing - Ordinance Second Reading - Disposition of Unclaimed Property - 9:24 PM

Public Hearing was opened at 9:24 PM and closed at 9:26 PM

Councilmember Marsh-Holschen moved to approve on second and final reading Ordinance No. 2285 amending Chapter 3-25 of the Broomfield Municipal Code relating to the Disposition of Unclaimed Property. The motion, seconded by Councilmember Nguyen, passed 10-0.

8. Mayor and Councilmember Requests for Future Action

9. Adjournment

APPROVED:

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Mayor Castriotta

_____

Office of the City and County Clerk

City and County of Broomfield

City Council Regular Meeting

B. Resolution - Mile High Water License Approval

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Consent Items Item: 6B.

Presented By
Ken Rutt, Director of Public Works

Community Goals

Overview

View Correspondence and visit BroomfieldVoice.com (link to project page OR remove if not applicable)
View Presentation

Resolution No. 2025-146 Approving the Issuance of a Water License to Mile High Water Company.

Attachments

Memo Mile High Water License Approval (2).pdf
Resolution No_ 2025-146.pdf

Title of Memo Mile High Water License Approval
Prepared By: Ken Rutt, Director of Water Utilities

Summary

View Correspondence
View Presentation

The City and County of Broomfield and the Mile High Water Company entered into a Water Service Agreement dated June 1, 2004. (Agreement). During a Study Session on February 12, 2019, Council provided direction to eliminate the need to demonstrate a hardship and remove the three additional water licenses per year limit on future requests from Mile High Water Company.

Broomfield has received a written request from Mile High Water Company for one residential water license. The request was submitted on behalf of the property owners who reside at 1350 W. 152nd Street, Broomfield, CO 80023. The written request from Mile High Water Company states that the property owner has agreed to pay for the water license fees at the rates set forth in the Agreement and to pay for the installation costs of the new water services.

Council has approved a total of 14 water license requests from Mile High Water since the Agreement became effective in June 2004. The dates of approval and corresponding addresses for these additional residential licenses are listed below:

- August 23, 2005 – 14730 Tejon Street
- December 20, 2005 – 1622 West 152nd Avenue
- September 12, 2006 – 1165 West 154th Avenue
- June 26, 2007 – 1990 West 150th Avenue
- September 11, 2018 - 15485 Lipan Street
- May 21, 2019 - 14614 Benton Street, 1780 West 152nd Avenue, and 2001 West 156th Avenue
- March 29, 2022 - 14540 Tejon Street
- April 12, 2022 - 15229 Navajo Street
- November 1, 2022 - 14975 Tejon Street
- May 14, 2024 - 12756 Polo Place
- August 13, 2024 - 14892 Kalamath Court, and 942 W. 149th Ave.

Proposed Resolution No. 2025-146 would approve Mile High Water Company's request for one (1) three-quarter-inch tap equivalent water license for the residential property located at 1350 W. 152nd Street, Broomfield, CO 80023.

Financial Considerations

Pursuant to the terms of the Agreement, Mile High Water Company must pay one and one-half times the current Broomfield residential water license fee of $37,850, which totals $56,775. If Council approves the request, and Mile High Water Company purchases the water licenses, $56,775 in revenues will accrue to Broomfield's Water Fund.

Prior Council or Other Entity Actions

On June 1, 2004, Council approved Resolution No. 2004-105 approving a Water Service Agreement with Mile High Water Company.

- On August 23, 2005, Council approved Resolution No. 2005-135 for 14730 Tejon Street
  - On December 20, 2005, Council approved Resolution No. 2005-183 for 1622 West 152nd Avenue
  - On September 12, 2006, Council approved Resolution No. 2006-120 for 1165 West 154th Avenue

- On June 26, 2007, Council approved Resolution No. 2007-102 for 1990 West 150th Avenue
- On September 11, 2018, Council approved Resolution No. 2018-163 for 15485 Lipan Street
- On May 21, 2019, Council approved Resolution No. 2019-128 for 14614 Benton Street, 1780 West 152nd Avenue, and 2001 West 156th Avenue
- On March 29, 2022, Council approved Resolution No. 2022-49 for 14540 Tejon Street
- On April 12, 2022, Council approved Resolution No. 2022-54 for 15229 Navajo Street
- On November 1, 2022, Council approved Resolution No. 2022-130 for 14975 Tejon Street
- On May 14, 2024, Council approved Resolution No. 2024-49 for 12756 Polo Place
- On August 13, 2024, Council approved Resolution No. 2024-98 for 14892 Kalamath Court, and 942 W. 149th Ave.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

If Council desires to approve the request, the appropriate motion is...

That Resolution 2025-146 be adopted.

Alternatives

Do not approve Mile High Water Company's request for the water license.

RESOLUTION NO. 2025-146

A resolution approving the Issuance of a Water License to Mile High Water Company

Be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

That the City and County Manager or a designee thereof is authorized to issue one additional three-quarter-inch tap equivalent water license to Mile High Water Company for the benefit of the property located at 1350 W. 152nd Street, Broomfield, CO 80023.

Section 2.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

C. Resolution - Assignment of 2025 Private Activity Bonds (PAB) to the Broomfield Housing Alliance (BHA)

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Consent Items Item: 6C.

Presented By
Lisa Sacker, Housing Programs Manager

Community Goals
☑ Thriving, Diverse, Safe and Welcoming Community

Overview

View Correspondence
View Presentation

Resolution 2025-149 follows up on the approval of Resolution 2025-117 to carry forward and assign $5,016,731 in Private Activity Bonds (PAB) to Broomfield Housing Alliance (BHA) for future affordable housing projects.

Attachments

Memo - Assigning PAB to BHA
Resolution No. 2025-149
CCOB Assignment of PAB Allocation Agmt (2025 carryforward) - incl all edits_Signed by BHA_10.10.25.pdf
DOLA Notice of Assignment of PAB.pdf
Attorney Certificate - PAB Assignment

Assigning PAB Carry Forward to Broomfield Housing Alliance
Prepared By: Lisa Sacker, Housing Programs Manager and Sharon Tessier, Housing Policy Manager

Summary

View Correspondence
View Presentation

This memo continues the administrative process of assigning an issuer for Broomfield's 2025 Private Activity Bond (PAB) allocation. On Sept 9, 2025, the Broomfield City Council passed Resolution 2025-117 to carry forward all of the 2025 PAB allocation in the amount of $5,016,731 with the intention of assigning the PABs to Broomfield Housing Alliance (BHA). The resolution allows the City and County of Broomfield to retain control of the allocation for future affordable housing projects. If not for this assignment process, Broomfield's PAB allocation will return to the statewide pool. The BHA Board approved BHA serving as an issuer of bonds at its board meeting on Sept 24, 2025. Resolution 2025-149 continues the administrative process of assigning Broomfield's PAB allocation to BHA.

Financial Considerations

This administrative action, carrying a minimal staff and administrative expense, does not obligate Broomfield to issue any bonds or pledge its credit. The assignment of PAB allocation to BHA has no direct financial impact on Broomfield's budget.

Prior Council or Other Entity Actions

September 09, 2025 Resolution 2025-117 Authorizing the Carry Forward Unused 2025 PAB Allocation

September 10, 2024 Resolution No 2024-128 Authorizing the Assignment of Broomfield 2024 PAB Allocation

August 8, 2023 Resolution No 2023-102- Authorizing the Assignment of Broomfield's 2023 PAB Allocation

September 13, 2022 Resolution 2022-122- Authorizing the Assignment of Broomfield's 2022 PAB Allocation

September 12, 2017 - Resolution 2017-137 Authorizing the assignment of the City and County of Broomfield's

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

If Council desires to proceed with assigning the 2025 PAB allocation to BHA, the appropriate motion is...

That Resolution 2025-149 be adopted.

Alternatives

Do not approve the assignment and return the 2025 PAB allocation to the Colorado Housing Finance Authority (CHFA) to use at its discretion.

RESOLUTION NO. 2025-149

A resolution transferring Broomfield's 2025 Private Activity Bond Allocation to the Broomfield Housing Alliance

Recitals.

Whereas, the City and County of Broomfield, Colorado ("City") is authorized and empowered under the laws of the State of Colorado ("State") to issue revenue bonds for the purpose of financing qualified residential rental projects for low- and moderate-income persons and families or providing single-family mortgage loans to low- and moderate-income persons and families; and

Whereas, the Internal Revenue Code of 1986, as amended ("Code") restricts the amount of tax-exempt bonds ("Private Activity Bonds") which may be issued in the State for such purposes; and

Whereas, pursuant to the Code, the Colorado General Assembly adopted the Colorado Private Activity Bond Ceiling Allocation Act, Part 17 of Article 32 of Title 24, Colorado Revised Statutes ("Allocation Act") providing for the allocation of the State Ceiling (as defined in the Allocation Act) among the Colorado Housing and Finance Authority and other governmental units in the State, such as local housing authorities such as the Housing Authority of the City and County of Broomfield, d/b/a the Broomfield Housing Alliance ("BHA"), and further providing for the assignment or delegation of such allocations from such other governmental units among each other; and

Whereas, pursuant to an allocation under C.R.S. § 24-32-1706, the City received an allocation of the 2025 State Ceiling in the amount of $5,016,731 for the issuance of a specified principal amount of Private Activity Bonds prior to September 15, 2025 (the "2025 Allocation"); and

Whereas, pursuant to the Allocation Act, the City Council (the "Council") adopted Resolution No. 2025-117 and elected to carry forward the 2025 Allocation to support the financing of long-term affordable rental or transitional housing and the City provided notice to the Department of Local Affairs of such carryforward election on or prior to September 15, 2025; and

Whereas, the Council hereby determines that, in order to increase the availability of adequate affordable housing for low- and moderate-income persons and families within the City, it is desirable to provide for the utilization of all or a portion of the 2025 Allocation (the "Allocation"); and

Whereas, the Council hereby determines that the Allocation can be utilized most efficiently by transferring the Allocation to the BHA to issue Private Activity Bonds for the

purpose of financing one or more multifamily rental housing projects for low- and moderate-income persons and families (the "Project"); and

Whereas, in order to assist in the financing of the Project, the Council hereby determines it in the City's best interest to assign the City's 2025 Allocation of $5,016,731 to BHA pursuant to an Assignment of Allocation between the City and BHA ("Assignment of Allocation"); and

Whereas, the Council has identified as a priority the need to address the acute shortage of housing in the community.

Now, therefore, be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

The assignment to BHA of all $5,016,731 of the City's 2025 Allocation is hereby approved. The assignment to BHA is made by the City without receipt of monetary consideration.

Section 2.

The form and substance of the Assignment of Allocation Agreement presented to the Council is approved; provided, however, that the City Attorney is authorized to make such technical variations, additions or deletions in or to such Assignment of Allocation Agreement as shall be deemed necessary or appropriate and not inconsistent with the approval thereof by this resolution. The execution of the Assignment shall be conclusive evidence of the approval by the City of such document in accordance with the terms hereof.

Section 3.

The Mayor is hereby authorized to execute (via manual or electronic signature) the Assignment of Allocation Agreement on behalf of the City. The officers and employees of the City are hereby authorized and directed to take all action necessary or appropriate to effectuate the provisions of this resolution and such Assignment of Allocation Agreement, including any amendments thereto and certificates not inconsistent with this resolution.

Section 4.

If any section, paragraph, clause, or provision of this resolution shall for any reason be held to be invalid or unenforceable, the invalidity or unenforceability of such section, paragraph, clause, or provision shall not affect any of the remaining provisions of this resolution.

Section 5.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

KKH

_____

City and County Attorney

Docusign Envelope ID: DDBCA03E-A685-48A7-9DA3-DFBAF73A2714

Assignment of Allocation Agreement

This Assignment of Allocation Agreement (this "Agreement") is made and entered as of October 28, 2025, between the City and County of Broomfield, Colorado (the "City" or "Assignor"), a home rule city and county of the State of Colorado (the "State"), and the Housing Authority of the City and County of Broomfield, Colorado, d/b/a Broomfield Housing Alliance, a public body corporate and politic doing business as the Broomfield Housing Alliance (the "Authority" or "Assignee"), a body corporate and politic.

Recitals

A. The Assignee intends to finance one or more multifamily rental housing projects for low - and moderate- income persons and families (the "Project"). The Project will be designed to qualify as a "project" within the meaning of Title 29, Article 4, Part 2, Colorado Revised Statutes, as amended (the "Act").

B. The Assignee intends to provide for the issuance of one or more series of multi-family housing revenue bonds, notes or other obligations (the "Proposed Bonds"), pursuant to the provisions of the Act for the purpose of financing the Project.

C. The Assignor has been previously notified that, pursuant to Section 24-32-1706 of the Colorado Private Activity Bond Ceiling Allocation Act, Part 17 of Article 32 of Title 24, Colorado Revised Statutes, as amended (the "Allocation Act"), it has an allocation of a portion of the State Ceiling (as defined in the Allocation Act) for 2025 in the amount of $5,016,731.

D. The Assignee, pursuant to a resolution adopted by the Board of Commissioners of the Assignee on October 22, 2025, declared its intention to accept the assignment and take all steps necessary or advisable to effect the issuance of the Proposed Bonds for the financing of the Project.

E. The Assignee has requested that the Assignor assign to the Assignee all $5,016,731 of the Assignor's 2025 allocation under the bond ceiling for the State of Colorado and its issuing authorities (the "State Ceiling") computed under Section 146(d) of the Internal Revenue Code of 1986, as amended (the "Code") as provided for the Assignor as a "designated local issuing authority" under the Allocation Act, for use in connection with the financing of the Project.

F. Subject to the terms and conditions set forth herein, the Assignor desires to assign to the Assignee, and the Assignee desires to accept, $5,016,731 of the Assignor's 2025 allocation from the State Ceiling, which allocation the Assignor has committed and reserved for the Project.

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Assignment

In exchange for the agreements set forth herein and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties hereto agree as follows:

1. The Assignor hereby assigns and transfers to the Assignee, the Assignor's 2025 allocation from the State Ceiling for private activity bonds in an amount equal to $5,016,731 for the purpose of issuing the Proposed Bonds to finance the Project. The Assignor and the Assignee understand that such assigned allocation shall automatically be relinquished to the "Statewide Balance" as defined under the Allocation Act unless Section 24-32-1706(3)(c), C.R.S., applies. For the avoidance of doubt, the City Council of the Assignor adopted Resolution No. 2025-117 and elected to carry forward its 2025 allocation to support the financing of long-term affordable rental or transitional housing, and the Assignor provided notice of such carryforward election on or prior to September 15, 2025.

2. The Assignor represents that it has received no monetary consideration for the assignment set forth above.

3. The Assignee hereby:

a. accepts the assignment of all $5,016,731 of the Assignor's 2025 allocation from the State Ceiling described above; and

b. agrees to abide by each of the terms and conditions of this Assignment and applicable provisions of the Allocation Act in connection with the use of such allocation; and

c. Agrees to use its best efforts to issue and use the Proposed Bonds for the purpose of financing the Project.

4. The Assignor hereby consents to the election by the Assignee, if the Assignee in its discretion so decides, to treat all or any portion of the assignment set forth herein as an allocation for a project or projects with a carryforward purpose within the meaning of the Allocation Act and the Code.

5. This Assignment shall not constitute the debt or indebtedness or financial obligation of the Assignor within the meaning of the constitution or statutes of the State of Colorado nor give rise to a pecuniary liability or charge against the general credit or taxing power of the Assignor.

6. This Assignment may be simultaneously executed in several counterparts, each of which shall be an original and all of which shall constitute but one and the same instrument. To the fullest extent permitted by applicable law, facsimile or electronically transmitted signatures shall be treated as original signatures for all purposes hereunder.

7.

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IN WITNESS WHEREOF, the Assignor and the Assignee have caused this instrument to be executed to be effective as of the date and year first written above.

City and County of Broomfield

By: _____
Guyleen Castriotta, Mayor

Approved as to form:

NCR

_____
City and County Attorney

Housing Authority of the City and County of Broomfield, Colorado, d/b/a Broomfield Housing Alliance, a public body corporate and politic doing business as the Broomfield Housing Alliance

By: Kristin Hyser
_____
Kristin Hyser, Executive Director

(Signature page to Assignment of Allocation Agreement)

Certificate Of Completion

Envelope Id: DDBCA03E-A685-48A7-9DA3-DFBAF73A2714 Status: Completed

Subject: Complete with Docusign: CCOB Assignment of Allocation Agreement (2025 carryforward) - incl of a...

Source Envelope:

Document Pages: 3 Signatures: 1 Envelope Originator:

Certificate Pages: 4 Initials: 0 Lisa Sacker

AutoNav: Enabled 1 DesCombes Dr

EnvelopeId Stamping: Enabled Broomfield, CO 80020

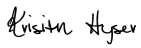
Time Zone: (UTC-07:00) Mountain Time (US & Canada) lsacker@broomfield.org

IP Address: 208.184.21.6

Record Tracking

Status: Original Holder: Lisa Sacker Location: DocuSign

10/10/2025 2:30:20 PM lsacker@broomfield.org

Signer Events	Signature	Timestamp
Krisitn Hyser khyser@broomfieldhousingalliance.org Executive Director Housing Authority of the City and County of Broomfield DBA Broomfield Housing Alliance Security Level: Email, Account Authentication (None) **Electronic Record and Signature Disclosure:** Accepted: 9/1/2023 10:21:13 AM ID: f253a992-1282-48a0-8af8-73f872b6034b	 Signature Adoption: Pre-selected Style Using IP Address: 97.122.233.222	Sent: 10/10/2025 2:39:44 PM Viewed: 10/10/2025 2:40:02 PM Signed: 10/10/2025 2:40:16 PM

In Person Signer Events	Signature	Timestamp

Editor Delivery Events	Status	Timestamp

Agent Delivery Events	Status	Timestamp

Intermediary Delivery Events	Status	Timestamp

Certified Delivery Events	Status	Timestamp

Carbon Copy Events	Status	Timestamp

Witness Events	Signature	Timestamp

Notary Events	Signature	Timestamp

Envelope Summary Events	Status	Timestamps
Envelope Sent	Hashed/Encrypted	10/10/2025 2:39:44 PM
Certified Delivered	Security Checked	10/10/2025 2:40:02 PM
Signing Complete	Security Checked	10/10/2025 2:40:16 PM
Completed	Security Checked	10/10/2025 2:40:16 PM

Payment Events	Status	Timestamps

Electronic Record and Signature Disclosure

ELECTRONIC RECORD AND SIGNATURE DISCLOSURE

From time to time, City and County of Broomfield (we, us or Company) may be required by law to provide to you certain written notices or disclosures. Described below are the terms and conditions for providing to you such notices and disclosures electronically through the DocuSign system. Please read the information below carefully and thoroughly, and if you can access this information electronically to your satisfaction and agree to this Electronic Record and Signature Disclosure (ERSD), please confirm your agreement by selecting the check-box next to 'I agree to use electronic records and signatures' before clicking 'CONTINUE' within the DocuSign system.

Getting paper copies

At any time, you may request from us a paper copy of any record provided or made available electronically to you by us. You will have the ability to download and print documents we send to you through the DocuSign system during and immediately after the signing session and, if you elect to create a DocuSign account, you may access the documents for a limited period of time (usually 30 days) after such documents are first sent to you. After such time, if you wish for us to send you paper copies of any such documents from our office to you, you will be charged a $0.00 per-page fee. You may request delivery of such paper copies from us by following the procedure described below.

Withdrawing your consent

If you decide to receive notices and disclosures from us electronically, you may at any time change your mind and tell us that thereafter you want to receive required notices and disclosures only in paper format. How you must inform us of your decision to receive future notices and disclosure in paper format and withdraw your consent to receive notices and disclosures electronically is described below.

Consequences of changing your mind

If you elect to receive required notices and disclosures only in paper format, it will slow the speed at which we can complete certain steps in transactions with you and delivering services to you because we will need first to send the required notices or disclosures to you in paper format, and then wait until we receive back from you your acknowledgment of your receipt of such paper notices or disclosures. Further, you will no longer be able to use the DocuSign system to receive required notices and consents electronically from us or to sign electronically documents from us.

All notices and disclosures will be sent to you electronically

Unless you tell us otherwise in accordance with the procedures described herein, we will provide electronically to you through the DocuSign system all required notices, disclosures, authorizations, acknowledgements, and other documents that are required to be provided or made available to you during the course of our relationship with you. To reduce the chance of you inadvertently not receiving any notice or disclosure, we prefer to provide all of the required notices and disclosures to you by the same method and to the same address that you have given us. Thus, you can receive all the disclosures and notices electronically or in paper format through the paper mail delivery system. If you do not agree with this process, please let us know as described below. Please also see the paragraph immediately above that describes the consequences of your electing not to receive delivery of the notices and disclosures electronically from us.

How to contact City and County of Broomfield:

You may contact us to let us know of your changes as to how we may contact you electronically, to request paper copies of certain information from us, and to withdraw your prior consent to receive notices and disclosures electronically as follows:

To advise City and County of Broomfield of your new email address

To let us know of a change in your email address where we should send notices and disclosures electronically to you, you must send an email message to us at info@broomfield.org and in the body of such request you must state: your previous email address, your new email address. We do not require any other information from you to change your email address.

If you created a DocuSign account, you may update it with your new email address through your account preferences.

To request paper copies from City and County of Broomfield

To request delivery from us of paper copies of the notices and disclosures previously provided by us to you electronically, you must send us an email to info@broomfield.org and in the body of such request you must state your email address, full name, mailing address, and telephone number. We will bill you for any fees at that time, if any.

To withdraw your consent with City and County of Broomfield

To inform us that you no longer wish to receive future notices and disclosures in electronic format you may:

i. decline to sign a document from within your signing session, and on the subsequent page, select the check-box indicating you wish to withdraw your consent, or you may;

ii. send us an email to it-devops@broomfield.org and in the body of such request you must state your email, full name, mailing address, and telephone number. We do not need any other information from you to withdraw consent.. The consequences of your withdrawing consent for online documents will be that transactions may take a longer time to process..

Required hardware and software

The minimum system requirements for using the DocuSign system may change over time. The current system requirements are found here: https://support.docusign.com/guides/signer-guide-signing-system-requirements.

Acknowledging your access and consent to receive and sign documents electronically

To confirm to us that you can access this information electronically, which will be similar to other electronic notices and disclosures that we will provide to you, please confirm that you have read this ERSD, and (i) that you are able to print on paper or electronically save this ERSD for your future reference and access; or (ii) that you are able to email this ERSD to an email address where you will be able to print on paper or save it for your future reference and access. Further, if you consent to receiving notices and disclosures exclusively in electronic format as described herein, then select the check-box next to 'I agree to use electronic records and signatures' before clicking 'CONTINUE' within the DocuSign system.

By selecting the check-box next to 'I agree to use electronic records and signatures', you confirm that:

- You can access and read this Electronic Record and Signature Disclosure; and
- You can print on paper this Electronic Record and Signature Disclosure, or save or send this Electronic Record and Disclosure to a location where you can print it, for future reference and access; and
- Until or unless you notify City and County of Broomfield as described above, you consent to receive exclusively through electronic means all notices, disclosures, authorizations, acknowledgements, and other documents that are required to be provided or made available to you by City and County of Broomfield during the course of your relationship with City and County of Broomfield.

October 28, 2025

VIA EMAIL

Elisa Blakeny
Colorado Department of Local Affairs
Division of Housing
1313 Sherman Street, Room 320
Denver, Colorado 80203

Eml: elisa.blakeney@state.co.us

NOTIFICATION OF ASSIGNMENT OF PRIVATE ACTIVITY BOND CEILING

Dear Ms. Blakeny:

Pursuant to Section 24-32-1706(2) of the Colorado Private Activity Bond Ceiling Allocation Act, I hereby notify you of the assignment by the City and County of Broomfield, Colorado (the "City") to the Housing Authority of the City and County of Broomfield, d/b/a Broomfield Housing Alliance of all $5,016,731 of the 2025 allocation of the State's private activity bond ceiling. The City previously notified you of the carryforward allocation in connection with such allocation on September 11, 2025.

Enclosed for your records is an executed copy of the Assignment of Allocation (the "Assignment"), dated October 28, 2025. As stated in Section 2 of the Assignment, the City has received no monetary consideration for the assignment.

CITY AND COUNTY OF BROOMFIELD, COLORADO

Guyleen Castriotta
City and County of Broomfield, Mayor

Enc.

Certificate of the City and County of Broomfield, Colorado Concerning the Assignment of Private Activity Bond Volume Cap Allocation

I, the undersigned, hereby certify that I am a duly chosen, qualified, and City and County Attorney of the City and County of Broomfield, Colorado (the "City"), and that:

1. The City is a public body politic and corporate, duly organized and existing under the constitution and laws of the State of Colorado.

2. The City has been previously notified that, pursuant to Section 24-32-1706 of the Colorado Private Activity Bond Ceiling Allocation Act, Part 17 of Article 32 of Title 24, Colorado Revised Statutes (the "Allocation Act"), it has an allocation of the State ceiling (as defined in the Allocation Act) for 2025 in the amount of $5,016,731 (the "2025 Allocation"), which the City elected to carryforward under the Allocation Act pursuant to a notice to the Department of Local Affairs on or prior to September 15, 2025.

3. Attached hereto as Exhibit A is a true and correct copy of a resolution and the related minutes thereto (the "Resolution") authorizing the assignment to the Housing Authority of the City and County of Broomfield, d/b/a Broomfield Housing Alliance (the "Authority") of all of the 2025 Allocation in an amount equal to $5,016,731 (the "Assigned Allocation"), and authorizing the execution and delivery of an Assignment of Allocation dated as of October 28, 2025 (the "Assignment of Allocation") between the City and the Authority in connection therewith, which Resolution was duly adopted by the City Council of the City (the "City Council") at a meeting thereof held October 28, 2025 at which meeting a quorum was present and acting throughout and which Resolution has not been revoked, rescinded, repealed, amended or modified and is in full force and effect on the date hereof.

4. The meeting of the City Council at which action has been taken with respect to the Assignment of Allocation was a regular meeting properly called and open to the public at all times.

5. With respect to the Assigned Allocation, the City has not heretofore: (a) issued private activity bonds; (b) assigned the Assigned Allocation to another "issuing authority," as defined in the Allocation Act; (c) made a mortgage credit certificate election; or (d) other than as described above, treated the Assigned Allocation as an allocation for any other project with a carryforward purpose, as defined in the Allocation Act.

6. The Assignment of Allocation, attached hereto as Exhibit B, is in the form presented to and approved by the City Council at the meeting thereof held on October 28, 2025.

7. On or before the date hereof, counterparts of the Assignment of Allocation were officially executed by the Mayor and the City Clerk of the City. On the date of such signing, such persons were the duly sworn, qualified, and acting officers of the City authorized to execute the Assignment of Allocation and holding the offices of the Mayor and City Clerk, respectively.

8. The City has authorized the execution, delivery and due performance of the Assignment of Allocation, and the execution and delivery of the Assignment of Allocation and the compliance by the City with the provisions thereof, will not, to the best of my knowledge, conflict with or constitute on the part of the City a breach of or a default under any existing Colorado law, City resolution, court or administrative regulation, decree or order or any agreement or other instrument to which the City is subject or by which it is bound.

9. To the best of my knowledge, there does not exist any action, suit, proceeding or investigation pending, or threatened against the City, contesting (a) the corporate existence of the City, (b) the title of its present officers or any of them to their respective offices, including, without limitation, the members of the City Council, (c) the validity of the Assignment of Allocation or (d) the power of the City to execute, deliver or perform the Assignment of Allocation.

10. No referendum petition has been filed concerning the Resolution; and to the best of my knowledge, none is being circulated or planned for circulation.

WITNESS my hand and the seal of the City this October 28, 2025.

NCR

_____

Nancy Rodgers, City and County Attorney

(SEAL)

EXHIBIT A

RESOLUTION

1 = 4 DocID

EXHIBIT B

ASSIGNMENT OF ALLOCATION

2 = 4 DocID

City and County of Broomfield

City Council Regular Meeting

D. Resolution - Board of Equalization (BOE) - Appointing Daisy Glassburn as an Arbitrator

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Consent Items Item: 6D.

Presented By
Crystal Clemens, City Clerk

Community Goals

Overview

View Correspondence
View Presentation

Resolution 2025-147-BOE appointing Daisy Glassburn as an arbitrator to conduct property valuation appeal hearings in accordance with section 2-66-080(A) of the Broomfield Municipal Code

Attachments

Memo for appointing Glassburn as BOE Arbitrator.pdf
Resolution 2025-147-BOE.pdf

Memo for Appointing a Board of Equalization Arbitrator
Prepared By: Crystal Clemens, City and County Clerk and Recorder

Summary

View Correspondence
View Presentation

Staff is requesting that Council, sitting as the Board of Equalization, appoint a new arbitrator, Daisy Glassburn to the list of arbitrators available to hear property tax appeals.

Financial Considerations

Sources and Uses of Funds	Amount
BOE Professional Services 02-14400-53170	$10,000
Hearing Officers	-$8,000
Arbitrators	-$2,000
Projected Balance	**$0**

Prior Council or Other Entity Actions

On February 13, 2024, Council approved Ordinance 2225 transferring the Board of Equalization (BOE) duties from a separate resident board to Council.

Boards and Commissions Prior Actions and Recommendations

Resolution 2024-41 re-appointing BOE hearing officers, appointing an additional hearing officer and two additional BOE arbitrators

Proposed Actions / Recommendations

If Council desires to appoint Daisy Glassburn as an arbitrator, the motion is . . .

That Resolution 2025-147-BOE be adopted.

Alternative

Not appoint Daisy Glassburn as an arbitrator and rely upon the services of the existing arbitrators currently approved by Council.

Background

On February 13, 2024, Council approved Ordinance 2225 transferring the Board of Equalization (BOE) duties from a separate resident board to Council. The previously appointed citizen Board of Equalization in the

past appointed hearing officers to assist with the annual property valuation protests that happen each year in July.

Arbitrators Generally

In accordance with Colorado Revised Statutes and the Broomfield Municipal Code 2-66-020, decisions of the Broomfield Board of Equalization (BOE) regarding property values can be appealed to the Colorado Board of Assessment Appeals, District Court, or binding arbitration at the option of the taxpayer. If a taxpayer chooses arbitration, an arbitrator is selected by mutual agreement of the taxpayer and the City from a list of arbitrators established by Council. The arbitrator then conducts a hearing at which the property owner and the Broomfield Assessor, on behalf of the Board of Equalization, provide evidence as to the appropriate value of the property in question. The decision of the arbitrator is binding and no further appeals are available to the taxpayer. Each arbitrator selected by Council will enter into a contractual agreement with the City and County of Broomfield which remains in effect unless terminated by either party upon 10 days written notice. Note: The appointment of arbitrators has always been completed by Council and this process has not been impacted by the transition of BOE duties to Council.

Section 2-66-020 BMC requires that arbitrators selected have experience in the area of property taxation and may be any of the following:

- An attorney licensed to practice law in the state;
- An appraiser who is a member of the institute of real estate appraisers or its equivalent;
- A former county assessor;
- A retired judge; or
- A licensed real estate broker.

The method of payment for arbitrators is set forth in C.R.S. 39-8-108.5 and arbitrators' expenses and fees may not exceed $150 for appeals concerning residential real property. For cases concerning personal property and commercial real property the arbitrators' expenses and fees are an amount agreed upon by the taxpayer and the Board of Equalization and are paid as provided in the arbitrator's decision. The Assessor's Office represents the county board of equalization at arbitration hearings. Staff currently has a list of 5 arbitrators to provide hearing services.

New Appointment

Staff has received the resume of Daisy Glassburn who is experienced in property tax valuations, who would be willing to serve as an arbitrator for Broomfield, and who would qualify to act as an arbitrator under the provision of the BMC cited above. Ms. Glassburn currently provides protest hearing services to the City as a hearing officer.

Staff recommends that Daisy Glassburn be named by the Council to act as an arbitrator of property valuation disputes. While the City currently has five arbitrators appointed, scheduling with these individuals can be challenging; as a result, it is helpful to have an additional arbitrator appointed and available.

RESOLUTION NO. 2025-147-BOE

A resolution appointing an arbitrator to conduct property valuation appeal hearings

Recitals.

A. Pursuant to Chapter 2-66 of the Broomfield Municipal Code, B.M.C, the Board of Equalization of the County of Broomfield (BOE) was created to hear appeals from the Broomfield County Assessor's determinations regarding valuations for assessment in accordance with state law.

B. Pursuant to B.M.C. 2-66-020, City Council/BOE shall develop a list of persons who are qualified to act as arbitrators of property valuation disputes.

Be it resolved by the city council of the City and County of Broomfield, Colorado:

Section 1.

That Daisy Glassburn be appointed to the list of arbitrators to be selected for the conduct of property valuation appeal hearings in accordance with §2-66-020(A) of the Broomfield Municipal Code, subject to Ms. Glassburn signing an agreement to provide arbitrator services in a form acceptable to the City and County Attorney's office.

Section 2.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025.

The City and County of Broomfield, Colorado

_____
Mayor

Attest:

_____
Office of the City and County Clerk

Approved As To Form:

NCR

_____
City and County Attorney

BROOMFIELD CITY COUNCIL

To: Mayor and City Council
From: Jennifer Hoffman, City and County Manager
Presented By: Nancy Rodgers

Meeting Date: Tuesday, October 28, 2025, 6:00 PM
Agenda Category: Consent Items
Agenda Item: 6E.
Subject: Executive Session Request for Legal Advice Related to a Conservation Easement

Goals: N/A

Overview

View Correspondence
View Presentation

The City and County Attorney's office requests Council hold an executive session for the purpose of obtaining legal advice about potential litigation involving a conservation easement. The executive session is proposed for November 18, 2025 to take place immediately following the regular council meeting.

Attachments

Executive Session Request for Legal Advice Related to a Conservation Easement .pdf

Memo for Request for Executive Session for Legal Advice re litigation regarding a conservation easement
Prepared By: Nancy Rodgers, City and County Attorney; Pat Gilbert, Deputy City and County Attorney

Summary

View Correspondence
View Presentation

The City and County Attorney's office requests Council hold an executive session for the purpose of obtaining legal advice about potential litigation involving a conservation easement in the Varra South Subdivision. The executive session is proposed for November 18, 2025, to take place immediately following the regular council meeting.

An executive session is permitted under C.R.S. § 24-6-402(4)(b) and requires an affirmative vote of 2/3rds of the quorum present.

The open meetings provision of the Colorado Sunshine Act of 1972 (Act) requires that any local public body announce in public the topic for discussion for the executive session. In addition, the local public body must include the specific citation in the Act that authorizes the local public body to meet in executive session. The local public body must also identify the particular matter to be discussed in as much detail as possible without compromising the purpose for which the executive session is authorized. C.R.S. § 24-6-402(4).

Executive sessions are electronically recorded. The record of an executive session must also state the specific citation in the Act authorizing the executive session. Portions of an executive session that are purely for purposes of obtaining legal advice do not need to be recorded.

Financial Considerations

N/A

Prior Council or Other Entity Actions

N/A

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

Based on the above, it is recommended that Council approve, by 2/3rds vote, the following motion …

> That the City Council schedule an executive session to be held on November 18, 2025 immediately after Council's regular council meeting, for the purpose of obtaining legal advice regarding litigation involving a conservation easement as permitted by C.R.S. § 24-6-402(4)(b).

Alternatives

Deny motion and not schedule the executive session.

City and County of Broomfield

City Council Regular Meeting

A. Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7A.

Presented By
Graham Clark, Director of Finance

Community Goals

Overview

View Correspondence
View Presentation

The purpose of this memo is to present financial information related to the second amendment of the 2025 City and County of Broomfield and the Broomfield Urban Renewal Authority Budgets, financial information related to the proposed 2026 budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District, information related to the proposed increases to utility rates for the Broomfield Enterprise Funds, information related to the proposal of two enterprise revenue bonds and police building and courts remodel certificate of participation, and information related to the Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) programs.

Attachments

Memo for 10_28_2025_2nd Amd to 2025 Budget; Adoption of 2026 Budget (CCOB, BURA, ALID); Utility Rates Ord; URAF; PPTR; Bond Ords.pdf
Resolution 2025-141 2nd Amd to 2025 Budget (CCOB).pdf
Resolution 2025-142 2026 Budget Adoption (CCOB).pdf

Memo for 2nd Amendment to the 2025 Budget and Adoption of the 2026 CCOB, BURA, and ALID Budgets; second reading of amending water, sewer, reclaimed water and stormwater rate ordinance; second reading of two enterprise revenue bonds and police building certificate of participation ordinances; URAF and PPTR programs for 2026
Prepared By: J. Stephanie Chen, Budget Manager

Summary

View Correspondence
View Presentation

Comprehensive Budget Process

The City and County of Broomfield's budget development is a comprehensive, year-long process designed to ensure fiscal responsibility, transparency, and meaningful community and Council engagement. This memorandum represents the culmination of extensive collaborative work that has unfolded throughout 2025, with multiple touchpoints providing City Council and the community opportunities to review, discuss, and shape the financial direction of our organization. This deliberate, methodical approach ensures that budget decisions are informed by current data, community needs, economic conditions, and strategic priorities while maintaining the highest standards of transparency and public accountability.

The Governmental Accounting Standards Board (GASB) sets the accounting and financial reporting standards that state and local governments must follow. Its purpose is to ensure that financial statements are consistent, transparent, and useful to the public, elected officials, and oversight bodies. GASB standards help governments show how public funds are managed, spent, and accounted for, promoting accountability and public trust. Our Broomfield budgets are built using GASB standards, which means our financial reporting and budgeting processes follow the same professional principles used nationwide to ensure accuracy, consistency, and transparency in how we manage public resources.

Year-Long Budget Development Timeline

The 2026 budget process began in early 2025 and has included the following key milestones:

- January-March 2025: Initial financial forecasting and departmental needs assessment
- March 8, 2025: Council Focus Session - 2.C. Conditions of/and influences on Broomfield's economic and fiscal status, 2.H. Anticipated Development and the impacts on fiscal sustainability
- April 15, 2025: Council Study Session - First Quarterly Enterprise Funds Study Session - Council review of enterprise fund status, capital projects, maintenance programs, 2024 financial results, and long-term financial sustainability strategies
- May 8, 2025: Council Study Session - Early introduction to the 2026 budget process and year-to-date financial information
- July 15, 2025: Council Study Session - Second Quarterly Enterprise Funds Study Session - Council review of enterprise fund updates, development projections, and initial utility rate recommendations with subject matter expert consultant AECOM
- August 19, 2025: Council Study Session - Economic and Fiscal Update and Draft Operating and Capital Budgets Study Session - Comprehensive presentation to Council on Broomfield's economic and financial outlook, including CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments
- August 21, 2025: Community Briefing - Public presentation and opportunity for public questions on Economic Long Range Financial Plan and Financial Status Briefing
- September 3, 2025: City Council received the 2026 Proposed Budget and supporting documentation
- September 4, 2025: 2026 Proposed Budget and supporting documents made available for public review and comment on Broomfield.org/Finance
- September 18 and September 25, 2025: Budget Study Sessions with opportunities for public comment - 2026 Proposed Operating & Capital Budgets with department representatives
- October 14, 2025: City Council Meeting - Public Hearing per Chapter 12.7 of the Charter for the 2026

Operating and Capital Budgets, with first reading of key ordinances
- October 21, 2025: City Council Study Session - Final Quarterly Enterprise Funds update of 2025
- October 28, 2025: City Council Meeting - Second reading of ordinances and adoption of budgets (this meeting) with public hearing

Strategic Context and Fiscal Discipline

1. Financial Sustainability and Resilience - Ensuring Broomfield's long-term fiscal health in an uncertain economic environment
2. Transparency and Public Engagement - Providing multiple opportunities for community input and Council deliberation
3. Data-Driven Decision Making - Utilizing comprehensive financial modeling, economic forecasting, and historical analysis
4. Prioritization of Core Services - Focusing resources on mandates, obligations, and critical needs
5. Infrastructure Investment - Addressing deferred maintenance and preparing for future growth
6. Responsible Debt Management - Maintaining our strong credit rating while financing essential capital projects

Summary of Items for Consideration

The City and County of Broomfields budget includes all government operations as well as Enterprise Funds (Water, Sewer, Stormwater and Reuse). The proposed budgets and related documents were available for public review and comment on Broomfield.org/Finance on September 4, 2025.

The staff memorandum from October 14, 2025 regarding the public hearing for City and County of Broomfield (CCOB), Arista Local Improvement District (ALID), Broomfield Urban Renewal Authority (BURA) budgets; first reading of Ordinance No. 2286 amending water, sewer, reclaimed water and stormwater rate ordinance; first reading of two enterprise revenue bonds and police building certificate of participation ordinances (Ordinances No. 2288, 2289 and 2290), included a detailed discussion of the proposed resolutions and ordinances.

It is important to note that the proposed budget is consistent with the October 14, 2025 memorandum and initial proposed budget, with the exception of one change:

- The operational expenditures are expected to increase by 5.8% as opposed to 5.9% due to the combination of a reduction to the amount recommended for the District Attorney (DA) budget discussed during the hearing on October 14, 2025, and a small increase in the budget used for non-profit distributions under the Human Services Fund.

This change is specific to the proposed 2026 budget for CCOB and is reflected in Resolution 2025-142. It does not alter the proposed budgets for BURA or ALID, the water project agreements, enterprise rate ordinance, or any of the bond ordinances considered on first reading during the October 14, 2025 meeting.

The content of this staff memorandum is consistent with the October 14, 2025 memorandum, with additional information provided for the following:

- Information regarding the 2025R Budget - 2nd Amendment.
- Details regarding the non-residential utility rates and license fees for 2026 are provided to clarify what is included in Ordinance 2286 in response to questions from the October 14, 2025 meeting.
- Additional details regarding how the 2025 rate increase was utilized to directly improve water, sanitary sewer, and stormwater resources for Broomfield residents and businesses.
- Details regarding the Utility Rate Assistance Fund program for 2026 as proposed in Resolution No. 2025-153.
- Details regarding the Partial Property Tax Refund program for 2026 as proposed in Resolution No. 2025-154.

City and County of Broomfield Budget

2025 Budget - 2nd Amendment Summary

- The 2025 City and County budget has been amended one time since its adoption to reflect capital project rollovers, grant rollovers, and operational budget adjustments.
- The following attachments are included with this memo to provide fund level details of the 2025 revised budget adjustments. These tables referenced below reflect cumulative prior amendment #1, in addition to the new adjustments in this proposed second (2nd) amendment to the 2025 budget. Revenue and expenditure adjustments (increases and decreases) are also included for reference.
    - 2025 Revised Budget Summary - General Governmental Funds
    - 2025 Revised Budget Summary - Governmental Capital Funds
    - 2025 Revised Budget Summary - Governmental Debt Service Fund
    - 2025 Revised Budget Summary - Enterprise Funds
    - 2025 Revised Budget Summary - Fiduciary Funds
- The second proposed City and County amendment, Resolution No. 2025-141, sets the final 2025 amended budget to reflect expenditures of $775,190,595.

2026 Budget

- The 2026 Proposed City and County of Broomfield Budget has been prepared to reflect expected revenues and expenditures. A set of summary budget tables are included with the resolutions under consideration.
- The 2026 Proposed Budget for the City and County of Broomfield total expenditures are $844,125,005. This amount includes interfund activities and transfers to reserves.
- Tables 1A-4C summarize the 2026 Proposed Budget for the City and County of Broomfield.
- Proposed Resolution No. 2025-142, if adopted, would approve the 2026 Budget for the City and County.

Broomfield Urban Renewal Authority

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2025 Budget - 2nd Amendment Summary

- The proposed BURA budget amendment, Resolution No. 2025-143-UR, is the second amendment proposed since its adoption and reflects unexpended capital improvement project budgets, and revenue adjustments which impacts expense budgets since the adoption of the fiscal year 2025 budget.
    - The proposed BURA budget amendment also reflects a slight decrease in expenditures for a total of $57,118,701.
    - BURA Budget Tables summarize the 2025 revised budget for BURA.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for BURA. In some URAs, planned uses of fund balance are being used for capital expenditures. The BURA proposed total revenues for 2026 are $65,119,746, and the proposed total expenditures are $49,978,125.
    - Tables 1-13 summarize the 2026 Proposed Budget for the BURA.
    - Proposed Resolution No. 2025-144-UR, if adopted, would approve the 2026 Budget for the Broomfield Urban Renewal Authority.

Arista Local Improvement District

The Arista Local Improvement District (ALID) was established in August 2005 to facilitate the construction of transportation facilities in the Arista Development.

2025 Budget - 2nd Amendment Summary

- The 2025 ALID budgeted expenditures have not changed, therefore, no amendment is required at this time.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for the ALID. Attached is a copy of the budget message and budget tables for the ALID for the 2026 Proposed Budget. Anticipated total revenues for 2026 are $45,000. Proposed total expenditures for 2026 are $45,000.
    - Table 1 summarizes the 2026 Proposed Budget for ALID.
    - Proposed Resolution No. 2025-145-AID, if adopted, would approve the 2026 Budget for the Arista Local Improvement District.

Enterprise Rate Ordinance

City Council held quarterly enterprise study sessions on April 15, 2025, July 15, 2025, and October 21, 2025, to review staff's updates on the status of the enterprise funds. The April meeting covered capital projects, maintenance programs, 2024 financial results, steps for ensuring long-term financial sustainability, and the proposed Fiscal Leadership on Water (FLOW) Advisory Committee. The July meeting covered similar topics as well as an overview of development projections and future rate recommendations. The October meeting included an update regarding ongoing capital and maintenance programs for 2025, as well as a presentation from the FLOW Advisory Committee.

City Council also received updates on the Enterprise Funds during the Economic and Fiscal Update held at a Study Session on August 19, 2025. Topics addressed included CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments.

In 2025, the City and County of Broomfield implemented the first utility rate increase of a comprehensive five-year financial plan to address the financial sustainability of the enterprise funds. This increase was necessary as the costs of providing safe, reliable water service continued to rise due to aging infrastructure requiring increased maintenance and replacement, new regulatory requirements and unfunded mandates,

and a substantial backlog of critical system repairs and upgrades. Recognizing the financial burden this placed on residents, Council established the Utility Rate Assistance Fund (URAF) to help eligible households manage the impact.

The five-year plan includes a year two increase totaling $16.89 per month for the average single-family home (9,000 gallons) starting in 2026. Staff anticipates that continued adjustments in future years should be expected due to the annual application of the utility's long-range model, the criticality of ongoing infrastructure support, and to accommodate costs from unknown, but anticipated, state and federal mandates. The URAF to help eligible households remains in the budget for 2026, with minor adjustments.

Bond Ordinances

Police Building/Courts Remodel

This item is presented for the City Council's consideration and authorization to issue $100M in bonds to fund the Police Building/Courts Remodel. This financing utilizes Certificates of Participation (COPS), where the City will finance the project's construction by collateralizing existing City facilities via a Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, and Escrow Agreement. A Preliminary Offering Statement, Indenture, and Disclosure Certificate are also required. Selected facilities that will be borrowed against include Paul Derda Recreation Center, the Broomfield Community Center, the Detention Center, and the Service Center Administration Building. The anticipated maximum annual debt payment resulting from the financing will not exceed $7.9M and the annual payments will come from the City's general fund; however, the debt does not create a general obligation debt or multiple-year fiscal obligation, as the annual debt service payment is subject to annual appropriation.

As part of the 2023 property tax revenue increase, funding was designated to support the construction of the new Police building. In collaboration with our financial advisors, staff determined that using the set-aside property tax dollars to retire the 2017 Certificates of Participation (COPs) represents a sound long-term financial strategy. By applying these funds and coordinating the payoff of prior debt, the City can help offset the financial impact of issuing new debt for the upcoming Police and Courts facility. Recent credit rating upgrades and the City's strong financial position further reinforce confidence in our ability to manage debt responsibly.

The term of the financing will mature on or before December 31, 2047. The anticipated net effective interest rate will not exceed 5.50%. Additionally, as part of this financing, the City will also pay off its 2017 Certificates of Participation (COP) that have a current outstanding balance of $10.89M utilizing unencumbered cash on hand. The 2017 COPs were to mature on December 1, 2027. They were originally issued in 2010 to fund facilities needed to provide county services and for parks and recreation activities, and were refinanced in 2017.

Water Tanks

This item is presented for the City Council's consideration and authorization to issue $80M in Water Revenue bonds for funding the new water tanks. Broomfield's water system model identifies capital improvements that will be needed as Broomfield develops, including the construction of the proposed Water Tanks. The model specifically focuses on the phased development of the areas north of W. 144th Avenue that are quickly developing. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $5.9M and the term of the bonds will mature on or before December 1, 2047.
The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Water Activity Enterprise and does not impact the City's general fund. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement.

Related to the issuance of the Water Bonds, staff will be presenting to the City Council on October 28, 2025 as part of agenda item 7(G) - Water Tanks Construction Agreement, proposed Resolution No. 2025-152

authorizing the reimbursement to the water enterprise fund from bond proceeds (if needed) for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to award a construction contract up to the amount of the advanced funds and begin construction before the bonds' closing. It is expected that a construction contract will be presented to the City Council for approval in November and construction to begin on or about January 1, 2026. An amendment to the construction contract would then be presented to the City Council for approval once the bond proceeds are available for appropriation. Construction of the water tanks is projected to last 36 months.

Wastewater Treatment Facility Improvements

This item is presented for the City Council's consideration and authorization to issue $125M in Sewer Revenue and Refunding bonds for funding the Wastewater Treatment Facility Expansion. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $11M and the term of the bonds will mature on or before December 1, 2047. The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Sewer Activity Enterprise and does not impact the City's general fund. As a part of this financing, the City will also refund and discharge its 2012 Sewer Revenue Refunding Bonds with an outstanding balance of $15.315M that matures on December 1, 2031. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement.

The Wastewater Treatment Facility Improvements are being driven by expected future increases in population and regulatory requirements from the CDPHE that will require significant expansion to the current facility to adequately treat the increase in wastewater and maintain compliance with current and future regulatory requirements. Project drivers include capacity, asset renewal, biosolids, reuse, and regulation. Construction is to begin in 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

This memo will affirm and clarify the planned continuation of the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) programs into the 2026 fiscal year, as outlined in the proposed 2026 Budget for the City and County of Broomfield. These programs are designed first and foremost to support residents experiencing financial burden, while also serving as key components of the City's broader commitment to Council Goals, Financial Sustainability and Resilience, and Organizational Health.

The adjustments provide a summary of operational updates to ensure both programs remain efficient, fiscally responsible, and responsive to community needs within the budgeted resource allocations.

Financial Considerations

2025 Budget - 2nd Amendment

Resolutions 2025-141 and 2025-143-UR outline the financial considerations related to the second amendment to the 2025 budgets for both the City and County of Broomfield and Broomfield Urban Renewal Authority.

2026 Budget

Resolutions 2025-142, 2025-144-UR, and 2025-145-AID outline the financial considerations related to the adoption of the 2026 Budgets for the City and County of Broomfield, the Arista Local Improvement District, and the Broomfield Urban Renewal Authority.

Enterprise Ordinances

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees outlines the financial considerations related to this agenda item.

Bond Ordinances

Ordinance No. 2288 upon approval, authorizes debt financing of up to $80M for the Water Tanks and

approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement related thereto.

Ordinance No. 2289 upon approval, authorizes debt financing of up to $125M for the Wastewater Treatment Facility Improvements and approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement related thereto.

Ordinance No. 2290 upon approval, authorizes debt financing of up to $100M for the Police Building/ Courts Remodel and approves as to form the Preliminary Official Statement, Indenture, Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, Disclosure Certificate, Escrow Agreement related thereto.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

Resolution 2025-153 outlines the financial and programmatic considerations related to the Utility Rate Assistance Fund (URAF) Program.

Resolution 2025-154 outlines the financial and programmatic considerations related to the Partial Property Tax Refund (PPTR) Program.

Prior Council or Other Entity Actions

2025 Budget

October 22, 2024: Council approved Resolution 2024-149 adopting the 2025 CCOB Budget; BURA approved Resolution 2024-150-UR adopting the 2025 City and County of Broomfield Budget
March 11, 2025: Council approved Resolution 2025-44 amending the 2025 CCOB Budget; BURA approved Resolution 2025-52-UR amending the 2025 BURA Budget

2026 Budget

August 19, 2025: Staff provided information and insights to inform the Council on Broomfield's economic and financial outlook, influencing the 2025 revised budget and the 2026 operating and capital proposed budgets.
August 21, 2025: Staff provided an overview of how Broomfield intends to fulfill the community goal of financial sustainability and resilience at the Broomfield 101: Economic and Fiscal Update Community Forum.
September 3, 2025: The City Council received the 2026 Proposed Budget and supporting documentation.
September 4, 2025: The 2026 Proposed Budget and supporting documents were made available for public view and comments on the City's website.
September 18 and September 25, 2025: Study Sessions to discuss the 2026 Proposed Operating & Capital Budgets with department representatives.
October 14, 2025: Public Hearing per Chapter 12.7 of the Charter for the 2026 Operating and Capital Budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District.

Enterprise Ordinances

April 15, 2025: Staff held the first 2025 quarterly Enterprise Funds study session and provided an overview to City Council on the status of the enterprise funds.
May 13, 2025: Creation of FLOW Advisory Committee approved by City Council.
July 15, 2025: Staff held the second 2025 quarterly Enterprise Funds study session, providing an update on the enterprise funds and initial recommendations on utility rate adjustments, along with a presentation by subject matter expert consultant AECOM.
October 14, 2025: First reading of ordinance number 2286.
October 21, 2025: Staff will provide an overview to City Council in a Broomfields Enterprise Funds study session and initial results of additional repair and replacement capital added during the 2025 budget.

Bond Ordinances

August 19, 2025: Staff provided information and insights to City Council on Broomfield's high credit rating

and the organization's "superior ability to repay short-term debt obligations," providing guidance to ensure Broomfield's financial stability while requesting new bonds to finance the 2026 capital improvement projects for the new Police Building / Courts Remodel and Water and Sewer infrastructure improvements.
October 14, 2025: First reading of ordinance numbers 2288, 2298, and 2290.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
November 1, 2022: Council Approved the 2023 PPTR Program with Resolution No. 2022-123.
January 23, 2024: Council Approved the Expansion of the PPTR Program in 2024 with Resolution No. 2024-27.
October 22, 2024: Council Approved the URAF Program with Resolution No.2024-165.
October 22, 2024: Council Approved the 2025 Budget with Resolution No. 2024-149.
December 3, 2024: Council Approved the 2025 PPTR Program with Resolution No. 2024-105.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

2025 and 2026 Budget
If Council desires to approve the proposed 2025 budget amendment, the appropriate motion is...
That Resolution 2025-141 be adopted.

If Council desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-142 be adopted.

If BURA desires to approve the proposed 2025 budget amendment, the appropriate motion is…
That Resolution 2025-143-UR be adopted.

If BURA desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-144-UR be adopted.

If ALID desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-145-AID be adopted.

Amending Enterprise Ordinance

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2286 be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to water, sewer, water reclamation, and stormwater charges and fees as set forth in these ordinances would be effective January 1, 2026.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2288 Issuing Enterprise Revenue Bond (Water Tanks) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2289 Issuing Enterprise Revenue Bond (Wastewater Treatment - Phase 1B) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2290 Issuing Certificates of Participation (Police and Courts Buildings) be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to the issuance of new bonds as set for in the ordinances would be effective January 1, 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program

If the Council desires to proceed with the staff recommendations for the continuation of the Utility Rate Assistance Fund Program in 2026, the appropriate motion is…

That Resolution 2025-153 be adopted.

If the Council desires to proceed with the staff recommendations for the continuation of the Partial Property Tax Refund Program in 2026, the appropriate motion is…

That Resolution 2025-154 be adopted.

Alternatives

Budget

Per Charter, the City Council must adopt a budget. If it fails to do so, the budget will be put on future agenda(s) until such time as it is approved. If Council fails to adopt the budget, the amounts appropriated for the operation of the current fiscal year shall be deemed adopted for the next fiscal year on a month-to-month basis, with all items in it prorated accordingly, until such time as the Council adopts the budget for the next fiscal year.

Amending Enterprise Ordinance

If Council does not approve the recommended utility rate ordinance, the existing fee structure would remain in place. CCOB's Enterprise funds' financial sustainability and resiliency would weaken. The ability to obtain favorable financing for necessary projects, including wastewater treatment facility expansion and water tanks, would be put at risk.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If Council does not approve the recommended two enterprise revenue bonds and police building certificate of participation ordinances, CCOB would not defease the existing certificates of participation and would not move forward with the issuance of the bonds. CCOB would not be able to finance the necessary projects, which include the Wastewater Treatment Facility Expansion, Water Tanks, and new Police Building.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
Do not approve staff recommendations. If not approved, provide an alternative direction.

Background - Budget

Broomfield has grown and evolved significantly over the past twenty years from an emerging suburban community into a large, thriving, and maturing urban-suburban community. Since the consolidation of our community in 2001, Broomfield has provided effective and efficient city and county programs and services. Today, Broomfield is home to nearly 80,000 residents, living in more than 34,000 housing units and thousands of businesses. While much of Broomfield's 34 square miles is built out, there is a continued focus on developing and evolving while maintaining long-term financial sustainability and resilience.

Budget Process and Philosophy

The budget is a planning tool that is used to meet the results of the March 3, 2023, Council Focus Session, where the Community Goals were solidified with an emphasis on Goal #1: Financial Sustainability and Resilience. Therefore, the budget process is flexible and responsive to organizational and community needs and economic conditions.

In addition, staff will continue with a comprehensive, clear, and transparent approach by bringing forth a consolidated number of budget amendments for the Council's review and consideration, and for transparency for Broomfield residents. Each budget amendment is designed to address specific topic areas outlined below.

- **Budget Amendment 1** (Q1): reflects the carryover of capital and grant projects from the prior fiscal year and any additions to operational budgets (i.e., increased cost for Spring Cleanup).

- **Budget Amendment 2** (In conjunction with adopting the following fiscal year's budget; Q4): reflects the current state of actual revenues and expenditures, including any supplemental requests, and sets the foundation for the following year's budget.
  This amendment also includes the prior year's audited financials (actual beginning fund balances), which helps inform the ability to fund future year financial shifts.

- **Budget Amendment 3** (Q4): if needed, addresses grants, which often require financial adjustments based on project or program status of implementation and execution due to the timing of the grant award.

Current and future budgeting processes are designed to ensure operational and capital success, focusing on creating a culture of accountability and intentionality while basing the budget on revenue and expenses. This helps to drive forward a sustainable, disciplined structure of reallocating funds and not continuing to increase expenditures arbitrarily.

Proposed Budgets

2025 Revised Budget Summary

On October 22, 2024, City Council passed Resolution 2024-149 to adopt the 2025 budget for the City and Council of Broomfield. Additionally, the Broomfield Urban Renewal Authority approved resolution 2024-150-UR to adopt the 2025 budget for BURA. Since the adoption, the budgets have been amended one (1) time to reflect capital project rollovers, grant rollovers, and additional capital and operational budget adjustments. As can be seen in the table below, adjustments to the City and County of Broomfield budget in amendment #1 is listed as well as the proposed adjustments in amendment #2.

CITY AND COUNTY OF BROOMFIELD
REVISED BUDGET SUMMARY - ALL FUNDS*

Fund	Original Budget 2025	Budget Amendments #1 2025	Budget Amendment #2 2025	Amended Budget 2025
Beginning Fund Balance	**$ 304,842,581**			**$ 408,834,091**
Revenues				
General Governmental Funds	$ 201,022,977	$ 14,388,112	$ 13,956,978	$ 229,368,067
Governmental Capital Funds	89,039,461	18,228,553	9,687,422	117,955,436
Enterprise Funds	83,761,446	(1,479,300)	(4,564,126)	77,718,020
Fiduciary Funds	223,100,356	-	-	223,100,356
Total Revenues	**$ 596,924,240**	**$ 31,137,365**	**$ 19,080,274**	**$ 648,141,879**
Expenditures				
General Governmental Funds	$ 216,385,986	$ 13,140,495	$ 5,475,993	$ 235,002,474
Governmental Capital Funds	103,310,912	73,107,734	4,355,292	181,773,938
Enterprise Funds	99,516,325	47,506,010	(2,731,036)	144,291,298
Fiduciary Funds	214,122,885	-	-	214,122,885
Total Expenditures	**$ 633,336,108**	**$ 133,754,239**	**$ 7,100,248**	**$ 775,190,595**
Ending Fund Balance	**$ 268,430,713**			**$ 281,785,375**

** Excludes transfers to reserves and interfund transfers*

2025 Operating and Capital Fund Revised Budget

Budget adjustments are made in order to respond to the changing demands of our operations in addition to the continued economic fluctuations occurring at the local, state, and national levels. In 2025, the City and County of Broomfield eliminated what had traditionally been the second amendment of the year. The Finance Department worked directly with departments to discuss needs and work strategically to accommodate needs by reallocating current budgets while continuing to monitor throughout the year to determine if budget adjustments were actually needed. Based on this collaborative effort, staff have been able to reduce the overall workload within the organization and minimize the number of times the budget needs to be reviewed, adjusted and considered by City Council.

The proposed operating fund budget adjustments include both personnel and non-personnel adjustments for programs and initiatives. While capital fund adjustments are the result of revising capital projects due to aspects such as timing or changes in project priorities since the adoption of the 2025 5-Year CIP Plan. The table below includes highlights of operational revisions to the 2025 budget.

2025 Revised Budget Highlights*		
Department or Category	**Description**	**Amount**
City & County Attorney	2025 Increase for Insurance Premiums	$ 70,000
Courts	Above Mid-Point Pay Request: Lead Court Clerk Hire	4,142
Human Resources	New Full-Time FT: HR Project Manager	71,498
Police	Increase to Axon Agreement	234,625

Police	Increase to Inmate Food Services Contract	172,050
Police	Increase to Psychological Support Contract	50,000
Police	Dual Sim Card Monthly Fees with First Net	36,500
Police	Inmate Medicine Expenses	38,252
Police	Outside Fund Award Funded Motorola Service Agreement for Back Up Dispatch Center Equipment	12,775
Police	Brower Resilience Visits	2,500
	Total	**$ 692,342**
*Personnel Highlights are pro-rated for partial year		

The 2025 revised operating budget includes a number of cost increases associated with existing contractual obligations. The 2025 budget process was completed in the middle of 2024, prior to a number of contractual amendments being executed, so adjustments are made during the 2nd amendment to appropriate the additional funds needed to meet these obligations.

In addition to the Budget Highlights noted above, the 2025 revised operating budget also includes a number of non-personnel budget reductions as part of the organization's efforts to optimize budgets. Travel and training budgets were reduced by $859,813 and other identified non-personnel budgets were reduced by $1,041,450. This effort was collaborative across the entire organization, with a focus on maintaining services to residents.

In total, staffing levels and service demands resulted in the addition of 4.13 FTE in 2025, as detailed in the Expenditures: 2025 Personnel Changes table.

Expenditures: 2025 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
City & County Manager	1.00	303,987	Economist (1.0FT), Administrative Analyst (1.0FT), Case Manager II - Housing (-1.0FT)
Community Development	-1.00	(133,296)	Senior Transportation Planner (-1.0FT)
Economic Vitality & Development	-2.00	(254,758)	Economist (-1.0FT), Administrative Analyst (-1.0FT), Administrative Support I/II LTA (2.0FT), Administrative Support I/II LTA (-2.0FT)
Human Resources	1.00	65,533	HR Project Manager (1.0FT)
Human Services	2.80	172,795	Case Managers II LTA (2.0FT), Case Manager II LTA (-2.0FT), Case Manager II (1.0FT) Workforce Specialist II LTA (0.8PT), Human Services Management Analyst (-0.8), Non-Profit & Community Engagement Manager (1.0), Human Services Grants Specialist (0.8)
Library, Arts & History, and CSU Extension	0.33	(1,718)	Creative Technologist (-0.8PT), Patron Services Associate (1.0FT), Creative Technologies (-0.6PT), Patron Services Associate (0.73PT)
Public Health & Environment	0.00	(2,845)	Human Services Management Analyst (-0.2), Human Services Grants Specialist (0.2)
Total	**4.13**	**$ 149,698**	
*Includes internal transfers. Costs prorated for partial year. Public Works to Public Works / Water Utilities reorganization is not included.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and estimated taxes and benefits			

2025 Broomfield Urban Renewal Authority Revised Budget

This is the second amendment to the 2025 BURA budget. This amendment reflects updated revenues and expenditures projected through the end of the year based on year-to-date information. The BURA Budget Tables summarize the 2025 proposed revisions to the budget.

2025 BURA Revenues - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 70,511,588	$ 605,615	$ 71,117,203
Debt Service	5,056,106	(607,935)	4,448,171

2025 BURA Expenditures - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 54,215,747	$ 2,902,954	$ 57,118,701
Debt Service	4,459,171	-	4,459,171

2026 Proposed Budget Summary

Planning for Increased Financial Stability

The City and County are guided by conservative revenue projections, reasonable cost assumptions (expenses), deploying strategic development decisions, effectively managing staffing patterns, and using

data-driven decision-making models to keep operational costs in check.

Transitioning into 2026, Broomfield's economic and financial position is fundamentally sound, but we remain in an ever-increasing volatile environment. This reality reinforces the need for prudent financial flexibility, conservative planning assumptions, and disciplined decision-making to ensure long-term sustainability.

Broomfield's two largest primary revenue sources are property tax and sales/use tax, with sales tax showing minimal growth in 2025 (measured at the halfway point through the year, sales tax is projected to end 1-2% higher than 2024). The minimal sales tax growth is expected to continue to build in 2026, a trend anticipated to continue into 2027. Additional retail and commercial investments in the pipeline begin to come online in 2027 (e.g., Macerich's HiFi area at FlatIron and the initial phase of McWhinney's Center Street area). Conversely, the property tax revenue is expected to fall in 2026 and remain stable in 2027. The property tax revenue reduction is occurring due to State changes in the property assessment rates and the decline in property market values.

Due to decreased property assessment rates, property owners will see lower tax bills, which correlates to the decreased county property tax revenue by approximately $6.5-7.5 million annually. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

The 2026 proposed budget reflects the organization's continued focus on balancing current needs and obligations while preparing to meet the organization's and community's future needs by prioritizing expenditures into Mandates, Obligations, and Critical needs. Broomfield's economic fundamentals continue to provide sustained economic and employment opportunities while ensuring a sound fiscal base for CCOB budgets.

Guiding Principle: Residential Growth and Service Capacity

Broomfield currently has the revenue to sustain current service levels, but each new residential development adds demand and costs to systems already operating near capacity. Sales tax revenue growth—expected as new commercial development comes online in 2027—will help, but will not fully offset rising expenditures. Property taxes remain outside local control and subject to state formulas and market values; those factors created a $6.6M - $7.5 decrease in general fund revenue, which is not anticipated to return.

Balancing Housing Needs with Community Capacity

While the Front Range continues to face an affordable housing shortage that calls for regional solutions, Broomfield must thoughtfully balance this need with our community's existing capacity. Demand for services is strong — recreation programs often fill quickly, fields are well used, the Library serves at or near capacity, and our core utilities, such as the wastewater treatment facility, are preparing for future growth. Broomfield has also made prior commitments to additional residential development through business development agreements. Looking ahead, future decisions will shape how we continue to provide high-quality services, invest in infrastructure, and remain fiscally responsible, while also contributing to broader housing solutions across the region.

Disciplined Development and Long-Term Financial Sustainability

Broomfield continues to take a thoughtful, yet disciplined, approach to development as the foundation for achieving long-term financial strength and sustainability. Our strategy emphasizes balanced growth and a diversified economy—ensuring that both residential and commercial development occur in alignment with community needs and fiscal realities.

Maintaining and strengthening the ratio of residential to commercial development is paramount as we move into the future. A healthy balance not only supports a diversified tax base and resilient economy but also ensures that service demands and infrastructure investments are financially sustainable over time.

By adhering to this disciplined approach, Broomfield positions itself to manage near-term fiscal challenges

while preserving the flexibility to invest in community priorities and future opportunities.

Broomfield recognizes that a strong community is made up of thriving neighborhoods and residential areas, combined with commercial areas and developments home to businesses in key sectors, such as finance, information technology, aerospace, and business/professional services. Broomfield is also successful in attracting and growing businesses in next-generation economic sectors, such as quantum computing, phonetics, and advanced manufacturing. Recent firms choosing and growing in Broomfield include Sierra Space, SiNaptic, Quantinuum, and Raven Space Systems.

Development and increasing redevelopment in the community continue to build on this economic and financial foundation. These developments provide sought-after locations for businesses to locate and grow, places for residents and visitors to shop, dine, and gather, and places where existing and new residents will call home. Current construction is underway around FlatIrons Crossing (the HiFi area: both the Novel FlatIron residential and new commercial space), MidPoint's flex/innovation space (255 Midway), the Simms Technology Park, and Harvest Hill apartments. Horizontal construction will soon start in Baseline's mixed-use Center Street development. Combined, these current developments total nearly 500 new residential units (over 200 income-aligned), about 500,000 square feet of new work space, and over 100,000 square feet of (already leased) shopping and dining space.

The 2026 proposed spending plan recognizes that our community looks to its local government as innovators and leaders. It supports this influential work by refocusing and committing to the identified Community Goals, with the fundamental goal of Fiscal Sustainability remaining paramount to a healthy and robust future.

Emphasis on Prioritizing Needs

As Broomfield continues to maintain economic and fiscal stability, our strategic approach includes a prudent and pragmatic fiscal approach to anticipate and withstand future economic or financial disruptions in the short and long term.

The proposed 2026 budget prioritizes expenditures in the following categories:

- **Mandates**: Regulatory requirements issued by the federal or state level that result in the need for funding.
- **Obligations**: Contractual requirement or agreement.
- **Critical Need**: This is essential to the organization's effective operations. Failure to fund it would threaten public health, the environment, or community safety, or create a more significant liability or risk to the organization.

Any funding request not categorized by a mandate, obligation, or critical need but necessary to provide ongoing programs and services would be defined as an 'other' this year. In 2026, only projects classified as 'other' that were moved forward were partially funded by grants.

The 2026 Recommended Budget reflects a collaborative effort across all departments. New services and their associated costs will be strategically timed for review only when budget flexibility improves – something not anticipated in 2026, and possibly not until the second half of 2027.

All departments determined needs based on the following high-level categories and corresponding thought-provoking questions, serving as the foundational lens through which all budgeting and resource allocation requests were reviewed:

- **Safety**: Eliminating or reducing a hazard/threat
- **Operational Cost vs. Revenue**: Is there a revenue offset that will help reduce costs?
- **Asset Maintenance**: Ability to extend the life cycle of a current asset
- **Comprehensive Plan**: Approach and alignment with existing roadmap

- **Operational Support**: Will the request create additional demand on existing resources or require new support?
- **Alternatives**: Does the alternative require greater resources, financially or otherwise?
- **Cost Sharing Opportunities**: Ability to leverage outside funding awards
- **Urgency**: Is there an immediate need that the request will satisfy?
- **Public Benefit & Quality of Life Impact**: Ability to benefit across various sectors
- **Socio-Economic Equity**: Determining the applicability within Broomfield's vulnerable populations or underrepresented
- **Sustainability**: Ability to address/correct the construct that will benefit the environment

For the fifth consecutive year, staff recommends maintaining Public Safety, Public Works, and Water Utilities as a top priority while continuing to adapt to growth, addressing deferred maintenance while moving forward with an asset management approach, and shifting to new and long-term fiscal realities.

Public Safety

This commitment is demonstrated by keeping the Broomfield Police Department organizationally separate from general employee groups. This approach has enabled the City and County of Broomfield to strengthen its police force effectively, resulting in a substantial increase in essential personnel to better serve the community. The Full-Time Equivalents (FTEs) grew from 242 in 2021 to 277 in 2025, a 14% increase. Concurrently, the police budget expanded from $34 million in 2021 to $44 million in 2025, marking a 27% increase. This investment is directly linked to Broomfield maintaining the lowest crime rate per capita in the metro area.

District Attorney – 17th Judicial District

The proposed budget for Broomfield's population share of the District Attorney's office is based on preliminary calculations received from Adams County in August 2025. On August 12, 2025, the District Attorney submitted his budget documents to Broomfield staff. Following that submission, Broomfield requested a meeting with the Adams County Board of Commissioners and leadership to discuss the request.

This meeting, held in mid-September, included the Mayor, Mayor Pro Tem, City Manager, and City Attorney. The discussion focused on the scope of services included in the DA's request, as well as the Family Justice Center, which is addressed in greater detail below.

Adams County is also in the process of finalizing its budget. On October 1, 2025, the District Attorney presented his budget request to the Adams County Board of Commissioners; however, the Board has not yet approved the request. Broomfield staff attended the presentation and will continue to monitor developments to ensure Broomfield's final budget reflects only its proportional share of approved expenses.

Broomfield's proposed budgeted amount for the DA reflects a budgeted amount that does not include costs for the proposed Family Justice Center (FJC). Per statute, Broomfield is only responsible for its per-population share for "the necessary expenses of maintaining an office for the transaction of official business" of the District Attorney.

While the intent of the FJC is admirable, the District Attorney has indicated that 75% of individuals to be served will be non-judicial clients. This represents not an expansion of existing prosecutorial services, but rather the creation of an entirely new entity, infrastructure, and team, as shown by 9 FTE in his budget request to Adams and Broomfield counties. While there is a connection with the domestic violence case work completed by the DA's office, this is a separate endeavor that warrants further scrutiny and should be subject to discussions about the creation of a regional and distinct intergovernmental entity before Broomfield commits taxpayer resources.

In addition, the revised proposed budgeted amount for the District Attorney does not include the cost of one FTE (an attorney) that Broomfield has solely funded since 2021 to reduce backlog following COVID. This was

a separate agreement with the DA, and three years later, after that backlog has been addressed, that cost should not be part of the base budget.

Public Works and Water Utilities

Our focus on infrastructure over the past several years has led to significant growth in resources dedicated to roads, streets, maintenance, and water. Full-time equivalents (FTEs) increased from 158 in 2021 to 220 in 2025 – a 39% rise (note: this includes 14 FTEs transferred to Public Works/Water Utilities from Community Development and Strategic Initiatives related to Construction Inspections and Energy and Sustainability, respectively). Investments in Public Works and Water Utilities have enabled staff to optimize infrastructure, boost productivity, and better manage assets. This directly impacts overall operations and effectiveness.

Broomfield has made major strides in core infrastructure and utility maintenance over the past five years. The Street Pavement Management Program expanded significantly, with more miles treated and a dramatic increase in crack sealing. Water Utilities strengthened operations with annual waterline replacements, full fire hydrant flushing and maintenance, and near-complete valve maintenance. The Sewer Collections Program has advanced to completing annual program system cleaning and inspection on a regular cycle. Meanwhile, the Stormwater Maintenance Program, established in 2021, now conducts annual program system cleaning and inspections each year. These operational improvements are supported by a five-year financial sustainability plan that ensures the long-term health of infrastructure, high-quality service delivery, and protection of public health and the environment.

Given the challenges and uncertainty in the economy and marketplace, the 2026 Proposed Budget relies on conservative fiscal policies and projections supporting balanced annual spending. The 2026 Proposed Budget was built using a combination of Council direction with existing planning documents, including, but not limited to, the Comprehensive Plan, the Long Range Financial Plan, and financial/economic modeling, to synthesize the work over the past several years of taking a comprehensive methodological approach to Broomfield's future.

2026 Areas of Focus & Key Highlights

- Broomfield has not acquired any additional general obligation (GO) debt since 2017. Broomfield will be defeasing prior debt and remains committed to maintaining and increasing our existing Aa2 bond rating, which means the organization has a "superior ability to repay short-term debt obligations." The rating is one of the highest within the state of Colorado. This high rating is essential. Having debt of 5% of revenues is considered appropriately leveraged and reflects the government's ability to repay debt.
- Broomfield will continue to leverage grant funding as part of efforts to diversify revenue sources. In 2025, overall, less grant revenue was available on the Federal and State levels. As of August 2025, CCOB has received 91 grants, representing an increase from 69 grants in 2024. This total reflects both new grant applications and recurring awards that continue from year to year. In 2025 alone, more than 35 new grant applications have been submitted, with 28 awarded to date. These awards total approximately $5.6 million, compared to $4 million last year. We will continue to seek grants in 2026 to pursue funding from private, local, and state sources. New grant funding to be explored in 2026 includes: Courts' First Defense Counsel Appearance, incentives for Norm Smith UST removal reimbursement, the Recycling Rebate Program, and Special Supplemental Nutritional Funds for Women, Infants, and Children (WIC).
- Police Facility construction is anticipated to begin in early 2026.
- Courts Remodel design to begin in 2026.
- Maintain the achieved goal of 20% reserves into 2026 and future years.
- Continue to explore opportunities for development of the former Event Center site: This development is expected to be a revenue generator for the community.
- Implementation of the selected City and County Enterprise Resource Planning (ERP) Software that will modernize our existing 30+ year manual/spreadsheet system to begin early 2026.
- Update the 2016 Comprehensive Plan in 2026, providing the Council, community, and our

organization an opportunity to play a critical role in shaping the vision for the next decade and beyond.
- Implementing the first organizational strategic plan to guide the 2026 work plan.
- Issuance of three bonds: Quarter one 2026, Certificate of Participation for the PD/Courts, and two in the Enterprise Funds for the Water Tanks & Wastewater Expansion - Phase IB.

This list alone requires us to be especially prudent in the upcoming year and beyond. We are operating in a constrained environment – both financially and with staffing capacity – and must therefore be intentional and strategic in every decision we make. The 2026 and 2027 budgets will require a reallocation methodology, not a reprioritization model – meaning that to add anything, other programs must be reduced or removed to accommodate new or enhanced funding. As we gain clearer insights into programmatic outcomes, we must be willing to have courageous conversations about whether programs and services are being fully maximized, widely utilized, effectively measured, and delivering the intended outcomes. If they are not, we must work together to thoughtfully realign our efforts and resources toward initiatives that deliver the greatest benefit to our community.

2026 Budget Highlights

Revenue Projections

Broomfield's two largest primary revenue sources are property tax and sales/use tax, accounting for 60% of Broomfield's revenue base. Sales tax is showing minimal growth for 2026. The minimal growth in sales tax is a trend anticipated to continue into 2027, while retail and commercial investments in the pipeline begin to come online in late 2027 (ie, Macerich development).

Conversely, the property tax rates are not expected to move in any direction but downward. Due to decreased property assessment rates, property owners will see lower tax bills. This reduction will decrease county property tax revenues by approximately $6.5-7.5 million annually – $3-4 million from residential properties and $3.5 million from commercial properties. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

Across all revenue streams[1], 2026 projected revenues are expected to increase by 5.2% from $332 million to $349 million compared to the 2025 revised budget per Table 1C of the proposed budget. This increase is primarily driven by anticipated revenues from Fiber contracts, building permits and use tax revenues.

The 2026 proposed budget was built with the projected increases in Utility Rates for water, sewer, reclaimed water, and stormwater.

Expenditure Projections

Broomfield continues to monitor the ongoing uncertainties surrounding the economic environment and is prepared to react as needed. The budget process is an example of staff working collaboratively to mitigate the impacts of these uncertainties.

Operational expenditures are expected to increase by 5.8% from the 2025 original budget to the 2026 proposed budget.

Total expenditures (Table 3B), which include the operating, capital, additions to reserves, and debt service obligations across all funds, is an estimated $897 million, excluding inter-fund transfers. This represents an increase of 41% in expenditures from the 2025 original budget to the 2026 proposed budget. This increase is primarily driven by large capital projects, such as the new Police building, Court building remodel, and the Water and Sewer projects.

Personnel

Over the last four years, Broomfield has implemented a market-driven, competitive compensation philosophy to lead the market. This was based on the legal requirements to comply with new federal equal pay mandates and aligned with the City Council's direction on employee compensation. In year five, Broomfield is working to maintain the progress while navigating economic uncertainties. Human Resources completes market evaluations every other year to ensure positions within CCOB are paid competitively against the Denver Metro market. This data is used to project salaries and personnel costs for the proposed budget. In 2026, Human Resources will not be conducting market evaluations.

Ongoing personnel costs and adding new positions to meet the community's needs are the primary drivers of the 5.8% operational budget increase referenced in the expenditures section.

Below is a list of the Personnel Changes implemented as part of the 2026 operating budget.

1Excludes Fiduciary Funds and Budgeted Bond Revenues

Expenditures: 2026 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
Human Services	0.10	13,463	Business Solutions & System Administrator (0.1FT)
Information Technology	-1.00	-	Accessibility Specialist LTA Expiration (-1.0FT)
Parks, Recreation, & Senior Services***	2.25	219,958	Lead Parks Tech (1.0FT), Parks Tech II PT to FT (0.25FT), Preschool Director (1.0FT)
Public Health & Environment	0.40	18,982	Business Solutions & System Administrator (-0.1FT), Administrative Support II PT to FT LTA (0.5FT)
Water Utilities	3.00	334,561	Cross Connection Foreman (1.0FT), Senior Water Utilities Locator (1.0FT), Senior Sewer Utilities Locator (1.0FT)
Total	**4.75**	**$ 586,964**	
*Includes internal transfers.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and est. taxes and benefits; does not include any non-personnel budgets associated with new FTE			
***Department has self-funded these positions with budget realignments - reducing temp and non-personnel budgets			

Non-Personnel

Non-personnel-related expenses include the supplies, equipment, and contractual service costs necessary to provide the programs and services in Broomfield. Some examples include:

- Fuel
- Vehicle Maintenance Supplies (i.e. air & oil filters, tires, etc)
- Electronic Equipment (i.e. telephones, computers, headsets, etc)
- Training and Development of staff
- Professional Services (i.e. outside auditors, specialized legal services)
- Insurance expenses
- Utilities
- Software (Annual License Fees, such as Google)

As part of the annual budget process, the budget staff meets with departments to discuss non-personnel requests and the drivers of individual items. Items like fuel are a basic necessity for the organization to accomplish its work and are subject to market conditions; thus, Broomfield has very little control over this type of expenditure. For other non-personnel items, the organization manages costs by finding alternatives or adjusting work procedures to eliminate or minimize expenses wherever possible.

Operating Budget Highlights

Below is a list of some highlights of the 2026 operating budget.

2026 Operating Budget Highlights		
Department or Category	**Description**	**Amount**
Assessor	One (1) 5-Month Overlap (Assessment Supervisor)	$ 66,708
City and County Clerk	Two (2) 2-Month Overlap (Recording & Motor Vehicle Specialist, Recording & Licensing Specialist)	25,141
City & County Manager	Hazardous Mitigation Plan Update - FEMA Mandate	65,000
Community Development	Two (2) Reclassifications (Senior Landscape Architect to Landscape Manager, Combination Inspector to Landscape Associate/Tech)	54,272
Parks, Recreation, & Senior Services	One (1) FT (Lead Parks Technician)*	-
Parks, Recreation, & Senior Services	One (1) PT to FT (Parks Technician II)*	-
Parks, Recreation, & Senior Services	One (1) TM to FT (Preschool Director)*	21,401
Police	One (1) FT Continuation (Victim Advocate) if Grant is discontinued	112,712
Police	Three (3) Reclassifications (Records Specialist to Records Supervisor, Budget Analyst to Budget Supervisor/Manager, Office Manager to Senior Operations Manager)	73,871
Public Health & Environment	Personnel Costs Transitions	(8,555)
Public Health & Environment	One (1) PT to FT LTA (Admin Support II)	33,899
Public Health & Environment	One (1) Reclassification (Environmental Health Specialist I to Environmental Health Specialist II)	5,953
Water Utilities	Three (3) New FT (Cross Connection Foreman, Senior Water Utility Locator, Senior Sewer Utility Locator)	381,107
Water Utilities	SCADA Environment Security Scanning Software (w/IT)	69,571
	Total	**$ 901,081**
*Department's non-personnel budget will be reduced for the personnel changes		

2026 Capital Improvement Plan Considerations

Using a conservative approach and understanding the constraints of Broomfield's finances, staff will continue to evaluate and prioritize projects based on mission essentials and those that affect the health and safety of the community. To proactively prevent unintended consequences with any changes in the funding of CIP, staff will continue to seek guidance from Council.

The 2026 Five Year Capital Improvement Project (CIP) Plan was developed in a parallel process at the same time as Broomfield's operating budgets. This process included an extensive year-long collaboration across all departments to ensure that all projects and community requests were considered. CIP requests are rated and prioritized using the same "buckets" described earlier in the document. Ensuring that our limited resources are focused on mandates, obligations, and critical infrastructure projects reinforces our financial sustainability and resilience goal. Finally, staff has worked to shift the focus of funding from new capital projects towards preventative maintenance, repair, and rehabilitation to ensure that Broomfield is focusing efforts on adequately addressing its existing infrastructure.

The 2026 budget for Capital Projects includes

- $142.9 million in expenditures for the General Governmental Funds
  - $100 million for the Police Building and Courts remodeling projects
- $217.2 million in expenditures for the Enterprise (Utility) Funds.
  - $70 million for the two new Water Tanks project
  - $114 million for Wastewater Treatment Facility Expansion Project

2026 Broomfield Urban Renewal Authority Budget

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2026 BURA revenues are budgeted at $65.1 million, representing a 7.7% decrease compared to the 2025 original BURA budget. BURA expenditures in 2026 are budgeted at $50.0 million. BURA also pays the City and County of Broomfield to cover administration costs and professional services related to the development of urban renewal areas. The 2026 budget includes $5.5 million for administrative and professional services expenditures.

2026 Arista Local Improvement District Budget

The Arista Local Improvement District (ALID) was established to facilitate the construction of transportation facilities in the Arista Development. The ALID is supported by a 0.2% sales tax collected on all taxable sales within its boundaries, and the revenue generated by the tax has been pledged to support the Arista Metro District's (AMD) debt service on bonds sold to construct the parking structure.

The only allowable use of the revenue is to support the funding of public transportation services or improvements, the 2026 budget for the ALID exists solely to authorize payments to AMD, as noted. The 2026 proposed ALID budget includes $45,000 in sales tax revenue and $45,000 in expenditures related to the AMD debt service for the construction of the parking structure.

Background - Enterprise/Utility Fee

Utilities are funded by four enterprise funds that are specifically dedicated to the Water, Wastewater, Reclaimed, and Stormwater/Flood Management utilities. Each enterprise operates as a self-supporting entity. Revenues generated from monthly utility bills are the largest source of revenue for each utility, accounting for generally between 85% to 90% of revenues in each fund. Other significant sources of funds include development fees and funding from the Mile High Flood District (MHFD). These cumulative funding sources cover day-to-day operations, capital and rehabilitation projects, and annual programs. A robust enterprise fund presents a significant strategic advantage, empowering the city to issue revenue bonds.

This mechanism is crucial for financing substantial capital projects, much like the extensive bonded projects anticipated in 2026. The ability to leverage revenue bonds ensures that vital infrastructure and development initiatives can proceed.

As previously noted, to prepare for critical utility infrastructure needs, Broomfield adjusted water and sewer rates last year. This was, in part, to support two upcoming enterprise bond issues – one to fund two new water storage tanks and another to expand our wastewater treatment facility. Staff has contracted with bond underwriting firms, Stifle & Piper Sandler, who have extensive Colorado market experience in issuing Enterprise Fund bonds. CCOB is still targeting issuance in quarter one 2026.

Staff has provided additional detailed information on how water and sewer rates are directly influenced by the process of repairing and replacing aging infrastructure, known as asset renewal. Here is the linked

document - Water Utilities System Asset Renewal - Key Aspects of Establishing Rates.

In addition to preparing Broomfield to support the two upcoming enterprise bond issues, the rate increase implemented in 2025 was able to be immediately utilized to implement the water meter replacement program and improve maintenance of existing assets, including the following notable improvements:

Potable Water Improvements

- Flushing 483 miles: 100% (vs. 19% in 2022).
- Hydrants 4,478: 100% maintained (vs. 47% in 2021).
- Backflow devices 2,737: 97.17% compliance (exceeds CDPHE 90%).

Sewer and Stormwater Improvements

- Sewer video inspections: Currently at 90%; 100% by year-end (vs. 20% in 2023).
- Sewer cleaning: Currently at 98%; 2-year full-cycle program (vs. 40% in 2022).
- Storm video inspections: Currently at 87%; 100% by year-end (vs. 9.6% in 2021). Cleaning: 100% of 2025 target (vs. 0% in 2021).
- Street sweeping: 3,381 miles swept in 2025 (+95% vs. 2023).

2026 Proposed Recommendations: Water, Sewer, Reclaimed, and Stormwater Rates

As detailed in the budget adopted by the Council in 2025, the five-year plan includes a year two increase totaling $16.89 per month for the average single-family home starting in 2026. This represents a 15% increase for utility rates across all funds, with a 9% ($1.00) increase for stormwater service fees, and aligns with projections presented in the original five-year plan presented in 2024 (also see October 22, 2024, memorandum). Similarly, the non-residential water, sewer, and reclaimed rates will increase by 15% and stormwater service fees will increase by 9%. License fees for water, sewer, and reclaimed water for new development will increase by 4%.

Staff has completed a comprehensive fiscal analysis to evaluate anticipated revenues from utility rates as well as projected expenses based on necessary costs associated with day-to-day operations, capital and rehabilitation projects, and annual maintenance requirements. The fiscal analysis includes multiple interdependent variables, and adjusting any one component impacts several other variables within the model, requiring a holistic re-evaluation of all dependencies within the five-year comprehensive plan.

This increase is essential to ensure the long-term financial sustainability of our enterprise funds while maintaining essential services and infrastructure. The recommended rate structure ensures sufficient funding for both ongoing maintenance of existing water infrastructure and necessary capital improvements. The proposed increase allows the utility to maintain a proactive maintenance schedule consistent with capital improvement planning recommendations, protecting the community's investment in water infrastructure while avoiding more costly emergency repairs. Deferring maintenance on water system components creates significant financial risk, as delayed repairs typically result in substantially higher replacement costs and potential service disruptions that impact the entire community.

It is important to understand why this rate increase cannot easily be reduced to a lesser amount. Each percentage point reduction in the proposed rate change would result in approximately $500,000 less annual revenue to the enterprise fund. Such reductions would necessitate corresponding cuts to maintenance programs, capital projects, or service levels to maintain a balanced budget.

Given the essential nature of water services and the potential for deferred maintenance to compound costs over time, the proposed increase represents the minimum funding level necessary to ensure reliable, long-term service delivery to our community.

In 2025, the increase for the water utility bill was only on the base fees, and there was no increase for the water usage rates. As discussed and presented last year, in 2026, the proposal also includes an increase to the water usage rate, and therefore, the monthly difference in the water bill will be dependent on how much water the residence typically utilizes.

The projected impact on an average monthly bill for a single-family home and a multi-family home are shown in the tables below.

The example provided below uses an average single-family home bill of 9,000 gallons for water and 6,000 gallons for sewer. The 9,000 gallons/month for water is based on a 4-year historical average of 107,000 gallons per year for a typical single-family home. Staff will be providing a Utility Bill Estimator tool and linking it on our website to help residents calculate how the proposed increase would apply to their home utility bill based on their specific household water usage.

Impact on Average Monthly Bill for a Single Family Home (9,000 gal)

	Rates		Average Bill		
Fee Type	2025	2026	2025	2026	Difference
Water Meter Base Charge	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Tier 1 (0-5k gal)	*$2.39*	*$2.75*	*$11.95*	*$13.75*	*$1.80*
Water Usage Tier 2 (6-9k gal)	*$3.82*	*$4.39*	*$15.28*	*$17.56*	*$2.28*
Water Usage Tier 3 (> 9k gal)	*$5.41*	*$6.22*	*$0.00*	*$0.00*	*$0.00*
Sewer Service Charge	$5.44	$6.26	$32.64	$37.56	$4.92
Sewer Fed Mandate Charge	$0.52	$0.52	$3.12	$3.12	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$11.00	$12.00	$11.00	$12.00	$1.00
Total Bill			**$119.90**	**$136.79**	**$16.89**

Projected 4-Year Outlook for Single-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$119.90	$136.79	$146.37	$156.61
Percentage Change		*14%*	*7%*	*7%*

Impact on Average Monthly Bill for a Multi-Family Home (3,000 gal)

	Rates		Average Bill		Difference
Fee Type	2025 Rate	2026 Rate	2025	2026	Difference
Water Base Fee	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Charge	*$2.55*	*$2.93*	*$7.65*	*$8.79*	*$1.14*
Sewer Service Charge	$5.44	$6.26	$21.76	$25.04	$3.28
Sewer Fed Mandate Charge	$0.52	$0.52	$2.08	$2.08	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$6.60	$7.20	$6.60	$7.20	$0.60
Total Bill			**$84.00**	**$95.91**	**$11.91**

Projected 4-Year Outlook for Multi-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$84.00	$95.91	$102.62	$109.81
Percentage Change		*14%*	*7%*	*7%*

The tables below show the proposed non-residential water base and usage rate changes as well as the proposed license fee changes.

Impact on Non-residential Rates

Fee Type	2025	2026	Difference	%
Water Usage Charge	$3.22	$3.70	$0.48	15%
Water Base Charge - 3/4"	$36.91	$42.45	$5.54	15%
Water Base Charge - 1.0"	$61.50	$70.73	$9.23	15%
Water Base Charge - 1.5"	$123.00	$141.46	$18.46	15%
Water Base Charge - 2.0"	$196.79	$226.33	$29.54	15%
Water Base Charge - 3.0"	$369.00	$424.39	$55.39	15%
Water Base Charge - 4.0"	$615.02	$707.33	$92.31	15%
Water Base Charge - 6.0"	$1,230.02	$1,414.64	$184.62	15%
Water Base Charge - 8.0"	$1,968.04	$2,263.43	$295.39	15%
Water Base Charge - 10.0"	$2,829.07	$3,253.70	$424.63	15%

License fees are the fees that are paid by developers and builders for new connections to the water and sanitary sewer systems. The purpose of license fees is to provide funds to pay for the capital costs of expanding the water utility to serve new growth.

Impact on License Fees

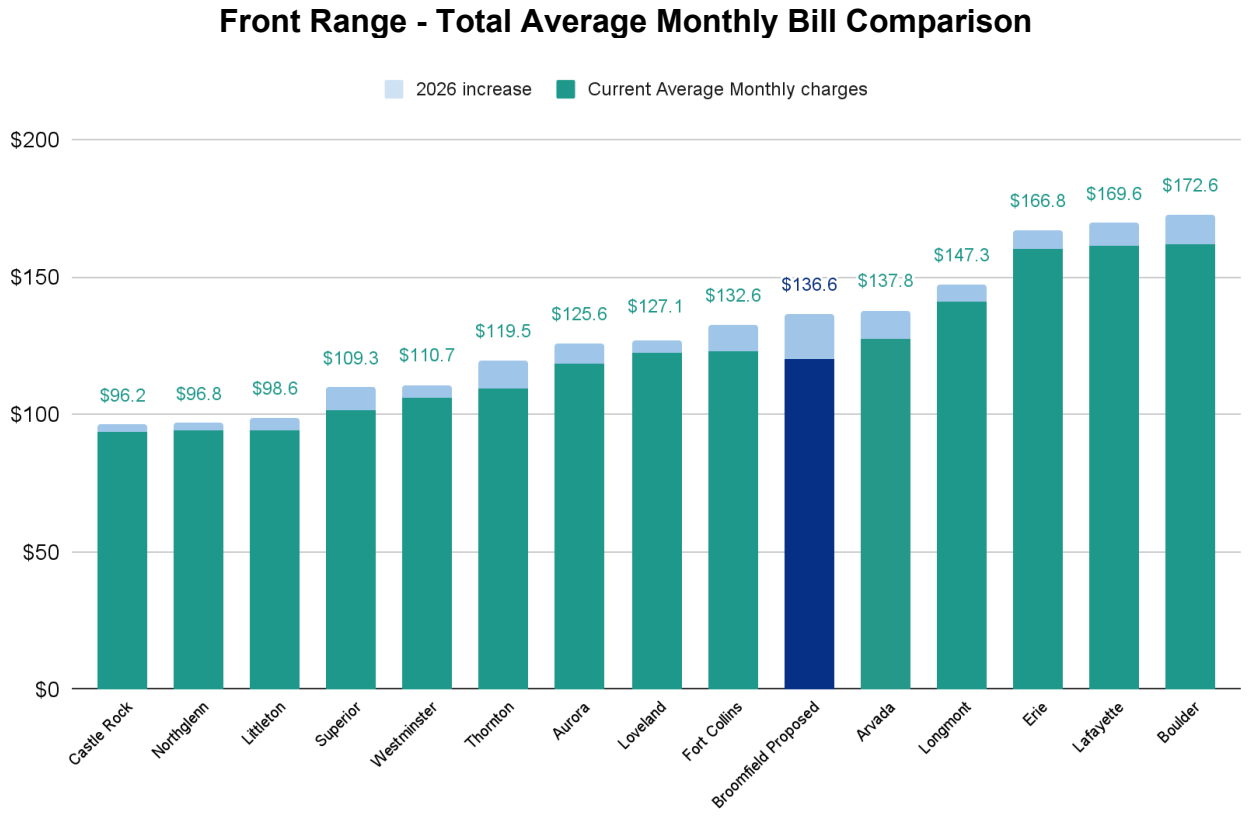
Fee Type	2025	2026	Difference	%
Water License	$37,850	$39,350	$1,500	4%
Sewer License	$14,900	$15,500	$600	4%
Reclaimed License	$13,780	$14,350	$570	4%

Front Range - Average Monthly Bill Comparison

The graph below shows Broomfield's total average monthly utility bill for water, sewer, and stormwater

compared to our neighboring municipalities. The comparison reflects where Broomfield is currently and how it would compare if the Council approves the proposed utility rates. The average monthly bill is normalized across all municipalities based on 9,000 gallons of water usage and 6,000 gallons of Average Winter Consumption (AWC) for sewer charges.

The 2026 rate increases shown in the graph below are not finalized, as the communities are going through a similar budget process as Broomfield, but staff have added the projected/proposed increases for municipalities where a projected increase is available, as shown in the light blue.



The degree to which neighboring municipalities increase their utility rates depends highly on how well they have managed their Enterprise Funds over the past decade, the growth versus expense challenges the municipality faces, and other factors unique to each entity.

Communication Plan:

Staff will be providing information for the community to learn about the proposed fee increase and how it could impact them directly. Updates have been included on the Broomfield.org website, including the proposed rates, estimated impacts for single-family homes and specific types of multifamily residential developments such as apartments, townhomes, and condominiums, and a Utility Bill Estimator tool for residents' use. Staff will also include information on the City and County of Broomfield's communications channels and work with Our Broomfield magazine, which was indicated in the Community Survey as a common place where residents seek to learn about Broomfield information, to share information about the rate change.

Additional information will be shared in late 2025 before the new rates take effect.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program in 2026

The City and County of Broomfield (CCOB) is committed to supporting residents facing financial challenges, particularly with utility costs and property taxes. To this end, two key programs were established: the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) Program.

The PPTR Program, launched in February 2023, was created in response to the increasing burden of property taxes and broader cost-of-living pressures. It provides refunds for seniors aged 65+, veterans with an 80% documented disability, and adult homeowners with 100% documented disabilities.

The URAF Program, launched in 2025 and administered by the Housing Division, helps residents with utility affordability. Building on the operational success of the 2024 PPTR Program signifies a significant step in CCOB's commitment to its residents.

Staff recommends continuing both programs in the 2026 fiscal year and both are included in the proposed 2026 Budget. Both programs will continue to accept new applications through October 30, 2026, or until funding has been exhausted, whichever occurs first. Resolutions 2025-153 and 2025-154 include clarifications and adjustments to the URAF and PPTR programs. These changes aim to ensure the programs remain efficient, fiscally responsible, and responsive to community needs, aligning with Council Goals, Financial Sustainability and Resilience, and Organizational Health.

Utility Rate Assistance Fund (URAF) Program 2025 and 2026 Update

In 2025, City Council Resolution 2024-165 established the Utility Rate Assistance Fund (URAF) program, directing staff to provide quarterly credits or refunds to eligible households with incomes up to 100% of the Area Median Income (AMI).

A review of 2025 URAF applications by the Housing Division revealed that 74% of applicants, the vast majority, had incomes at or below 60% AMI. Consequently, staff recommended reducing the 2026 eligibility threshold to 60% AMI, a change first discussed during the July 2025 second quarterly update for Enterprise Funds.

In 2025, eligible households received monthly reimbursements for utility fees, covering about 50% of the increase from 2024. The maximum annual refund was capped at $240 per household. Reimbursement rates varied by housing type: $20 for single-family detached homes, $18 for townhomes, duplexes, and mobile homes, and $17 for apartments and condominiums. The proposal for 2026 is to maintain these same assistance levels for eligible residents. Eligibility will be based on the total adjusted earnings of all household members aged 18 and older. Residents who pay their water utility bill directly to Broomfield will receive the refund as a credit on their utility account. For residents who pay their water utility as part of rent, via an HOA or other third party, the refund will be issued in check form to the resident.

Broomfield's Housing Division, which also manages the partial property tax refund program, will continue to administer the URAF program, maintaining quarterly payouts based on Council feedback from the July 2025 enterprise funds update.

To support the 2025 URAF program rollout, two nine-month Limited Term Assignment (LTA) full-time staff positions were added to the Housing Division. The 2026 budget does not allocate funds for new staff to

manage the Utility Rate Assistance Fund (URAF). Instead, the administration will leverage current staff within the Housing Division of Economic Vitality. These staff members will track the time and costs associated with administering the program without additional long-term assistance (LTA) capacity. Updates will be provided during quarterly enterprise updates, and the Housing Division will continue to advertise the URAF program via social media, Broomfield's website, Our Broomfield, and alongside other housing initiatives throughout 2026. If additional advertising, postage, or other related expenses are determined to be necessary specifically for URAF, an amendment to the 2026 budget will be requested in 2026.

Utility Rate Assistance Fund (URAF) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 100% AMI	0% - 60% AMI
Payment Frequency	Quarterly	Quarterly

During the October 14, 2025 City Council meeting, a resident reported concern regarding the eligibility of mobile home residents for the URAF program. It should be noted, residents of mobile home communities are eligible for the program. Since their utility bill is typically paid through a third party, the resident would be issued a quarterly check rather than a credit toward their utility bill to ensure the program benefits the resident directly. In 2025, mailers were sent to mobile home residents to inform them about the program. As of October 1, 2025, approximately 12 mobile home residents have applied for and been approved for the URAF. Broomfield staff will continue to focus on outreach to mobile home residents in 2026.

URAF Program Data

URAF Program Data as of September 30, 2025		
URAF - Data Points	2025	2026
Program Budget	Program Credits*: $600,000 Program Checks: $493,100 Personnel: $104,300 URAF specific Advertising: $7,000 URAF Software: $8,300 URAF Equipment: $8,000	Program (credits/checks): $350,000 Personnel: $35,000 URAF specific Advertising: $0 URAF Software: $0 URAF Equipment: $0
Budget Expended	Program Credits: $132,879 Program Checks: $18,639 Personnel: $66,810 URAF Advertising/Postage: $7,620 Software: $8,300 Equipment: $4,492	N/A
Total Payments Processed	Through 2025 Q3: 3833	N/A
Total Applications Processed	1813	N/A
Eligibility	One of the following docs: IRS Tax Form, SS, SNAP, LEAP, etc.	Required - IRS Tax Form No tax filing - Proof of all income (SS, Bank Statements, Paystubs, etc.)
AMIs Served	0-30% ▫ 40% 31-60% ▫ 34% 61-80% ▫ 19% 81-100% ▫ 7%	0-30% 31-60% N/A N/A
Communication Efforts	Phone Calls: 1171 Emails: 446 Consultations: 429 (96 Spanish)	N/A N/A N/A
Outreach Events	31	N/A

*As part of the 2025 Budget - 1st Amendment, program credits were budgeted at $1,479,300; as part of the 2025 Budget - 2nd Amendment, program credits are now budgeted at $600k.

Partial Property Tax Refund (PPTR) Program - 2025 Update and 2026 Recommendation

The Partial Property Tax Refund (PPTR) Program, established by Resolution No. 2022-123 and expanded with Resolution No. 2024-27 and Resolution No. 2024-105, offers financial relief to specific demographics facing increasing property tax burdens and general cost-of-living pressures. Eligible participants include seniors aged 65 and older, veterans with a documented disability of 80% or more, and adult homeowners with 100% documented disabilities.

While the Housing Division will continue to utilize 2021 tax year data as the program's baseline, the 2026 refund is anticipated to be lower than in 2025 due to the recently adopted House Bill 24B-1001. Despite these adjustments, the program is expected to continue providing significant support to qualifying households.

Partial Property Tax Refund (PPTR) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 80% AMI	0% - 80% AMI
Program Final Application Date	October 30, 2025	October 30, 2026

PPTR Program Data

PPTR Program Data as of October 13, 2025		
PPTR - Data Points	2025	2026
Program Budget	Program ≤ 60% AMI: $402,000 Program 61-80%: $100,000	Total Program: $600,000 Anticipated utilization ≤ 60% AMI: $500,000 61-80%: $100,000
Budget Expended	Program ≤ 60% AMI: $401,693 Program 61-80%: $90,016	N/A
Total Payments Processed	963	N/A
Total Applications Processed	1265	N/A
AMIs Served/Processed	0-30% ▫ 41.5% 31-60% ▫ 36.0% 61-80% ▫ 18.5% Ineligible ▫ 4.0%	0-30% 31-60% 61-80%
Communication Efforts	Phone Calls: 517 Emails: 332 Consultations: 397 (77 Spanish)	N/A N/A N/A
Outreach Events	33	N/A

Bond Issuances

Until 2021, Broomfield did not have a formal Debt Policy. Since adopting one, we have aligned with industry and government standards by capping total debt at no more than 10% of the City's assessed value. As of the close of fiscal year 2024, Broomfield's total debt was at 5.25% of assessed value – well below industry standards.

In 2023, debt service accounted for 4.6% of total revenues, and in 2024, that decreased slightly to 4.2%, reflecting our intentional focus on managing and reducing outstanding obligations. For context, debt service levels under 5% of total revenue are typically considered "best in class."

As we look ahead, the staff has strategically timed the issuance of new debt to coincide with the defeasance of the 2017 Certificates of Participation (COP) for the County building. This approach will help offset the impact of new debt issuance for the upcoming Police and Courts facility. While we expect to slightly exceed the 5% debt-to-revenue ratio following issuance, our strong financial standing provides confidence in our ability to manage this responsibly. In the past two years, Broomfield has earned three credit rating upgrades, which is a significant achievement

Conclusion and Next Steps

The 2026 budget represents a disciplined, data-driven approach to maintaining Broomfield's financial sustainability while meeting our community's needs. Through careful stewardship of public resources, strategic infrastructure investments, and thoughtful prioritization of mandates, obligations, and critical needs, this budget positions our organization to navigate current fiscal challenges while preparing for future opportunities.

Key Takeaways

The proposed 2026 budget demonstrates our commitment to:

- **Fiscal Responsibility**: Maintaining 20% reserves and managing debt prudently
- **Infrastructure Investment**: Addressing critical water, sewer, and public safety facility needs
- **Community Support**: Continuing programs like URAF and PPTR to assist residents facing financial challenges
- **Operational Excellence**: Optimizing existing resources before requesting new ones

Action for Council - October 28, 2025

7.A Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-141 - 2025 Budget - 2nd Amendment
- Resolution 2025-142 - 2026 CCOB Budget

7.B Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-143-UR - 2025 BURA Budget - 2nd Amendment
- Resolution 2025-144-UR - 2026 BURA Budget

7.C Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

- Resolution 2025-145-AID - 2026 ALID Budget

7.D Public Hearing - Ordinance Section Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

- Ordinance 2286 - Enterprise Rate Ordinance

7.E Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

- Ordinance 2288 - Water Tanks Bond
- Ordinance 2289 - Wastewater Treatment Bond
- Ordinance 2290 - Police/Courts COP

7.F Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

- Resolution 2025-153 - URAF Program Continuation
- Resolution 2025-154 - PPTR Program Continuation

Looking Ahead

Following the adoption of the 2026 budget, staff will:

- Issue bonds in Q1 2026 for Police/Courts facility and enterprise projects
- Begin construction on the Police building, Water tanks, and Wastewater Expansion Project
- Implement the updated URAF and PPTR programs
- Come before Council Dec. 9th with an amendment focused on grants received in 2025
- Continue quarterly Enterprise Fund updates to Council
- Collaborate with FLOW on recommendations for the 5-Year Water Utilities Capital Improvement Plan (CIP) and rate adjustments for the 2027 budget.
- Monitor economic conditions and provide budget updates as needed
- Prepare for the 2027 budget process with continued emphasis on financial sustainability

Staff remains committed to transparent communication, data-driven decision-making, and collaborative problem-solving as we work together to serve our community and achieve our shared goals.

RESOLUTION NO. 2025-141

A resolution authorizing and approving the second amendment to the City and County of Broomfield Budget for the year 2025

Recitals.

Whereas, the City Council, by Resolution No. 2024-149, dated October 22, 2024, adopted the budget for the City and County of Broomfield for the calendar year 2025; and

Whereas, the City Council, by Resolution No. 2025-44, dated March 11, 2025, amended the budget for the City and County of Broomfield for the calendar year 2025; and

Whereas, the City Council desires to amend said budget a second time to reflect additional revisions to expenditures and revenues.

Now, therefore, be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1. Budget Amendment

Pursuant to Section 12.10 of the Charter for the City of Broomfield and upon certification by the City and County Manager, the Budget for the City and County of Broomfield for the year 2025 is hereby amended as follows.

A. City and County General Fund
The amount budgeted for total City and County General Fund Expenditures is hereby increased by $4,249,796 from $172,445,034 to $176,694,829.

The amount budgeted for total City and County Fund Revenues is hereby increased by $12,717,331 from $159,068,748 to $171,786,079.

With this amendment, the projected ending fund balance for the City and County General Funds will be $16,868,506.

B. Recreation Fund
The amount budgeted for total Recreation Fund Expenditures is hereby decreased by $80,156 from $11,763,560 to $11,683,404.

The amount budgeted for total Recreation Fund Revenues is hereby decreased by $89,721 from $11,773,125 to $11,683,404.

With this amendment, the projected ending fund balance for the Recreation Fund will be $0.

C. Streets Maintenance Fund

The amount budgeted for total Streets Maintenance Fund Expenditures is hereby decreased by $534,483 from $8,480,698 to $7,946,215.

The amount budgeted for total Streets Maintenance Fund Revenues is hereby decreased by $534,483 from $8,480,698 to $7,946,215.

With this amendment, the projected ending fund balance for the Streets Maintenance Fund will be $0.

D. Library Fund

The amount budgeted for total Library Fund Expenditures is hereby decreased by $25,191 from $4,842,067 to $4,816,876.

The amount budgeted for total Library Fund Revenues is hereby increased by $10,748 from $4,572,130 to $4,582,878.

With this amendment, the projected ending fund balance for the Library Fund will be $1,0790,505.

E. Facility Maintenance Fund

The amount budgeted for total Facility Maintenance Fund Expenditures is hereby increased by $184,099 from $8,651,560 to $8,835,659.

The amount budgeted for total Facility Maintenance Fund Revenues is hereby increased by $184,099 from $8,651,560 to $8,835,659.

With this amendment, the projected ending fund balance for the Facility Maintenance Fund will be $0.

F. Human Services Fund

The amount budgeted for total Human Services Fund Expenditures is hereby increased by $1,681,928 from $22,241,484 to $23,923,412.

The amount budgeted for total Human Services Fund Revenues is hereby increased by $1,669,004 from $21,762,749 to $23,431,753.

With this amendment, the projected ending fund balance for the Human Services Fund will be $5,789,938.

G. Capital Improvement Fund

The amount budgeted for total Capital Improvement Fund Expenditures is hereby increased by $1,952,020 from $122,249,587 to $124,201,607.

The amount budgeted for total Capital Improvement Fund Revenues is hereby increased by $7,689,351 from $58,171,882 to $65,861,233.

With this amendment, the projected ending fund balance for the Capital Improvement Fund will be $5,781,778.

H. Open Space & Parks Fund

The amount budgeted for total Open Space & Parks Fund Expenditures is hereby increased by $100,000 from $19,451,935 to $19,551,935.

The amount budgeted for total Open Space & Parks Fund Revenues is hereby increased by $898,127 from $15,784,427 to $16,682,554.

With this amendment, the projected ending fund balance for the Open Space & Parks Fund will be $20,494,109.

I. Services Expansion Fee Fund

The amount budgeted for total Services Expansion Fee Fund Expenditures is hereby increased by $279,046 from $108,011 to $387,057.

The amount budgeted for total Services Expansion Fee Fund Revenues is hereby increased by $182,850 from $1,220,350 to $1,403,200.

With this amendment, the projected ending fund balance for the Services Expansion Fee Fund will be $14,020,030.

J. Developer Agreement Fund

The amount budgeted for total Developer Agreement Fund Expenditures is hereby increased by $2,024,226 from $16,662,433 to $18,686,659.

The amount budgeted for total Developer Agreement Fund Revenues is hereby increased by $917,094 from $16,746,741 to $17,663,835.

With this amendment, the projected ending fund balance for the Developer Agreement Fund will be $3,857,562.

K. Debt Service Fund

The amount budgeted for total Debt Service Fund Expenditures is hereby increased by $1,000,000 from $14,054,500 to $15,054,500.

The amount budgeted for total Debt Service Fund Revenues is hereby increased by $1,000,000 from $14,050,800 to $15,050,800.

With this amendment, the projected ending fund balance for the Debt Service Fund will be $120,001.

L. Water Fund

The amount budgeted for total Water Fund Expenditures is hereby decreased by $1,757,172 from $75,202,923 to $73,445,751.

The amount budgeted for total Water Fund Revenues is hereby decreased by $1,821,061 from $43,880,825 to $42,059,764.

With this amendment, the projected ending fund balance for the Water Fund will be $18,729,436.

M. Sewer Fund

The amount budgeted for total Sewer Fund Expenditures is hereby decreased by $3,280,802 from $62,989,221 to $59,708,419.

The amount budgeted for total Sewer Fund Revenues is hereby decreased by $2,743,065 from $29,719,799 to $26,976,734.

With this amendment, the projected ending fund balance for the Sewer Fund will be $57,191,911.

N. Water Reclamation Fund

The amount budgeted for total Water Reclamation Fund Expenditures is hereby decreased by $3,171 from $5,891,002 to $5,887,831.

The amount budgeted for total Water Reclamation Fund Revenues is hereby unchanged and remains at 2,081,522.

With this amendment, the projected ending fund balance for the Water Reclamation Fund will be 5,910,632.

O. Stormwater Fund

The amount budgeted for total Stormwater Fund Expenditures is hereby increased by $2,310,109 from $2,939,188 to $5,249,297.

The amount budgeted for total Stormwater Fund Revenues is hereby unchanged and remains at 6,600,000.

With this amendment, the projected ending fund balance for the Stormwater Fund will be $1,350,703.

Section 2. Budget Tables

Budget Tables for all amended funds are made an integral part hereof, and all other applicable budget tables are amended by the inclusion of the amendments set forth above.

Section 3. Effective Date

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

RESOLUTION NO. 2025-142

A resolution adopting the budget for the City and County of Broomfield for the fiscal year 2026 and appropriating sums of money

Be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1. Budget Adoption

The following sums of money are hereby appropriated for fiscal year 2026 in the amounts set forth as follows:

Expenditures*	
Fund	2026 Proposed Budget
City General	$ 108,628,047
County General	50,529,983
Facility Maintenance	9,080,551
Recreation Services	12,014,827
Library	4,745,938
Street Maintenance	8,022,020
Cemetery	405,750
Health and Human Services	25,823,384
Lodging Tax	750,000
Development Agreements	19,988,652
Capital Improvement & Asset Replacement	156,306,473
Open Space & Parks	7,971,382
Conservation Trust	495,000
Service Expansion Fee Fund	217,050
Water	121,646,196
Sewer	138,188,587
Water Reclamation	6,744,715
Stormwater	7,973,834
Police Defined Benefit Pension	6,000

Police Money Purchase Pension	7,000
Employee Defined Benefit Pension	1,994,000
Employee Money Purchase Pension	6,925,000
Retiree Health Insurance Plan	249,000
Tax Passthrough Fund	171,969,389
Inmate Checking Fund	1,200,000
Employee Medical Care	18,049,124
Debt Service	17,231,519
Total City & County Budget	**$ 897,163,421**

Section 2.

Any and all year-end fund balances in 2026 shall be considered “reserve increase” and shall constitute a part of 2026 “fiscal year spending” within the meaning of Sections 20(2) and (3) of Article X of the Constitution of the State of Colorado.

Section 3.

Pursuant to Section 20(5) of Article X of the Constitution of the State of Colorado, not less than three (3) percent of the Fiscal Year 2026 spending is reserved for emergencies.

Section 4. Effective Date

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

B. Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7B.

Voted By Board	Presented By
Broomfield Urban Renewal Authority - BURA	Graham Clark, Director of Finance

Community Goals
☑ Financial Sustainability and Resilience

Overview

View Correspondence
View Presentation

The purpose of this memo is to present financial information related to the second amendment of the 2025 City and County of Broomfield and the Broomfield Urban Renewal Authority Budgets, financial information related to the proposed 2026 budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District, information related to the proposed increases to utility rates for the Broomfield Enterprise Funds, information related to the proposal of two enterprise revenue bonds and police building and courts remodel certificate of participation, and information related to the Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) programs.

Attachments

Memo for 10_28_2025_2nd Amd to 2025 Budget; Adoption of 2026 Budget (CCOB, BURA, ALID); Utility Rates Ord; URAF, PPTR, Bond Ords.pdf
Resolution 2025-143-UR 2nd Amd to 2025 Budget (BURA).pdf
Resolution 2025-144-UR 2026 Budget Adoption (BURA).pdf

Memo for 2nd Amendment to the 2025 Budget and Adoption of the 2026 CCOB, BURA, and ALID Budgets; second reading of amending water, sewer, reclaimed water and stormwater rate ordinance; second reading of two enterprise revenue bonds and police building certificate of participation ordinances; URAF and PPTR programs for 2026
Prepared By: J. Stephanie Chen, Budget Manager

Summary

View Correspondence
View Presentation

Comprehensive Budget Process

The City and County of Broomfield's budget development is a comprehensive, year-long process designed to ensure fiscal responsibility, transparency, and meaningful community and Council engagement. This memorandum represents the culmination of extensive collaborative work that has unfolded throughout 2025, with multiple touchpoints providing City Council and the community opportunities to review, discuss, and shape the financial direction of our organization. This deliberate, methodical approach ensures that budget decisions are informed by current data, community needs, economic conditions, and strategic priorities while maintaining the highest standards of transparency and public accountability.

The Governmental Accounting Standards Board (GASB) sets the accounting and financial reporting standards that state and local governments must follow. Its purpose is to ensure that financial statements are consistent, transparent, and useful to the public, elected officials, and oversight bodies. GASB standards help governments show how public funds are managed, spent, and accounted for, promoting accountability and public trust. Our Broomfield budgets are built using GASB standards, which means our financial reporting and budgeting processes follow the same professional principles used nationwide to ensure accuracy, consistency, and transparency in how we manage public resources.

Year-Long Budget Development Timeline

The 2026 budget process began in early 2025 and has included the following key milestones:

- January-March 2025: Initial financial forecasting and departmental needs assessment
- March 8, 2025: Council Focus Session - 2.C. Conditions of/and influences on Broomfield's economic and fiscal status, 2.H. Anticipated Development and the impacts on fiscal sustainability
- April 15, 2025: Council Study Session - First Quarterly Enterprise Funds Study Session - Council review of enterprise fund status, capital projects, maintenance programs, 2024 financial results, and long-term financial sustainability strategies
- May 8, 2025: Council Study Session - Early introduction to the 2026 budget process and year-to-date financial information
- July 15, 2025: Council Study Session - Second Quarterly Enterprise Funds Study Session - Council review of enterprise fund updates, development projections, and initial utility rate recommendations with subject matter expert consultant AECOM
- August 19, 2025: Council Study Session - Economic and Fiscal Update and Draft Operating and Capital Budgets Study Session - Comprehensive presentation to Council on Broomfield's economic and financial outlook, including CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments
- August 21, 2025: Community Briefing - Public presentation and opportunity for public questions on Economic Long Range Financial Plan and Financial Status Briefing
- September 3, 2025: City Council received the 2026 Proposed Budget and supporting documentation
- September 4, 2025: 2026 Proposed Budget and supporting documents made available for public review and comment on Broomfield.org/Finance
- September 18 and September 25, 2025: Budget Study Sessions with opportunities for public comment - 2026 Proposed Operating & Capital Budgets with department representatives
- October 14, 2025: City Council Meeting - Public Hearing per Chapter 12.7 of the Charter for the 2026

Operating and Capital Budgets, with first reading of key ordinances
- October 21, 2025: City Council Study Session - Final Quarterly Enterprise Funds update of 2025
- October 28, 2025: City Council Meeting - Second reading of ordinances and adoption of budgets (this meeting) with public hearing

Strategic Context and Fiscal Discipline

1. Financial Sustainability and Resilience - Ensuring Broomfield's long-term fiscal health in an uncertain economic environment
2. Transparency and Public Engagement - Providing multiple opportunities for community input and Council deliberation
3. Data-Driven Decision Making - Utilizing comprehensive financial modeling, economic forecasting, and historical analysis
4. Prioritization of Core Services - Focusing resources on mandates, obligations, and critical needs
5. Infrastructure Investment - Addressing deferred maintenance and preparing for future growth
6. Responsible Debt Management - Maintaining our strong credit rating while financing essential capital projects

Summary of Items for Consideration

The City and County of Broomfields budget includes all government operations as well as Enterprise Funds (Water, Sewer, Stormwater and Reuse). The proposed budgets and related documents were available for public review and comment on Broomfield.org/Finance on September 4, 2025.

The staff memorandum from October 14, 2025 regarding the public hearing for City and County of Broomfield (CCOB), Arista Local Improvement District (ALID), Broomfield Urban Renewal Authority (BURA) budgets; first reading of Ordinance No. 2286 amending water, sewer, reclaimed water and stormwater rate ordinance; first reading of two enterprise revenue bonds and police building certificate of participation ordinances (Ordinances No. 2288, 2289 and 2290), included a detailed discussion of the proposed resolutions and ordinances.

It is important to note that the proposed budget is consistent with the October 14, 2025 memorandum and initial proposed budget, with the exception of one change:

- The operational expenditures are expected to increase by 5.8% as opposed to 5.9% due to the combination of a reduction to the amount recommended for the District Attorney (DA) budget discussed during the hearing on October 14, 2025, and a small increase in the budget used for non-profit distributions under the Human Services Fund.

This change is specific to the proposed 2026 budget for CCOB and is reflected in Resolution 2025-142. It does not alter the proposed budgets for BURA or ALID, the water project agreements, enterprise rate ordinance, or any of the bond ordinances considered on first reading during the October 14, 2025 meeting.

The content of this staff memorandum is consistent with the October 14, 2025 memorandum, with additional information provided for the following:

- Information regarding the 2025R Budget - 2nd Amendment.
- Details regarding the non-residential utility rates and license fees for 2026 are provided to clarify what is included in Ordinance 2286 in response to questions from the October 14, 2025 meeting.
- Additional details regarding how the 2025 rate increase was utilized to directly improve water, sanitary sewer, and stormwater resources for Broomfield residents and businesses.
- Details regarding the Utility Rate Assistance Fund program for 2026 as proposed in Resolution No. 2025-153.
- Details regarding the Partial Property Tax Refund program for 2026 as proposed in Resolution No. 2025-154.

City and County of Broomfield Budget

2025 Budget - 2nd Amendment Summary

- The 2025 City and County budget has been amended one time since its adoption to reflect capital project rollovers, grant rollovers, and operational budget adjustments.
- The following attachments are included with this memo to provide fund level details of the 2025 revised budget adjustments. These tables referenced below reflect cumulative prior amendment #1, in addition to the new adjustments in this proposed second (2nd) amendment to the 2025 budget. Revenue and expenditure adjustments (increases and decreases) are also included for reference.
    - 2025 Revised Budget Summary - General Governmental Funds
    - 2025 Revised Budget Summary - Governmental Capital Funds
    - 2025 Revised Budget Summary - Governmental Debt Service Fund
    - 2025 Revised Budget Summary - Enterprise Funds
    - 2025 Revised Budget Summary - Fiduciary Funds
- The second proposed City and County amendment, Resolution No. 2025-141, sets the final 2025 amended budget to reflect expenditures of $775,190,595.

2026 Budget

- The 2026 Proposed City and County of Broomfield Budget has been prepared to reflect expected revenues and expenditures. A set of summary budget tables are included with the resolutions under consideration.
- The 2026 Proposed Budget for the City and County of Broomfield total expenditures are $844,125,005. This amount includes interfund activities and transfers to reserves.
- Tables 1A-4C summarize the 2026 Proposed Budget for the City and County of Broomfield.
- Proposed Resolution No. 2025-142, if adopted, would approve the 2026 Budget for the City and County.

Broomfield Urban Renewal Authority

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2025 Budget - 2nd Amendment Summary

- The proposed BURA budget amendment, Resolution No. 2025-143-UR, is the second amendment proposed since its adoption and reflects unexpended capital improvement project budgets, and revenue adjustments which impacts expense budgets since the adoption of the fiscal year 2025 budget.
    - The proposed BURA budget amendment also reflects a slight decrease in expenditures for a total of $57,118,701.
    - BURA Budget Tables summarize the 2025 revised budget for BURA.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for BURA. In some URAs, planned uses of fund balance are being used for capital expenditures. The BURA proposed total revenues for 2026 are $65,119,746, and the proposed total expenditures are $49,978,125.
    - Tables 1-13 summarize the 2026 Proposed Budget for the BURA.
    - Proposed Resolution No. 2025-144-UR, if adopted, would approve the 2026 Budget for the Broomfield Urban Renewal Authority.

Arista Local Improvement District

The Arista Local Improvement District (ALID) was established in August 2005 to facilitate the construction of transportation facilities in the Arista Development.

2025 Budget - 2nd Amendment Summary

- The 2025 ALID budgeted expenditures have not changed, therefore, no amendment is required at this time.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for the ALID. Attached is a copy of the budget message and budget tables for the ALID for the 2026 Proposed Budget. Anticipated total revenues for 2026 are $45,000. Proposed total expenditures for 2026 are $45,000.
    - Table 1 summarizes the 2026 Proposed Budget for ALID.
    - Proposed Resolution No. 2025-145-AID, if adopted, would approve the 2026 Budget for the Arista Local Improvement District.

Enterprise Rate Ordinance

City Council held quarterly enterprise study sessions on April 15, 2025, July 15, 2025, and October 21, 2025, to review staff's updates on the status of the enterprise funds. The April meeting covered capital projects, maintenance programs, 2024 financial results, steps for ensuring long-term financial sustainability, and the proposed Fiscal Leadership on Water (FLOW) Advisory Committee. The July meeting covered similar topics as well as an overview of development projections and future rate recommendations. The October meeting included an update regarding ongoing capital and maintenance programs for 2025, as well as a presentation from the FLOW Advisory Committee.

City Council also received updates on the Enterprise Funds during the Economic and Fiscal Update held at a Study Session on August 19, 2025. Topics addressed included CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments.

In 2025, the City and County of Broomfield implemented the first utility rate increase of a comprehensive five-year financial plan to address the financial sustainability of the enterprise funds. This increase was necessary as the costs of providing safe, reliable water service continued to rise due to aging infrastructure requiring increased maintenance and replacement, new regulatory requirements and unfunded mandates,

and a substantial backlog of critical system repairs and upgrades. Recognizing the financial burden this placed on residents, Council established the Utility Rate Assistance Fund (URAF) to help eligible households manage the impact.

The five-year plan includes a year two increase totaling $16.89 per month for the average single-family home (9,000 gallons) starting in 2026. Staff anticipates that continued adjustments in future years should be expected due to the annual application of the utility's long-range model, the criticality of ongoing infrastructure support, and to accommodate costs from unknown, but anticipated, state and federal mandates. The URAF to help eligible households remains in the budget for 2026, with minor adjustments.

Bond Ordinances

Police Building/Courts Remodel

This item is presented for the City Council's consideration and authorization to issue $100M in bonds to fund the Police Building/Courts Remodel. This financing utilizes Certificates of Participation (COPS), where the City will finance the project's construction by collateralizing existing City facilities via a Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, and Escrow Agreement. A Preliminary Offering Statement, Indenture, and Disclosure Certificate are also required. Selected facilities that will be borrowed against include Paul Derda Recreation Center, the Broomfield Community Center, the Detention Center, and the Service Center Administration Building. The anticipated maximum annual debt payment resulting from the financing will not exceed $7.9M and the annual payments will come from the City's general fund; however, the debt does not create a general obligation debt or multiple-year fiscal obligation, as the annual debt service payment is subject to annual appropriation.

As part of the 2023 property tax revenue increase, funding was designated to support the construction of the new Police building. In collaboration with our financial advisors, staff determined that using the set-aside property tax dollars to retire the 2017 Certificates of Participation (COPs) represents a sound long-term financial strategy. By applying these funds and coordinating the payoff of prior debt, the City can help offset the financial impact of issuing new debt for the upcoming Police and Courts facility. Recent credit rating upgrades and the City's strong financial position further reinforce confidence in our ability to manage debt responsibly.

The term of the financing will mature on or before December 31, 2047. The anticipated net effective interest rate will not exceed 5.50%. Additionally, as part of this financing, the City will also pay off its 2017 Certificates of Participation (COP) that have a current outstanding balance of $10.89M utilizing unencumbered cash on hand. The 2017 COPs were to mature on December 1, 2027. They were originally issued in 2010 to fund facilities needed to provide county services and for parks and recreation activities, and were refinanced in 2017.

Water Tanks

This item is presented for the City Council's consideration and authorization to issue $80M in Water Revenue bonds for funding the new water tanks. Broomfield's water system model identifies capital improvements that will be needed as Broomfield develops, including the construction of the proposed Water Tanks. The model specifically focuses on the phased development of the areas north of W. 144th Avenue that are quickly developing. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $5.9M and the term of the bonds will mature on or before December 1, 2047.
The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Water Activity Enterprise and does not impact the City's general fund. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement.

Related to the issuance of the Water Bonds, staff will be presenting to the City Council on October 28, 2025 as part of agenda item 7(G) - Water Tanks Construction Agreement, proposed Resolution No. 2025-152

authorizing the reimbursement to the water enterprise fund from bond proceeds (if needed) for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to award a construction contract up to the amount of the advanced funds and begin construction before the bonds' closing. It is expected that a construction contract will be presented to the City Council for approval in November and construction to begin on or about January 1, 2026. An amendment to the construction contract would then be presented to the City Council for approval once the bond proceeds are available for appropriation. Construction of the water tanks is projected to last 36 months.

Wastewater Treatment Facility Improvements

This item is presented for the City Council's consideration and authorization to issue $125M in Sewer Revenue and Refunding bonds for funding the Wastewater Treatment Facility Expansion. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $11M and the term of the bonds will mature on or before December 1, 2047. The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Sewer Activity Enterprise and does not impact the City's general fund. As a part of this financing, the City will also refund and discharge its 2012 Sewer Revenue Refunding Bonds with an outstanding balance of $15.315M that matures on December 1, 2031. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement.

The Wastewater Treatment Facility Improvements are being driven by expected future increases in population and regulatory requirements from the CDPHE that will require significant expansion to the current facility to adequately treat the increase in wastewater and maintain compliance with current and future regulatory requirements. Project drivers include capacity, asset renewal, biosolids, reuse, and regulation. Construction is to begin in 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

This memo will affirm and clarify the planned continuation of the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) programs into the 2026 fiscal year, as outlined in the proposed 2026 Budget for the City and County of Broomfield. These programs are designed first and foremost to support residents experiencing financial burden, while also serving as key components of the City's broader commitment to Council Goals, Financial Sustainability and Resilience, and Organizational Health.

The adjustments provide a summary of operational updates to ensure both programs remain efficient, fiscally responsible, and responsive to community needs within the budgeted resource allocations.

Financial Considerations

2025 Budget - 2nd Amendment

Resolutions 2025-141 and 2025-143-UR outline the financial considerations related to the second amendment to the 2025 budgets for both the City and County of Broomfield and Broomfield Urban Renewal Authority.

2026 Budget

Resolutions 2025-142, 2025-144-UR, and 2025-145-AID outline the financial considerations related to the adoption of the 2026 Budgets for the City and County of Broomfield, the Arista Local Improvement District, and the Broomfield Urban Renewal Authority.

Enterprise Ordinances

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees outlines the financial considerations related to this agenda item.

Bond Ordinances

Ordinance No. 2288 upon approval, authorizes debt financing of up to $80M for the Water Tanks and

approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement related thereto.

Ordinance No. 2289 upon approval, authorizes debt financing of up to $125M for the Wastewater Treatment Facility Improvements and approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement related thereto.

Ordinance No. 2290 upon approval, authorizes debt financing of up to $100M for the Police Building/ Courts Remodel and approves as to form the Preliminary Official Statement, Indenture, Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, Disclosure Certificate, Escrow Agreement related thereto.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

Resolution 2025-153 outlines the financial and programmatic considerations related to the Utility Rate Assistance Fund (URAF) Program.

Resolution 2025-154 outlines the financial and programmatic considerations related to the Partial Property Tax Refund (PPTR) Program.

Prior Council or Other Entity Actions

2025 Budget

October 22, 2024: Council approved Resolution 2024-149 adopting the 2025 CCOB Budget; BURA approved Resolution 2024-150-UR adopting the 2025 City and County of Broomfield Budget
March 11, 2025: Council approved Resolution 2025-44 amending the 2025 CCOB Budget; BURA approved Resolution 2025-52-UR amending the 2025 BURA Budget

2026 Budget

August 19, 2025: Staff provided information and insights to inform the Council on Broomfield's economic and financial outlook, influencing the 2025 revised budget and the 2026 operating and capital proposed budgets.
August 21, 2025: Staff provided an overview of how Broomfield intends to fulfill the community goal of financial sustainability and resilience at the Broomfield 101: Economic and Fiscal Update Community Forum.
September 3, 2025: The City Council received the 2026 Proposed Budget and supporting documentation.
September 4, 2025: The 2026 Proposed Budget and supporting documents were made available for public view and comments on the City's website.
September 18 and September 25, 2025: Study Sessions to discuss the 2026 Proposed Operating & Capital Budgets with department representatives.
October 14, 2025: Public Hearing per Chapter 12.7 of the Charter for the 2026 Operating and Capital Budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District.

Enterprise Ordinances

April 15, 2025: Staff held the first 2025 quarterly Enterprise Funds study session and provided an overview to City Council on the status of the enterprise funds.
May 13, 2025: Creation of FLOW Advisory Committee approved by City Council.
July 15, 2025: Staff held the second 2025 quarterly Enterprise Funds study session, providing an update on the enterprise funds and initial recommendations on utility rate adjustments, along with a presentation by subject matter expert consultant AECOM.
October 14, 2025: First reading of ordinance number 2286.
October 21, 2025: Staff will provide an overview to City Council in a Broomfields Enterprise Funds study session and initial results of additional repair and replacement capital added during the 2025 budget.

Bond Ordinances

August 19, 2025: Staff provided information and insights to City Council on Broomfield's high credit rating

and the organization's "superior ability to repay short-term debt obligations," providing guidance to ensure Broomfield's financial stability while requesting new bonds to finance the 2026 capital improvement projects for the new Police Building / Courts Remodel and Water and Sewer infrastructure improvements.
October 14, 2025: First reading of ordinance numbers 2288, 2298, and 2290.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
November 1, 2022: Council Approved the 2023 PPTR Program with Resolution No. 2022-123.
January 23, 2024: Council Approved the Expansion of the PPTR Program in 2024 with Resolution No. 2024-27.
October 22, 2024: Council Approved the URAF Program with Resolution No.2024-165.
October 22, 2024: Council Approved the 2025 Budget with Resolution No. 2024-149.
December 3, 2024: Council Approved the 2025 PPTR Program with Resolution No. 2024-105.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

2025 and 2026 Budget
If Council desires to approve the proposed 2025 budget amendment, the appropriate motion is...
That Resolution 2025-141 be adopted.

If Council desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-142 be adopted.

If BURA desires to approve the proposed 2025 budget amendment, the appropriate motion is…
That Resolution 2025-143-UR be adopted.

If BURA desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-144-UR be adopted.

If ALID desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-145-AID be adopted.

Amending Enterprise Ordinance

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2286 be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to water, sewer, water reclamation, and stormwater charges and fees as set forth in these ordinances would be effective January 1, 2026.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2288 Issuing Enterprise Revenue Bond (Water Tanks) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2289 Issuing Enterprise Revenue Bond (Wastewater Treatment - Phase 1B) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2290 Issuing Certificates of Participation (Police and Courts Buildings) be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to the issuance of new bonds as set for in the ordinances would be effective January 1, 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program

If the Council desires to proceed with the staff recommendations for the continuation of the Utility Rate Assistance Fund Program in 2026, the appropriate motion is…

That Resolution 2025-153 be adopted.

If the Council desires to proceed with the staff recommendations for the continuation of the Partial Property Tax Refund Program in 2026, the appropriate motion is…

That Resolution 2025-154 be adopted.

Alternatives

Budget

Per Charter, the City Council must adopt a budget. If it fails to do so, the budget will be put on future agenda(s) until such time as it is approved. If Council fails to adopt the budget, the amounts appropriated for the operation of the current fiscal year shall be deemed adopted for the next fiscal year on a month-to-month basis, with all items in it prorated accordingly, until such time as the Council adopts the budget for the next fiscal year.

Amending Enterprise Ordinance

If Council does not approve the recommended utility rate ordinance, the existing fee structure would remain in place. CCOB's Enterprise funds' financial sustainability and resiliency would weaken. The ability to obtain favorable financing for necessary projects, including wastewater treatment facility expansion and water tanks, would be put at risk.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If Council does not approve the recommended two enterprise revenue bonds and police building certificate of participation ordinances, CCOB would not defease the existing certificates of participation and would not move forward with the issuance of the bonds. CCOB would not be able to finance the necessary projects, which include the Wastewater Treatment Facility Expansion, Water Tanks, and new Police Building.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
Do not approve staff recommendations. If not approved, provide an alternative direction.

Background - Budget

Broomfield has grown and evolved significantly over the past twenty years from an emerging suburban community into a large, thriving, and maturing urban-suburban community. Since the consolidation of our community in 2001, Broomfield has provided effective and efficient city and county programs and services. Today, Broomfield is home to nearly 80,000 residents, living in more than 34,000 housing units and thousands of businesses. While much of Broomfield's 34 square miles is built out, there is a continued focus on developing and evolving while maintaining long-term financial sustainability and resilience.

Budget Process and Philosophy

The budget is a planning tool that is used to meet the results of the March 3, 2023, Council Focus Session, where the Community Goals were solidified with an emphasis on Goal #1: Financial Sustainability and Resilience. Therefore, the budget process is flexible and responsive to organizational and community needs and economic conditions.

In addition, staff will continue with a comprehensive, clear, and transparent approach by bringing forth a consolidated number of budget amendments for the Council's review and consideration, and for transparency for Broomfield residents. Each budget amendment is designed to address specific topic areas outlined below.

- **Budget Amendment 1** (Q1): reflects the carryover of capital and grant projects from the prior fiscal year and any additions to operational budgets (i.e., increased cost for Spring Cleanup).

- **Budget Amendment 2** (In conjunction with adopting the following fiscal year's budget; Q4): reflects the current state of actual revenues and expenditures, including any supplemental requests, and sets the foundation for the following year's budget.
  This amendment also includes the prior year's audited financials (actual beginning fund balances), which helps inform the ability to fund future year financial shifts.

- **Budget Amendment 3** (Q4): if needed, addresses grants, which often require financial adjustments based on project or program status of implementation and execution due to the timing of the grant award.

Current and future budgeting processes are designed to ensure operational and capital success, focusing on creating a culture of accountability and intentionality while basing the budget on revenue and expenses. This helps to drive forward a sustainable, disciplined structure of reallocating funds and not continuing to increase expenditures arbitrarily.

Proposed Budgets

2025 Revised Budget Summary

On October 22, 2024, City Council passed Resolution 2024-149 to adopt the 2025 budget for the City and Council of Broomfield. Additionally, the Broomfield Urban Renewal Authority approved resolution 2024-150-UR to adopt the 2025 budget for BURA. Since the adoption, the budgets have been amended one (1) time to reflect capital project rollovers, grant rollovers, and additional capital and operational budget adjustments. As can be seen in the table below, adjustments to the City and County of Broomfield budget in amendment #1 is listed as well as the proposed adjustments in amendment #2.

CITY AND COUNTY OF BROOMFIELD
REVISED BUDGET SUMMARY - ALL FUNDS*

Fund	Original Budget 2025	Budget Amendments #1 2025	Budget Amendment #2 2025	Amended Budget 2025
Beginning Fund Balance	**$ 304,842,581**			**$ 408,834,091**
Revenues				
General Governmental Funds	$ 201,022,977	$ 14,388,112	$ 13,956,978	$ 229,368,067
Governmental Capital Funds	89,039,461	18,228,553	9,687,422	117,955,436
Enterprise Funds	83,761,446	(1,479,300)	(4,564,126)	77,718,020
Fiduciary Funds	223,100,356	-	-	223,100,356
Total Revenues	**$ 596,924,240**	**$ 31,137,365**	**$ 19,080,274**	**$ 648,141,879**
Expenditures				
General Governmental Funds	$ 216,385,986	$ 13,140,495	$ 5,475,993	$ 235,002,474
Governmental Capital Funds	103,310,912	73,107,734	4,355,292	181,773,938
Enterprise Funds	99,516,325	47,506,010	(2,731,036)	144,291,298
Fiduciary Funds	214,122,885	-	-	214,122,885
Total Expenditures	**$ 633,336,108**	**$ 133,754,239**	**$ 7,100,248**	**$ 775,190,595**
Ending Fund Balance	**$ 268,430,713**			**$ 281,785,375**

** Excludes transfers to reserves and interfund transfers*

2025 Operating and Capital Fund Revised Budget

Budget adjustments are made in order to respond to the changing demands of our operations in addition to the continued economic fluctuations occurring at the local, state, and national levels. In 2025, the City and County of Broomfield eliminated what had traditionally been the second amendment of the year. The Finance Department worked directly with departments to discuss needs and work strategically to accommodate needs by reallocating current budgets while continuing to monitor throughout the year to determine if budget adjustments were actually needed. Based on this collaborative effort, staff have been able to reduce the overall workload within the organization and minimize the number of times the budget needs to be reviewed, adjusted and considered by City Council.

The proposed operating fund budget adjustments include both personnel and non-personnel adjustments for programs and initiatives. While capital fund adjustments are the result of revising capital projects due to aspects such as timing or changes in project priorities since the adoption of the 2025 5-Year CIP Plan. The table below includes highlights of operational revisions to the 2025 budget.

2025 Revised Budget Highlights*		
Department or Category	**Description**	**Amount**
City & County Attorney	2025 Increase for Insurance Premiums	$ 70,000
Courts	Above Mid-Point Pay Request: Lead Court Clerk Hire	4,142
Human Resources	New Full-Time FT: HR Project Manager	71,498
Police	Increase to Axon Agreement	234,625

Police	Increase to Inmate Food Services Contract	172,050
Police	Increase to Psychological Support Contract	50,000
Police	Dual Sim Card Monthly Fees with First Net	36,500
Police	Inmate Medicine Expenses	38,252
Police	Outside Fund Award Funded Motorola Service Agreement for Back Up Dispatch Center Equipment	12,775
Police	Brower Resilience Visits	2,500
	Total	**$ 692,342**
*Personnel Highlights are pro-rated for partial year		

The 2025 revised operating budget includes a number of cost increases associated with existing contractual obligations. The 2025 budget process was completed in the middle of 2024, prior to a number of contractual amendments being executed, so adjustments are made during the 2nd amendment to appropriate the additional funds needed to meet these obligations.

In addition to the Budget Highlights noted above, the 2025 revised operating budget also includes a number of non-personnel budget reductions as part of the organization's efforts to optimize budgets. Travel and training budgets were reduced by $859,813 and other identified non-personnel budgets were reduced by $1,041,450. This effort was collaborative across the entire organization, with a focus on maintaining services to residents.

In total, staffing levels and service demands resulted in the addition of 4.13 FTE in 2025, as detailed in the Expenditures: 2025 Personnel Changes table.

Expenditures: 2025 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
City & County Manager	1.00	303,987	Economist (1.0FT), Administrative Analyst (1.0FT), Case Manager II - Housing (-1.0FT)
Community Development	-1.00	(133,296)	Senior Transportation Planner (-1.0FT)
Economic Vitality & Development	-2.00	(254,758)	Economist (-1.0FT), Administrative Analyst (-1.0FT), Administrative Support I/II LTA (2.0FT), Administrative Support I/II LTA (-2.0FT)
Human Resources	1.00	65,533	HR Project Manager (1.0FT)
Human Services	2.80	172,795	Case Managers II LTA (2.0FT), Case Manager II LTA (-2.0FT), Case Manager II (1.0FT) Workforce Specialist II LTA (0.8PT), Human Services Management Analyst (-0.8), Non-Profit & Community Engagement Manager (1.0), Human Services Grants Specialist (0.8)
Library, Arts & History, and CSU Extension	0.33	(1,718)	Creative Technologist (-0.8PT), Patron Services Associate (1.0FT), Creative Technologies (-0.6PT), Patron Services Associate (0.73PT)
Public Health & Environment	0.00	(2,845)	Human Services Management Analyst (-0.2), Human Services Grants Specialist (0.2)
Total	**4.13**	**$ 149,698**	
*Includes internal transfers. Costs prorated for partial year. Public Works to Public Works / Water Utilities reorganization is not included.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and estimated taxes and benefits			

2025 Broomfield Urban Renewal Authority Revised Budget

This is the second amendment to the 2025 BURA budget. This amendment reflects updated revenues and expenditures projected through the end of the year based on year-to-date information. The BURA Budget Tables summarize the 2025 proposed revisions to the budget.

2025 BURA Revenues - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 70,511,588	$ 605,615	$ 71,117,203
Debt Service	5,056,106	(607,935)	4,448,171

2025 BURA Expenditures - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 54,215,747	$ 2,902,954	$ 57,118,701
Debt Service	4,459,171	-	4,459,171

2026 Proposed Budget Summary

Planning for Increased Financial Stability

The City and County are guided by conservative revenue projections, reasonable cost assumptions (expenses), deploying strategic development decisions, effectively managing staffing patterns, and using

data-driven decision-making models to keep operational costs in check.

Transitioning into 2026, Broomfield's economic and financial position is fundamentally sound, but we remain in an ever-increasing volatile environment. This reality reinforces the need for prudent financial flexibility, conservative planning assumptions, and disciplined decision-making to ensure long-term sustainability.

Broomfield's two largest primary revenue sources are property tax and sales/use tax, with sales tax showing minimal growth in 2025 (measured at the halfway point through the year, sales tax is projected to end 1-2% higher than 2024). The minimal sales tax growth is expected to continue to build in 2026, a trend anticipated to continue into 2027. Additional retail and commercial investments in the pipeline begin to come online in 2027 (e.g., Macerich's HiFi area at FlatIron and the initial phase of McWhinney's Center Street area). Conversely, the property tax revenue is expected to fall in 2026 and remain stable in 2027. The property tax revenue reduction is occurring due to State changes in the property assessment rates and the decline in property market values.

Due to decreased property assessment rates, property owners will see lower tax bills, which correlates to the decreased county property tax revenue by approximately $6.5-7.5 million annually. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

The 2026 proposed budget reflects the organization's continued focus on balancing current needs and obligations while preparing to meet the organization's and community's future needs by prioritizing expenditures into Mandates, Obligations, and Critical needs. Broomfield's economic fundamentals continue to provide sustained economic and employment opportunities while ensuring a sound fiscal base for CCOB budgets.

Guiding Principle: Residential Growth and Service Capacity

Broomfield currently has the revenue to sustain current service levels, but each new residential development adds demand and costs to systems already operating near capacity. Sales tax revenue growth—expected as new commercial development comes online in 2027—will help, but will not fully offset rising expenditures. Property taxes remain outside local control and subject to state formulas and market values; those factors created a $6.6M - $7.5 decrease in general fund revenue, which is not anticipated to return.

Balancing Housing Needs with Community Capacity

While the Front Range continues to face an affordable housing shortage that calls for regional solutions, Broomfield must thoughtfully balance this need with our community's existing capacity. Demand for services is strong — recreation programs often fill quickly, fields are well used, the Library serves at or near capacity, and our core utilities, such as the wastewater treatment facility, are preparing for future growth. Broomfield has also made prior commitments to additional residential development through business development agreements. Looking ahead, future decisions will shape how we continue to provide high-quality services, invest in infrastructure, and remain fiscally responsible, while also contributing to broader housing solutions across the region.

Disciplined Development and Long-Term Financial Sustainability

Broomfield continues to take a thoughtful, yet disciplined, approach to development as the foundation for achieving long-term financial strength and sustainability. Our strategy emphasizes balanced growth and a diversified economy—ensuring that both residential and commercial development occur in alignment with community needs and fiscal realities.

Maintaining and strengthening the ratio of residential to commercial development is paramount as we move into the future. A healthy balance not only supports a diversified tax base and resilient economy but also ensures that service demands and infrastructure investments are financially sustainable over time.

By adhering to this disciplined approach, Broomfield positions itself to manage near-term fiscal challenges

while preserving the flexibility to invest in community priorities and future opportunities.

Broomfield recognizes that a strong community is made up of thriving neighborhoods and residential areas, combined with commercial areas and developments home to businesses in key sectors, such as finance, information technology, aerospace, and business/professional services. Broomfield is also successful in attracting and growing businesses in next-generation economic sectors, such as quantum computing, phonetics, and advanced manufacturing. Recent firms choosing and growing in Broomfield include Sierra Space, SiNaptic, Quantinuum, and Raven Space Systems.

Development and increasing redevelopment in the community continue to build on this economic and financial foundation. These developments provide sought-after locations for businesses to locate and grow, places for residents and visitors to shop, dine, and gather, and places where existing and new residents will call home. Current construction is underway around FlatIrons Crossing (the HiFi area: both the Novel FlatIron residential and new commercial space), MidPoint's flex/innovation space (255 Midway), the Simms Technology Park, and Harvest Hill apartments. Horizontal construction will soon start in Baseline's mixed-use Center Street development. Combined, these current developments total nearly 500 new residential units (over 200 income-aligned), about 500,000 square feet of new work space, and over 100,000 square feet of (already leased) shopping and dining space.

The 2026 proposed spending plan recognizes that our community looks to its local government as innovators and leaders. It supports this influential work by refocusing and committing to the identified Community Goals, with the fundamental goal of Fiscal Sustainability remaining paramount to a healthy and robust future.

Emphasis on Prioritizing Needs

As Broomfield continues to maintain economic and fiscal stability, our strategic approach includes a prudent and pragmatic fiscal approach to anticipate and withstand future economic or financial disruptions in the short and long term.

The proposed 2026 budget prioritizes expenditures in the following categories:

- **Mandates**: Regulatory requirements issued by the federal or state level that result in the need for funding.
- **Obligations**: Contractual requirement or agreement.
- **Critical Need**: This is essential to the organization's effective operations. Failure to fund it would threaten public health, the environment, or community safety, or create a more significant liability or risk to the organization.

Any funding request not categorized by a mandate, obligation, or critical need but necessary to provide ongoing programs and services would be defined as an 'other' this year. In 2026, only projects classified as 'other' that were moved forward were partially funded by grants.

The 2026 Recommended Budget reflects a collaborative effort across all departments. New services and their associated costs will be strategically timed for review only when budget flexibility improves – something not anticipated in 2026, and possibly not until the second half of 2027.

All departments determined needs based on the following high-level categories and corresponding thought-provoking questions, serving as the foundational lens through which all budgeting and resource allocation requests were reviewed:

- **Safety**: Eliminating or reducing a hazard/threat
- **Operational Cost vs. Revenue**: Is there a revenue offset that will help reduce costs?
- **Asset Maintenance**: Ability to extend the life cycle of a current asset
- **Comprehensive Plan**: Approach and alignment with existing roadmap

- **Operational Support**: Will the request create additional demand on existing resources or require new support?
- **Alternatives**: Does the alternative require greater resources, financially or otherwise?
- **Cost Sharing Opportunities**: Ability to leverage outside funding awards
- **Urgency**: Is there an immediate need that the request will satisfy?
- **Public Benefit & Quality of Life Impact**: Ability to benefit across various sectors
- **Socio-Economic Equity**: Determining the applicability within Broomfield's vulnerable populations or underrepresented
- **Sustainability**: Ability to address/correct the construct that will benefit the environment

For the fifth consecutive year, staff recommends maintaining Public Safety, Public Works, and Water Utilities as a top priority while continuing to adapt to growth, addressing deferred maintenance while moving forward with an asset management approach, and shifting to new and long-term fiscal realities.

Public Safety

This commitment is demonstrated by keeping the Broomfield Police Department organizationally separate from general employee groups. This approach has enabled the City and County of Broomfield to strengthen its police force effectively, resulting in a substantial increase in essential personnel to better serve the community. The Full-Time Equivalents (FTEs) grew from 242 in 2021 to 277 in 2025, a 14% increase. Concurrently, the police budget expanded from $34 million in 2021 to $44 million in 2025, marking a 27% increase. This investment is directly linked to Broomfield maintaining the lowest crime rate per capita in the metro area.

District Attorney – 17th Judicial District

The proposed budget for Broomfield's population share of the District Attorney's office is based on preliminary calculations received from Adams County in August 2025. On August 12, 2025, the District Attorney submitted his budget documents to Broomfield staff. Following that submission, Broomfield requested a meeting with the Adams County Board of Commissioners and leadership to discuss the request.

This meeting, held in mid-September, included the Mayor, Mayor Pro Tem, City Manager, and City Attorney. The discussion focused on the scope of services included in the DA's request, as well as the Family Justice Center, which is addressed in greater detail below.

Adams County is also in the process of finalizing its budget. On October 1, 2025, the District Attorney presented his budget request to the Adams County Board of Commissioners; however, the Board has not yet approved the request. Broomfield staff attended the presentation and will continue to monitor developments to ensure Broomfield's final budget reflects only its proportional share of approved expenses.

Broomfield's proposed budgeted amount for the DA reflects a budgeted amount that does not include costs for the proposed Family Justice Center (FJC). Per statute, Broomfield is only responsible for its per-population share for "the necessary expenses of maintaining an office for the transaction of official business" of the District Attorney.

While the intent of the FJC is admirable, the District Attorney has indicated that 75% of individuals to be served will be non-judicial clients. This represents not an expansion of existing prosecutorial services, but rather the creation of an entirely new entity, infrastructure, and team, as shown by 9 FTE in his budget request to Adams and Broomfield counties. While there is a connection with the domestic violence case work completed by the DA's office, this is a separate endeavor that warrants further scrutiny and should be subject to discussions about the creation of a regional and distinct intergovernmental entity before Broomfield commits taxpayer resources.

In addition, the revised proposed budgeted amount for the District Attorney does not include the cost of one FTE (an attorney) that Broomfield has solely funded since 2021 to reduce backlog following COVID. This was

a separate agreement with the DA, and three years later, after that backlog has been addressed, that cost should not be part of the base budget.

Public Works and Water Utilities

Our focus on infrastructure over the past several years has led to significant growth in resources dedicated to roads, streets, maintenance, and water. Full-time equivalents (FTEs) increased from 158 in 2021 to 220 in 2025 – a 39% rise (note: this includes 14 FTEs transferred to Public Works/Water Utilities from Community Development and Strategic Initiatives related to Construction Inspections and Energy and Sustainability, respectively). Investments in Public Works and Water Utilities have enabled staff to optimize infrastructure, boost productivity, and better manage assets. This directly impacts overall operations and effectiveness.

Broomfield has made major strides in core infrastructure and utility maintenance over the past five years. The Street Pavement Management Program expanded significantly, with more miles treated and a dramatic increase in crack sealing. Water Utilities strengthened operations with annual waterline replacements, full fire hydrant flushing and maintenance, and near-complete valve maintenance. The Sewer Collections Program has advanced to completing annual program system cleaning and inspection on a regular cycle. Meanwhile, the Stormwater Maintenance Program, established in 2021, now conducts annual program system cleaning and inspections each year. These operational improvements are supported by a five-year financial sustainability plan that ensures the long-term health of infrastructure, high-quality service delivery, and protection of public health and the environment.

Given the challenges and uncertainty in the economy and marketplace, the 2026 Proposed Budget relies on conservative fiscal policies and projections supporting balanced annual spending. The 2026 Proposed Budget was built using a combination of Council direction with existing planning documents, including, but not limited to, the Comprehensive Plan, the Long Range Financial Plan, and financial/economic modeling, to synthesize the work over the past several years of taking a comprehensive methodological approach to Broomfield's future.

2026 Areas of Focus & Key Highlights

- Broomfield has not acquired any additional general obligation (GO) debt since 2017. Broomfield will be defeasing prior debt and remains committed to maintaining and increasing our existing Aa2 bond rating, which means the organization has a "superior ability to repay short-term debt obligations." The rating is one of the highest within the state of Colorado. This high rating is essential. Having debt of 5% of revenues is considered appropriately leveraged and reflects the government's ability to repay debt.
- Broomfield will continue to leverage grant funding as part of efforts to diversify revenue sources. In 2025, overall, less grant revenue was available on the Federal and State levels. As of August 2025, CCOB has received 91 grants, representing an increase from 69 grants in 2024. This total reflects both new grant applications and recurring awards that continue from year to year. In 2025 alone, more than 35 new grant applications have been submitted, with 28 awarded to date. These awards total approximately $5.6 million, compared to $4 million last year. We will continue to seek grants in 2026 to pursue funding from private, local, and state sources. New grant funding to be explored in 2026 includes: Courts' First Defense Counsel Appearance, incentives for Norm Smith UST removal reimbursement, the Recycling Rebate Program, and Special Supplemental Nutritional Funds for Women, Infants, and Children (WIC).
- Police Facility construction is anticipated to begin in early 2026.
- Courts Remodel design to begin in 2026.
- Maintain the achieved goal of 20% reserves into 2026 and future years.
- Continue to explore opportunities for development of the former Event Center site: This development is expected to be a revenue generator for the community.
- Implementation of the selected City and County Enterprise Resource Planning (ERP) Software that will modernize our existing 30+ year manual/spreadsheet system to begin early 2026.
- Update the 2016 Comprehensive Plan in 2026, providing the Council, community, and our

organization an opportunity to play a critical role in shaping the vision for the next decade and beyond.
- Implementing the first organizational strategic plan to guide the 2026 work plan.
- Issuance of three bonds: Quarter one 2026, Certificate of Participation for the PD/Courts, and two in the Enterprise Funds for the Water Tanks & Wastewater Expansion - Phase IB.

This list alone requires us to be especially prudent in the upcoming year and beyond. We are operating in a constrained environment – both financially and with staffing capacity – and must therefore be intentional and strategic in every decision we make. The 2026 and 2027 budgets will require a reallocation methodology, not a reprioritization model – meaning that to add anything, other programs must be reduced or removed to accommodate new or enhanced funding. As we gain clearer insights into programmatic outcomes, we must be willing to have courageous conversations about whether programs and services are being fully maximized, widely utilized, effectively measured, and delivering the intended outcomes. If they are not, we must work together to thoughtfully realign our efforts and resources toward initiatives that deliver the greatest benefit to our community.

2026 Budget Highlights

Revenue Projections

Broomfield's two largest primary revenue sources are property tax and sales/use tax, accounting for 60% of Broomfield's revenue base. Sales tax is showing minimal growth for 2026. The minimal growth in sales tax is a trend anticipated to continue into 2027, while retail and commercial investments in the pipeline begin to come online in late 2027 (ie, Macerich development).

Conversely, the property tax rates are not expected to move in any direction but downward. Due to decreased property assessment rates, property owners will see lower tax bills. This reduction will decrease county property tax revenues by approximately $6.5-7.5 million annually – $3-4 million from residential properties and $3.5 million from commercial properties. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

Across all revenue streams[1], 2026 projected revenues are expected to increase by 5.2% from $332 million to $349 million compared to the 2025 revised budget per Table 1C of the proposed budget. This increase is primarily driven by anticipated revenues from Fiber contracts, building permits and use tax revenues.

The 2026 proposed budget was built with the projected increases in Utility Rates for water, sewer, reclaimed water, and stormwater.

Expenditure Projections

Broomfield continues to monitor the ongoing uncertainties surrounding the economic environment and is prepared to react as needed. The budget process is an example of staff working collaboratively to mitigate the impacts of these uncertainties.

Operational expenditures are expected to increase by 5.8% from the 2025 original budget to the 2026 proposed budget.

Total expenditures (Table 3B), which include the operating, capital, additions to reserves, and debt service obligations across all funds, is an estimated $897 million, excluding inter-fund transfers. This represents an increase of 41% in expenditures from the 2025 original budget to the 2026 proposed budget. This increase is primarily driven by large capital projects, such as the new Police building, Court building remodel, and the Water and Sewer projects.

Personnel

Over the last four years, Broomfield has implemented a market-driven, competitive compensation philosophy to lead the market. This was based on the legal requirements to comply with new federal equal pay mandates and aligned with the City Council's direction on employee compensation. In year five, Broomfield is working to maintain the progress while navigating economic uncertainties. Human Resources completes market evaluations every other year to ensure positions within CCOB are paid competitively against the Denver Metro market. This data is used to project salaries and personnel costs for the proposed budget. In 2026, Human Resources will not be conducting market evaluations.

Ongoing personnel costs and adding new positions to meet the community's needs are the primary drivers of the 5.8% operational budget increase referenced in the expenditures section.

Below is a list of the Personnel Changes implemented as part of the 2026 operating budget.

1Excludes Fiduciary Funds and Budgeted Bond Revenues

Expenditures: 2026 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
Human Services	0.10	13,463	Business Solutions & System Administrator (0.1FT)
Information Technology	-1.00	-	Accessibility Specialist LTA Expiration (-1.0FT)
Parks, Recreation, & Senior Services***	2.25	219,958	Lead Parks Tech (1.0FT), Parks Tech II PT to FT (0.25FT), Preschool Director (1.0FT)
Public Health & Environment	0.40	18,982	Business Solutions & System Administrator (-0.1FT), Administrative Support II PT to FT LTA (0.5FT)
Water Utilities	3.00	334,561	Cross Connection Foreman (1.0FT), Senior Water Utilities Locator (1.0FT), Senior Sewer Utilities Locator (1.0FT)
Total	**4.75**	**$ 586,964**	
*Includes internal transfers.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and est. taxes and benefits; does not include any non-personnel budgets associated with new FTE			
***Department has self-funded these positions with budget realignments - reducing temp and non-personnel budgets			

Non-Personnel

Non-personnel-related expenses include the supplies, equipment, and contractual service costs necessary to provide the programs and services in Broomfield. Some examples include:

- Fuel
- Vehicle Maintenance Supplies (i.e. air & oil filters, tires, etc)
- Electronic Equipment (i.e. telephones, computers, headsets, etc)
- Training and Development of staff
- Professional Services (i.e. outside auditors, specialized legal services)
- Insurance expenses
- Utilities
- Software (Annual License Fees, such as Google)

As part of the annual budget process, the budget staff meets with departments to discuss non-personnel requests and the drivers of individual items. Items like fuel are a basic necessity for the organization to accomplish its work and are subject to market conditions; thus, Broomfield has very little control over this type of expenditure. For other non-personnel items, the organization manages costs by finding alternatives or adjusting work procedures to eliminate or minimize expenses wherever possible.

Operating Budget Highlights

Below is a list of some highlights of the 2026 operating budget.

2026 Operating Budget Highlights		
Department or Category	**Description**	**Amount**
Assessor	One (1) 5-Month Overlap (Assessment Supervisor)	$ 66,708
City and County Clerk	Two (2) 2-Month Overlap (Recording & Motor Vehicle Specialist, Recording & Licensing Specialist)	25,141
City & County Manager	Hazardous Mitigation Plan Update - FEMA Mandate	65,000
Community Development	Two (2) Reclassifications (Senior Landscape Architect to Landscape Manager, Combination Inspector to Landscape Associate/Tech)	54,272
Parks, Recreation, & Senior Services	One (1) FT (Lead Parks Technician)*	-
Parks, Recreation, & Senior Services	One (1) PT to FT (Parks Technician II)*	-
Parks, Recreation, & Senior Services	One (1) TM to FT (Preschool Director)*	21,401
Police	One (1) FT Continuation (Victim Advocate) if Grant is discontinued	112,712
Police	Three (3) Reclassifications (Records Specialist to Records Supervisor, Budget Analyst to Budget Supervisor/Manager, Office Manager to Senior Operations Manager)	73,871
Public Health & Environment	Personnel Costs Transitions	(8,555)
Public Health & Environment	One (1) PT to FT LTA (Admin Support II)	33,899
Public Health & Environment	One (1) Reclassification (Environmental Health Specialist I to Environmental Health Specialist II)	5,953
Water Utilities	Three (3) New FT (Cross Connection Foreman, Senior Water Utility Locator, Senior Sewer Utility Locator)	381,107
Water Utilities	SCADA Environment Security Scanning Software (w/IT)	69,571
	Total	**$ 901,081**
*Department's non-personnel budget will be reduced for the personnel changes		

2026 Capital Improvement Plan Considerations

Using a conservative approach and understanding the constraints of Broomfield's finances, staff will continue to evaluate and prioritize projects based on mission essentials and those that affect the health and safety of the community. To proactively prevent unintended consequences with any changes in the funding of CIP, staff will continue to seek guidance from Council.

The 2026 Five Year Capital Improvement Project (CIP) Plan was developed in a parallel process at the same time as Broomfield's operating budgets. This process included an extensive year-long collaboration across all departments to ensure that all projects and community requests were considered. CIP requests are rated and prioritized using the same "buckets" described earlier in the document. Ensuring that our limited resources are focused on mandates, obligations, and critical infrastructure projects reinforces our financial sustainability and resilience goal. Finally, staff has worked to shift the focus of funding from new capital projects towards preventative maintenance, repair, and rehabilitation to ensure that Broomfield is focusing efforts on adequately addressing its existing infrastructure.

The 2026 budget for Capital Projects includes

- $142.9 million in expenditures for the General Governmental Funds
  - $100 million for the Police Building and Courts remodeling projects
- $217.2 million in expenditures for the Enterprise (Utility) Funds.
  - $70 million for the two new Water Tanks project
  - $114 million for Wastewater Treatment Facility Expansion Project

2026 Broomfield Urban Renewal Authority Budget

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2026 BURA revenues are budgeted at $65.1 million, representing a 7.7% decrease compared to the 2025 original BURA budget. BURA expenditures in 2026 are budgeted at $50.0 million. BURA also pays the City and County of Broomfield to cover administration costs and professional services related to the development of urban renewal areas. The 2026 budget includes $5.5 million for administrative and professional services expenditures.

2026 Arista Local Improvement District Budget

The Arista Local Improvement District (ALID) was established to facilitate the construction of transportation facilities in the Arista Development. The ALID is supported by a 0.2% sales tax collected on all taxable sales within its boundaries, and the revenue generated by the tax has been pledged to support the Arista Metro District's (AMD) debt service on bonds sold to construct the parking structure.

The only allowable use of the revenue is to support the funding of public transportation services or improvements, the 2026 budget for the ALID exists solely to authorize payments to AMD, as noted. The 2026 proposed ALID budget includes $45,000 in sales tax revenue and $45,000 in expenditures related to the AMD debt service for the construction of the parking structure.

Background - Enterprise/Utility Fee

Utilities are funded by four enterprise funds that are specifically dedicated to the Water, Wastewater, Reclaimed, and Stormwater/Flood Management utilities. Each enterprise operates as a self-supporting entity. Revenues generated from monthly utility bills are the largest source of revenue for each utility, accounting for generally between 85% to 90% of revenues in each fund. Other significant sources of funds include development fees and funding from the Mile High Flood District (MHFD). These cumulative funding sources cover day-to-day operations, capital and rehabilitation projects, and annual programs. A robust enterprise fund presents a significant strategic advantage, empowering the city to issue revenue bonds.

This mechanism is crucial for financing substantial capital projects, much like the extensive bonded projects anticipated in 2026. The ability to leverage revenue bonds ensures that vital infrastructure and development initiatives can proceed.

As previously noted, to prepare for critical utility infrastructure needs, Broomfield adjusted water and sewer rates last year. This was, in part, to support two upcoming enterprise bond issues – one to fund two new water storage tanks and another to expand our wastewater treatment facility. Staff has contracted with bond underwriting firms, Stifle & Piper Sandler, who have extensive Colorado market experience in issuing Enterprise Fund bonds. CCOB is still targeting issuance in quarter one 2026.

Staff has provided additional detailed information on how water and sewer rates are directly influenced by the process of repairing and replacing aging infrastructure, known as asset renewal. Here is the linked

document - Water Utilities System Asset Renewal - Key Aspects of Establishing Rates.

In addition to preparing Broomfield to support the two upcoming enterprise bond issues, the rate increase implemented in 2025 was able to be immediately utilized to implement the water meter replacement program and improve maintenance of existing assets, including the following notable improvements:

Potable Water Improvements

- Flushing 483 miles: 100% (vs. 19% in 2022).
- Hydrants 4,478: 100% maintained (vs. 47% in 2021).
- Backflow devices 2,737: 97.17% compliance (exceeds CDPHE 90%).

Sewer and Stormwater Improvements

- Sewer video inspections: Currently at 90%; 100% by year-end (vs. 20% in 2023).
- Sewer cleaning: Currently at 98%; 2-year full-cycle program (vs. 40% in 2022).
- Storm video inspections: Currently at 87%; 100% by year-end (vs. 9.6% in 2021). Cleaning: 100% of 2025 target (vs. 0% in 2021).
- Street sweeping: 3,381 miles swept in 2025 (+95% vs. 2023).

2026 Proposed Recommendations: Water, Sewer, Reclaimed, and Stormwater Rates

As detailed in the budget adopted by the Council in 2025, the five-year plan includes a year two increase totaling $16.89 per month for the average single-family home starting in 2026. This represents a 15% increase for utility rates across all funds, with a 9% ($1.00) increase for stormwater service fees, and aligns with projections presented in the original five-year plan presented in 2024 (also see October 22, 2024, memorandum). Similarly, the non-residential water, sewer, and reclaimed rates will increase by 15% and stormwater service fees will increase by 9%. License fees for water, sewer, and reclaimed water for new development will increase by 4%.

Staff has completed a comprehensive fiscal analysis to evaluate anticipated revenues from utility rates as well as projected expenses based on necessary costs associated with day-to-day operations, capital and rehabilitation projects, and annual maintenance requirements. The fiscal analysis includes multiple interdependent variables, and adjusting any one component impacts several other variables within the model, requiring a holistic re-evaluation of all dependencies within the five-year comprehensive plan.

This increase is essential to ensure the long-term financial sustainability of our enterprise funds while maintaining essential services and infrastructure. The recommended rate structure ensures sufficient funding for both ongoing maintenance of existing water infrastructure and necessary capital improvements. The proposed increase allows the utility to maintain a proactive maintenance schedule consistent with capital improvement planning recommendations, protecting the community's investment in water infrastructure while avoiding more costly emergency repairs. Deferring maintenance on water system components creates significant financial risk, as delayed repairs typically result in substantially higher replacement costs and potential service disruptions that impact the entire community.

It is important to understand why this rate increase cannot easily be reduced to a lesser amount. Each percentage point reduction in the proposed rate change would result in approximately $500,000 less annual revenue to the enterprise fund. Such reductions would necessitate corresponding cuts to maintenance programs, capital projects, or service levels to maintain a balanced budget.

Given the essential nature of water services and the potential for deferred maintenance to compound costs over time, the proposed increase represents the minimum funding level necessary to ensure reliable, long-term service delivery to our community.

In 2025, the increase for the water utility bill was only on the base fees, and there was no increase for the water usage rates. As discussed and presented last year, in 2026, the proposal also includes an increase to the water usage rate, and therefore, the monthly difference in the water bill will be dependent on how much water the residence typically utilizes.

The projected impact on an average monthly bill for a single-family home and a multi-family home are shown in the tables below.

The example provided below uses an average single-family home bill of 9,000 gallons for water and 6,000 gallons for sewer. The 9,000 gallons/month for water is based on a 4-year historical average of 107,000 gallons per year for a typical single-family home. Staff will be providing a Utility Bill Estimator tool and linking it on our website to help residents calculate how the proposed increase would apply to their home utility bill based on their specific household water usage.

Impact on Average Monthly Bill for a Single Family Home (9,000 gal)

	Rates		Average Bill		
Fee Type	2025	2026	2025	2026	Difference
Water Meter Base Charge	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Tier 1 (0-5k gal)	*$2.39*	*$2.75*	*$11.95*	*$13.75*	*$1.80*
Water Usage Tier 2 (6-9k gal)	*$3.82*	*$4.39*	*$15.28*	*$17.56*	*$2.28*
Water Usage Tier 3 (> 9k gal)	*$5.41*	*$6.22*	*$0.00*	*$0.00*	*$0.00*
Sewer Service Charge	$5.44	$6.26	$32.64	$37.56	$4.92
Sewer Fed Mandate Charge	$0.52	$0.52	$3.12	$3.12	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$11.00	$12.00	$11.00	$12.00	$1.00
Total Bill			**$119.90**	**$136.79**	**$16.89**

Projected 4-Year Outlook for Single-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$119.90	$136.79	$146.37	$156.61
Percentage Change		*14%*	*7%*	*7%*

Impact on Average Monthly Bill for a Multi-Family Home (3,000 gal)

	Rates		Average Bill		Difference
Fee Type	2025 Rate	2026 Rate	2025	2026	Difference
Water Base Fee	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Charge	*$2.55*	*$2.93*	*$7.65*	*$8.79*	*$1.14*
Sewer Service Charge	$5.44	$6.26	$21.76	$25.04	$3.28
Sewer Fed Mandate Charge	$0.52	$0.52	$2.08	$2.08	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$6.60	$7.20	$6.60	$7.20	$0.60
Total Bill			**$84.00**	**$95.91**	**$11.91**

Projected 4-Year Outlook for Multi-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$84.00	$95.91	$102.62	$109.81
Percentage Change		*14%*	*7%*	*7%*

The tables below show the proposed non-residential water base and usage rate changes as well as the proposed license fee changes.

Impact on Non-residential Rates

Fee Type	2025	2026	Difference	%
Water Usage Charge	$3.22	$3.70	$0.48	15%
Water Base Charge - 3/4"	$36.91	$42.45	$5.54	15%
Water Base Charge - 1.0"	$61.50	$70.73	$9.23	15%
Water Base Charge - 1.5"	$123.00	$141.46	$18.46	15%
Water Base Charge - 2.0"	$196.79	$226.33	$29.54	15%
Water Base Charge - 3.0"	$369.00	$424.39	$55.39	15%
Water Base Charge - 4.0"	$615.02	$707.33	$92.31	15%
Water Base Charge - 6.0"	$1,230.02	$1,414.64	$184.62	15%
Water Base Charge - 8.0"	$1,968.04	$2,263.43	$295.39	15%
Water Base Charge - 10.0"	$2,829.07	$3,253.70	$424.63	15%

License fees are the fees that are paid by developers and builders for new connections to the water and sanitary sewer systems. The purpose of license fees is to provide funds to pay for the capital costs of expanding the water utility to serve new growth.

Impact on License Fees

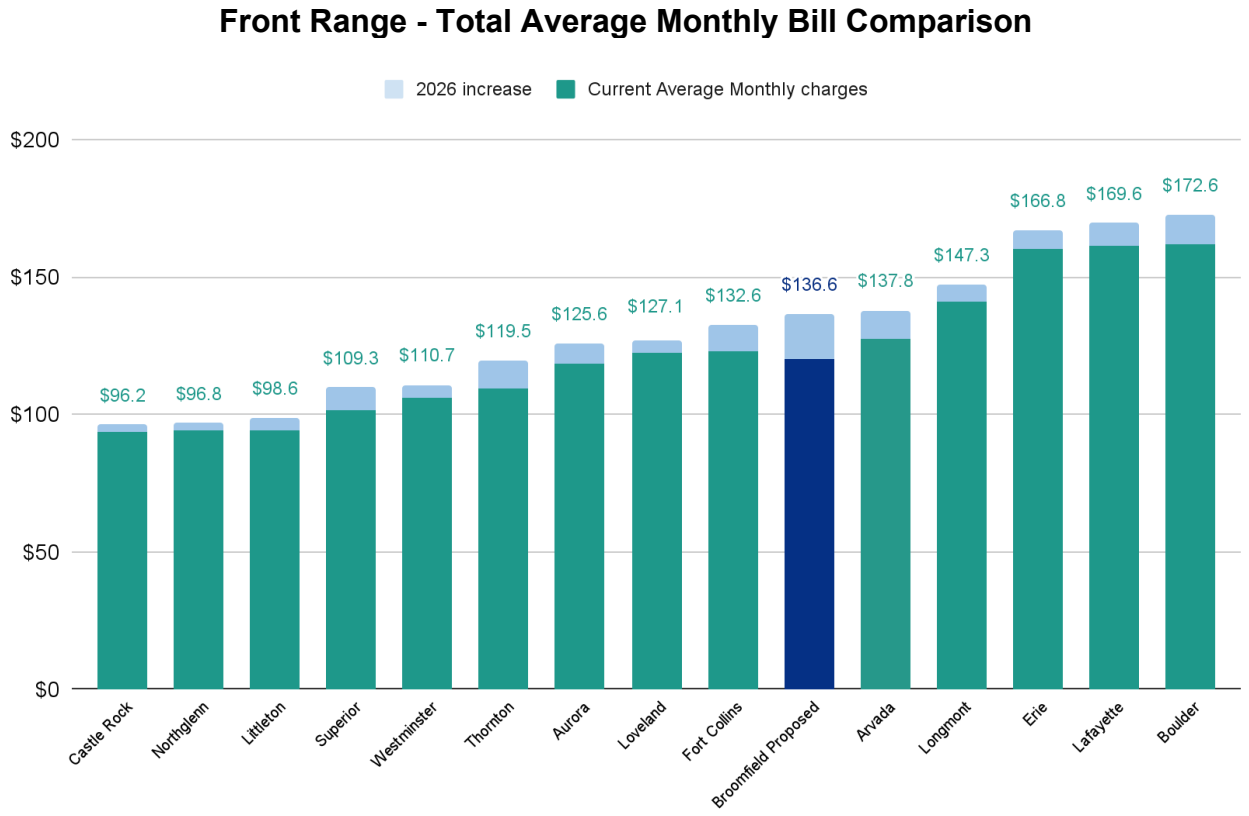
Fee Type	2025	2026	Difference	%
Water License	$37,850	$39,350	$1,500	4%
Sewer License	$14,900	$15,500	$600	4%
Reclaimed License	$13,780	$14,350	$570	4%

Front Range - Average Monthly Bill Comparison

The graph below shows Broomfield's total average monthly utility bill for water, sewer, and stormwater

compared to our neighboring municipalities. The comparison reflects where Broomfield is currently and how it would compare if the Council approves the proposed utility rates. The average monthly bill is normalized across all municipalities based on 9,000 gallons of water usage and 6,000 gallons of Average Winter Consumption (AWC) for sewer charges.

The 2026 rate increases shown in the graph below are not finalized, as the communities are going through a similar budget process as Broomfield, but staff have added the projected/proposed increases for municipalities where a projected increase is available, as shown in the light blue.



The degree to which neighboring municipalities increase their utility rates depends highly on how well they have managed their Enterprise Funds over the past decade, the growth versus expense challenges the municipality faces, and other factors unique to each entity.

Communication Plan:

Staff will be providing information for the community to learn about the proposed fee increase and how it could impact them directly. Updates have been included on the Broomfield.org website, including the proposed rates, estimated impacts for single-family homes and specific types of multifamily residential developments such as apartments, townhomes, and condominiums, and a Utility Bill Estimator tool for residents' use. Staff will also include information on the City and County of Broomfield's communications channels and work with Our Broomfield magazine, which was indicated in the Community Survey as a common place where residents seek to learn about Broomfield information, to share information about the rate change.

Additional information will be shared in late 2025 before the new rates take effect.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program in 2026

The City and County of Broomfield (CCOB) is committed to supporting residents facing financial challenges, particularly with utility costs and property taxes. To this end, two key programs were established: the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) Program.

The PPTR Program, launched in February 2023, was created in response to the increasing burden of property taxes and broader cost-of-living pressures. It provides refunds for seniors aged 65+, veterans with an 80% documented disability, and adult homeowners with 100% documented disabilities.

The URAF Program, launched in 2025 and administered by the Housing Division, helps residents with utility affordability. Building on the operational success of the 2024 PPTR Program signifies a significant step in CCOB's commitment to its residents.

Staff recommends continuing both programs in the 2026 fiscal year and both are included in the proposed 2026 Budget. Both programs will continue to accept new applications through October 30, 2026, or until funding has been exhausted, whichever occurs first. Resolutions 2025-153 and 2025-154 include clarifications and adjustments to the URAF and PPTR programs. These changes aim to ensure the programs remain efficient, fiscally responsible, and responsive to community needs, aligning with Council Goals, Financial Sustainability and Resilience, and Organizational Health.

Utility Rate Assistance Fund (URAF) Program 2025 and 2026 Update

In 2025, City Council Resolution 2024-165 established the Utility Rate Assistance Fund (URAF) program, directing staff to provide quarterly credits or refunds to eligible households with incomes up to 100% of the Area Median Income (AMI).

A review of 2025 URAF applications by the Housing Division revealed that 74% of applicants, the vast majority, had incomes at or below 60% AMI. Consequently, staff recommended reducing the 2026 eligibility threshold to 60% AMI, a change first discussed during the July 2025 second quarterly update for Enterprise Funds.

In 2025, eligible households received monthly reimbursements for utility fees, covering about 50% of the increase from 2024. The maximum annual refund was capped at $240 per household. Reimbursement rates varied by housing type: $20 for single-family detached homes, $18 for townhomes, duplexes, and mobile homes, and $17 for apartments and condominiums. The proposal for 2026 is to maintain these same assistance levels for eligible residents. Eligibility will be based on the total adjusted earnings of all household members aged 18 and older. Residents who pay their water utility bill directly to Broomfield will receive the refund as a credit on their utility account. For residents who pay their water utility as part of rent, via an HOA or other third party, the refund will be issued in check form to the resident.

Broomfield's Housing Division, which also manages the partial property tax refund program, will continue to administer the URAF program, maintaining quarterly payouts based on Council feedback from the July 2025 enterprise funds update.

To support the 2025 URAF program rollout, two nine-month Limited Term Assignment (LTA) full-time staff positions were added to the Housing Division. The 2026 budget does not allocate funds for new staff to

manage the Utility Rate Assistance Fund (URAF). Instead, the administration will leverage current staff within the Housing Division of Economic Vitality. These staff members will track the time and costs associated with administering the program without additional long-term assistance (LTA) capacity. Updates will be provided during quarterly enterprise updates, and the Housing Division will continue to advertise the URAF program via social media, Broomfield's website, Our Broomfield, and alongside other housing initiatives throughout 2026. If additional advertising, postage, or other related expenses are determined to be necessary specifically for URAF, an amendment to the 2026 budget will be requested in 2026.

Utility Rate Assistance Fund (URAF) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 100% AMI	0% - 60% AMI
Payment Frequency	Quarterly	Quarterly

During the October 14, 2025 City Council meeting, a resident reported concern regarding the eligibility of mobile home residents for the URAF program. It should be noted, residents of mobile home communities are eligible for the program. Since their utility bill is typically paid through a third party, the resident would be issued a quarterly check rather than a credit toward their utility bill to ensure the program benefits the resident directly. In 2025, mailers were sent to mobile home residents to inform them about the program. As of October 1, 2025, approximately 12 mobile home residents have applied for and been approved for the URAF. Broomfield staff will continue to focus on outreach to mobile home residents in 2026.

URAF Program Data

URAF Program Data as of September 30, 2025		
URAF - Data Points	2025	2026
Program Budget	Program Credits*: $600,000 Program Checks: $493,100 Personnel: $104,300 URAF specific Advertising: $7,000 URAF Software: $8,300 URAF Equipment: $8,000	Program (credits/checks): $350,000 Personnel: $35,000 URAF specific Advertising: $0 URAF Software: $0 URAF Equipment: $0
Budget Expended	Program Credits: $132,879 Program Checks: $18,639 Personnel: $66,810 URAF Advertising/Postage: $7,620 Software: $8,300 Equipment: $4,492	N/A
Total Payments Processed	Through 2025 Q3: 3833	N/A
Total Applications Processed	1813	N/A
Eligibility	One of the following docs: IRS Tax Form, SS, SNAP, LEAP, etc.	Required - IRS Tax Form No tax filing - Proof of all income (SS, Bank Statements, Paystubs, etc.)
AMIs Served	0-30% ▫ 40% 31-60% ▫ 34% 61-80% ▫ 19% 81-100% ▫ 7%	0-30% 31-60% N/A N/A
Communication Efforts	Phone Calls: 1171 Emails: 446 Consultations: 429 (96 Spanish)	N/A N/A N/A
Outreach Events	31	N/A

*As part of the 2025 Budget - 1st Amendment, program credits were budgeted at $1,479,300; as part of the 2025 Budget - 2nd Amendment, program credits are now budgeted at $600k.

Partial Property Tax Refund (PPTR) Program - 2025 Update and 2026 Recommendation

The Partial Property Tax Refund (PPTR) Program, established by Resolution No. 2022-123 and expanded with Resolution No. 2024-27 and Resolution No. 2024-105, offers financial relief to specific demographics facing increasing property tax burdens and general cost-of-living pressures. Eligible participants include seniors aged 65 and older, veterans with a documented disability of 80% or more, and adult homeowners with 100% documented disabilities.

While the Housing Division will continue to utilize 2021 tax year data as the program's baseline, the 2026 refund is anticipated to be lower than in 2025 due to the recently adopted House Bill 24B-1001. Despite these adjustments, the program is expected to continue providing significant support to qualifying households.

Partial Property Tax Refund (PPTR) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 80% AMI	0% - 80% AMI
Program Final Application Date	October 30, 2025	October 30, 2026

PPTR Program Data

PPTR Program Data as of October 13, 2025		
PPTR - Data Points	2025	2026
Program Budget	Program ≤ 60% AMI: $402,000 Program 61-80%: $100,000	Total Program: $600,000 Anticipated utilization ≤ 60% AMI: $500,000 61-80%: $100,000
Budget Expended	Program ≤ 60% AMI: $401,693 Program 61-80%: $90,016	N/A
Total Payments Processed	963	N/A
Total Applications Processed	1265	N/A
AMIs Served/Processed	0-30% ▫ 41.5% 31-60% ▫ 36.0% 61-80% ▫ 18.5% Ineligible ▫ 4.0%	0-30% 31-60% 61-80%
Communication Efforts	Phone Calls: 517 Emails: 332 Consultations: 397 (77 Spanish)	N/A N/A N/A
Outreach Events	33	N/A

Bond Issuances

Until 2021, Broomfield did not have a formal Debt Policy. Since adopting one, we have aligned with industry and government standards by capping total debt at no more than 10% of the City's assessed value. As of the close of fiscal year 2024, Broomfield's total debt was at 5.25% of assessed value – well below industry standards.

In 2023, debt service accounted for 4.6% of total revenues, and in 2024, that decreased slightly to 4.2%, reflecting our intentional focus on managing and reducing outstanding obligations. For context, debt service levels under 5% of total revenue are typically considered "best in class."

As we look ahead, the staff has strategically timed the issuance of new debt to coincide with the defeasance of the 2017 Certificates of Participation (COP) for the County building. This approach will help offset the impact of new debt issuance for the upcoming Police and Courts facility. While we expect to slightly exceed the 5% debt-to-revenue ratio following issuance, our strong financial standing provides confidence in our ability to manage this responsibly. In the past two years, Broomfield has earned three credit rating upgrades, which is a significant achievement

Conclusion and Next Steps

The 2026 budget represents a disciplined, data-driven approach to maintaining Broomfield's financial sustainability while meeting our community's needs. Through careful stewardship of public resources, strategic infrastructure investments, and thoughtful prioritization of mandates, obligations, and critical needs, this budget positions our organization to navigate current fiscal challenges while preparing for future opportunities.

Key Takeaways

The proposed 2026 budget demonstrates our commitment to:

- **Fiscal Responsibility**: Maintaining 20% reserves and managing debt prudently
- **Infrastructure Investment**: Addressing critical water, sewer, and public safety facility needs
- **Community Support**: Continuing programs like URAF and PPTR to assist residents facing financial challenges
- **Operational Excellence**: Optimizing existing resources before requesting new ones

Action for Council - October 28, 2025

7.A Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-141 - 2025 Budget - 2nd Amendment
- Resolution 2025-142 - 2026 CCOB Budget

7.B Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-143-UR - 2025 BURA Budget - 2nd Amendment
- Resolution 2025-144-UR - 2026 BURA Budget

7.C Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

- Resolution 2025-145-AID - 2026 ALID Budget

7.D Public Hearing - Ordinance Section Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

- Ordinance 2286 - Enterprise Rate Ordinance

7.E Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

- Ordinance 2288 - Water Tanks Bond
- Ordinance 2289 - Wastewater Treatment Bond
- Ordinance 2290 - Police/Courts COP

7.F Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

- Resolution 2025-153 - URAF Program Continuation
- Resolution 2025-154 - PPTR Program Continuation

Looking Ahead

Following the adoption of the 2026 budget, staff will:

- Issue bonds in Q1 2026 for Police/Courts facility and enterprise projects
- Begin construction on the Police building, Water tanks, and Wastewater Expansion Project
- Implement the updated URAF and PPTR programs
- Come before Council Dec. 9th with an amendment focused on grants received in 2025
- Continue quarterly Enterprise Fund updates to Council
- Collaborate with FLOW on recommendations for the 5-Year Water Utilities Capital Improvement Plan (CIP) and rate adjustments for the 2027 budget.
- Monitor economic conditions and provide budget updates as needed
- Prepare for the 2027 budget process with continued emphasis on financial sustainability

Staff remains committed to transparent communication, data-driven decision-making, and collaborative problem-solving as we work together to serve our community and achieve our shared goals.

RESOLUTION NO. 2025-143-UR

A resolution authorizing and approving the second amendment to the Broomfield Urban Renewal Authority budget for the year 2025

Recitals.

Whereas, the Broomfield Urban Renewal Authority, by Resolution No. 2024-150-UR, dated October 22, 2024, adopted the budget for the Broomfield Urban Renewal Authority for the calendar year 2025; and

Whereas, the Broomfield Urban Renewal Authority, by Resolution No. 2024-52-UR, dated March 11, 2025, amended the budget for the Broomfield Urban Renewal Authority for the calendar year 2025; and

Whereas, the Broomfield Urban Renewal Authority desires to amend said budget a second time to reflect additional revisions to expenditures and revenues.

Now, therefore, be it resolved by the Broomfield Urban Renewal Authority of Broomfield, Colorado:

Section 1. Budget Amendment

The second amendment to the Broomfield Urban Renewal Authority for fiscal year 2025 is hereby approved. The following sums of money are hereby appropriated for the fiscal year 2025 in the amounts set forth below:

Summary of 2025 Budget Amendment #2

Expenditures				
Fund	2025 Original Budget	2025 Amd #1 Change	2025 Amd #2 Change	2025 Amended Budget
Broomfield Urban Renewal Area	$54,215,747	$4,013,669	-$1,110,715	$57,118,701
Broomfield Urban Renewal Area Debt Service	5,052,106	0	-592,935	4,459,171

Section 2. Budget Tables

Budget tables for all amended funds are made an integral part hereof, and all other applicable budget tables are amended by the inclusion of the amendments set forth above.

Section 3. Effective Date

This resolution is effective upon its approval by the Broomfield Urban Renewal Authority.

Approved on October 28, 2025

The Broomfield Urban Renewal Authority

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

RESOLUTION NO. 2025-144-UR

A resolution adopting the budget for the Broomfield Urban Renewal Authority for the Fiscal Year 2026 and appropriating sums of money

Be it resolved by the Broomfield Urban Renewal Authority of Broomfield, Colorado:

Section 1. Budget Adoption

The following sums of money are hereby appropriated for fiscal year 2026 in the amounts set forth as follows:

Summary of 2026 Budget

Expenditures	
Fund	2026 Proposed Budget
Broomfield Urban Renewal Area	$49,978,125
Broomfield Urban Renewal Area Debt Service	$4,458,143

Section 2. Effective Date

This resolution is effective upon its approval by the Broomfield Urban Renewal Authority.

Approved on October 28, 2025

The Broomfield Urban Renewal Authority

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

C. Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7C.

Voted By Board	Presented By
Arista Local Improvement District	Graham Clark, Director of Finance

Community Goals
☑ Financial Sustainability and Resilience

Overview

View Correspondence
View Presentation

The purpose of this memo is to present financial information related to the second amendment of the 2025 City and County of Broomfield and the Broomfield Urban Renewal Authority Budgets, financial information related to the proposed 2026 budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District, information related to the proposed increases to utility rates for the Broomfield Enterprise Funds, information related to the proposal of two enterprise revenue bonds and police building and courts remodel certificate of participation, and information related to the Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) programs.

Attachments

Memo for 10_28_2025_2nd Amd to 2025 Budget; Adoption of 2026 Budget (CCOB, BURA, ALID); Utility Rates Ord; URAF, PPTR, Bond Ords.pdf

Resolution 2025-145-AID 2026 Budget Adoption (ALID).pdf

Memo for 2nd Amendment to the 2025 Budget and Adoption of the 2026 CCOB, BURA, and ALID Budgets; second reading of amending water, sewer, reclaimed water and stormwater rate ordinance; second reading of two enterprise revenue bonds and police building certificate of participation ordinances; URAF and PPTR programs for 2026
Prepared By: J. Stephanie Chen, Budget Manager

Summary

View Correspondence
View Presentation

Comprehensive Budget Process

The City and County of Broomfield's budget development is a comprehensive, year-long process designed to ensure fiscal responsibility, transparency, and meaningful community and Council engagement. This memorandum represents the culmination of extensive collaborative work that has unfolded throughout 2025, with multiple touchpoints providing City Council and the community opportunities to review, discuss, and shape the financial direction of our organization. This deliberate, methodical approach ensures that budget decisions are informed by current data, community needs, economic conditions, and strategic priorities while maintaining the highest standards of transparency and public accountability.

The Governmental Accounting Standards Board (GASB) sets the accounting and financial reporting standards that state and local governments must follow. Its purpose is to ensure that financial statements are consistent, transparent, and useful to the public, elected officials, and oversight bodies. GASB standards help governments show how public funds are managed, spent, and accounted for, promoting accountability and public trust. Our Broomfield budgets are built using GASB standards, which means our financial reporting and budgeting processes follow the same professional principles used nationwide to ensure accuracy, consistency, and transparency in how we manage public resources.

Year-Long Budget Development Timeline

The 2026 budget process began in early 2025 and has included the following key milestones:

- January-March 2025: Initial financial forecasting and departmental needs assessment
- March 8, 2025: Council Focus Session - 2.C. Conditions of/and influences on Broomfield's economic and fiscal status, 2.H. Anticipated Development and the impacts on fiscal sustainability
- April 15, 2025: Council Study Session - First Quarterly Enterprise Funds Study Session - Council review of enterprise fund status, capital projects, maintenance programs, 2024 financial results, and long-term financial sustainability strategies
- May 8, 2025: Council Study Session - Early introduction to the 2026 budget process and year-to-date financial information
- July 15, 2025: Council Study Session - Second Quarterly Enterprise Funds Study Session - Council review of enterprise fund updates, development projections, and initial utility rate recommendations with subject matter expert consultant AECOM
- August 19, 2025: Council Study Session - Economic and Fiscal Update and Draft Operating and Capital Budgets Study Session - Comprehensive presentation to Council on Broomfield's economic and financial outlook, including CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments
- August 21, 2025: Community Briefing - Public presentation and opportunity for public questions on Economic Long Range Financial Plan and Financial Status Briefing
- September 3, 2025: City Council received the 2026 Proposed Budget and supporting documentation
- September 4, 2025: 2026 Proposed Budget and supporting documents made available for public review and comment on Broomfield.org/Finance
- September 18 and September 25, 2025: Budget Study Sessions with opportunities for public comment - 2026 Proposed Operating & Capital Budgets with department representatives
- October 14, 2025: City Council Meeting - Public Hearing per Chapter 12.7 of the Charter for the 2026

Operating and Capital Budgets, with first reading of key ordinances
- October 21, 2025: City Council Study Session - Final Quarterly Enterprise Funds update of 2025
- October 28, 2025: City Council Meeting - Second reading of ordinances and adoption of budgets (this meeting) with public hearing

Strategic Context and Fiscal Discipline

1. Financial Sustainability and Resilience - Ensuring Broomfield's long-term fiscal health in an uncertain economic environment
2. Transparency and Public Engagement - Providing multiple opportunities for community input and Council deliberation
3. Data-Driven Decision Making - Utilizing comprehensive financial modeling, economic forecasting, and historical analysis
4. Prioritization of Core Services - Focusing resources on mandates, obligations, and critical needs
5. Infrastructure Investment - Addressing deferred maintenance and preparing for future growth
6. Responsible Debt Management - Maintaining our strong credit rating while financing essential capital projects

Summary of Items for Consideration

The City and County of Broomfields budget includes all government operations as well as Enterprise Funds (Water, Sewer, Stormwater and Reuse). The proposed budgets and related documents were available for public review and comment on Broomfield.org/Finance on September 4, 2025.

The staff memorandum from October 14, 2025 regarding the public hearing for City and County of Broomfield (CCOB), Arista Local Improvement District (ALID), Broomfield Urban Renewal Authority (BURA) budgets; first reading of Ordinance No. 2286 amending water, sewer, reclaimed water and stormwater rate ordinance; first reading of two enterprise revenue bonds and police building certificate of participation ordinances (Ordinances No. 2288, 2289 and 2290), included a detailed discussion of the proposed resolutions and ordinances.

It is important to note that the proposed budget is consistent with the October 14, 2025 memorandum and initial proposed budget, with the exception of one change:

- The operational expenditures are expected to increase by 5.8% as opposed to 5.9% due to the combination of a reduction to the amount recommended for the District Attorney (DA) budget discussed during the hearing on October 14, 2025, and a small increase in the budget used for non-profit distributions under the Human Services Fund.

This change is specific to the proposed 2026 budget for CCOB and is reflected in Resolution 2025-142. It does not alter the proposed budgets for BURA or ALID, the water project agreements, enterprise rate ordinance, or any of the bond ordinances considered on first reading during the October 14, 2025 meeting.

The content of this staff memorandum is consistent with the October 14, 2025 memorandum, with additional information provided for the following:

- Information regarding the 2025R Budget - 2nd Amendment.
- Details regarding the non-residential utility rates and license fees for 2026 are provided to clarify what is included in Ordinance 2286 in response to questions from the October 14, 2025 meeting.
- Additional details regarding how the 2025 rate increase was utilized to directly improve water, sanitary sewer, and stormwater resources for Broomfield residents and businesses.
- Details regarding the Utility Rate Assistance Fund program for 2026 as proposed in Resolution No. 2025-153.
- Details regarding the Partial Property Tax Refund program for 2026 as proposed in Resolution No. 2025-154.

City and County of Broomfield Budget

2025 Budget - 2nd Amendment Summary

- The 2025 City and County budget has been amended one time since its adoption to reflect capital project rollovers, grant rollovers, and operational budget adjustments.
- The following attachments are included with this memo to provide fund level details of the 2025 revised budget adjustments. These tables referenced below reflect cumulative prior amendment #1, in addition to the new adjustments in this proposed second (2nd) amendment to the 2025 budget. Revenue and expenditure adjustments (increases and decreases) are also included for reference.
    - 2025 Revised Budget Summary - General Governmental Funds
    - 2025 Revised Budget Summary - Governmental Capital Funds
    - 2025 Revised Budget Summary - Governmental Debt Service Fund
    - 2025 Revised Budget Summary - Enterprise Funds
    - 2025 Revised Budget Summary - Fiduciary Funds
- The second proposed City and County amendment, Resolution No. 2025-141, sets the final 2025 amended budget to reflect expenditures of $775,190,595.

2026 Budget

- The 2026 Proposed City and County of Broomfield Budget has been prepared to reflect expected revenues and expenditures. A set of summary budget tables are included with the resolutions under consideration.
- The 2026 Proposed Budget for the City and County of Broomfield total expenditures are $844,125,005. This amount includes interfund activities and transfers to reserves.
- Tables 1A-4C summarize the 2026 Proposed Budget for the City and County of Broomfield.
- Proposed Resolution No. 2025-142, if adopted, would approve the 2026 Budget for the City and County.

Broomfield Urban Renewal Authority

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2025 Budget - 2nd Amendment Summary

- The proposed BURA budget amendment, Resolution No. 2025-143-UR, is the second amendment proposed since its adoption and reflects unexpended capital improvement project budgets, and revenue adjustments which impacts expense budgets since the adoption of the fiscal year 2025 budget.
    - The proposed BURA budget amendment also reflects a slight decrease in expenditures for a total of $57,118,701.
    - BURA Budget Tables summarize the 2025 revised budget for BURA.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for BURA. In some URAs, planned uses of fund balance are being used for capital expenditures. The BURA proposed total revenues for 2026 are $65,119,746, and the proposed total expenditures are $49,978,125.
    - Tables 1-13 summarize the 2026 Proposed Budget for the BURA.
    - Proposed Resolution No. 2025-144-UR, if adopted, would approve the 2026 Budget for the Broomfield Urban Renewal Authority.

Arista Local Improvement District

The Arista Local Improvement District (ALID) was established in August 2005 to facilitate the construction of transportation facilities in the Arista Development.

2025 Budget - 2nd Amendment Summary

- The 2025 ALID budgeted expenditures have not changed, therefore, no amendment is required at this time.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for the ALID. Attached is a copy of the budget message and budget tables for the ALID for the 2026 Proposed Budget. Anticipated total revenues for 2026 are $45,000. Proposed total expenditures for 2026 are $45,000.
    - Table 1 summarizes the 2026 Proposed Budget for ALID.
    - Proposed Resolution No. 2025-145-AID, if adopted, would approve the 2026 Budget for the Arista Local Improvement District.

Enterprise Rate Ordinance

City Council held quarterly enterprise study sessions on April 15, 2025, July 15, 2025, and October 21, 2025, to review staff's updates on the status of the enterprise funds. The April meeting covered capital projects, maintenance programs, 2024 financial results, steps for ensuring long-term financial sustainability, and the proposed Fiscal Leadership on Water (FLOW) Advisory Committee. The July meeting covered similar topics as well as an overview of development projections and future rate recommendations. The October meeting included an update regarding ongoing capital and maintenance programs for 2025, as well as a presentation from the FLOW Advisory Committee.

City Council also received updates on the Enterprise Funds during the Economic and Fiscal Update held at a Study Session on August 19, 2025. Topics addressed included CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments.

In 2025, the City and County of Broomfield implemented the first utility rate increase of a comprehensive five-year financial plan to address the financial sustainability of the enterprise funds. This increase was necessary as the costs of providing safe, reliable water service continued to rise due to aging infrastructure requiring increased maintenance and replacement, new regulatory requirements and unfunded mandates,

and a substantial backlog of critical system repairs and upgrades. Recognizing the financial burden this placed on residents, Council established the Utility Rate Assistance Fund (URAF) to help eligible households manage the impact.

The five-year plan includes a year two increase totaling $16.89 per month for the average single-family home (9,000 gallons) starting in 2026. Staff anticipates that continued adjustments in future years should be expected due to the annual application of the utility's long-range model, the criticality of ongoing infrastructure support, and to accommodate costs from unknown, but anticipated, state and federal mandates. The URAF to help eligible households remains in the budget for 2026, with minor adjustments.

Bond Ordinances

Police Building/Courts Remodel

This item is presented for the City Council's consideration and authorization to issue $100M in bonds to fund the Police Building/Courts Remodel. This financing utilizes Certificates of Participation (COPS), where the City will finance the project's construction by collateralizing existing City facilities via a Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, and Escrow Agreement. A Preliminary Offering Statement, Indenture, and Disclosure Certificate are also required. Selected facilities that will be borrowed against include Paul Derda Recreation Center, the Broomfield Community Center, the Detention Center, and the Service Center Administration Building. The anticipated maximum annual debt payment resulting from the financing will not exceed $7.9M and the annual payments will come from the City's general fund; however, the debt does not create a general obligation debt or multiple-year fiscal obligation, as the annual debt service payment is subject to annual appropriation.

As part of the 2023 property tax revenue increase, funding was designated to support the construction of the new Police building. In collaboration with our financial advisors, staff determined that using the set-aside property tax dollars to retire the 2017 Certificates of Participation (COPs) represents a sound long-term financial strategy. By applying these funds and coordinating the payoff of prior debt, the City can help offset the financial impact of issuing new debt for the upcoming Police and Courts facility. Recent credit rating upgrades and the City's strong financial position further reinforce confidence in our ability to manage debt responsibly.

The term of the financing will mature on or before December 31, 2047. The anticipated net effective interest rate will not exceed 5.50%. Additionally, as part of this financing, the City will also pay off its 2017 Certificates of Participation (COP) that have a current outstanding balance of $10.89M utilizing unencumbered cash on hand. The 2017 COPs were to mature on December 1, 2027. They were originally issued in 2010 to fund facilities needed to provide county services and for parks and recreation activities, and were refinanced in 2017.

Water Tanks

This item is presented for the City Council's consideration and authorization to issue $80M in Water Revenue bonds for funding the new water tanks. Broomfield's water system model identifies capital improvements that will be needed as Broomfield develops, including the construction of the proposed Water Tanks. The model specifically focuses on the phased development of the areas north of W. 144th Avenue that are quickly developing. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $5.9M and the term of the bonds will mature on or before December 1, 2047.
The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Water Activity Enterprise and does not impact the City's general fund. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement.

Related to the issuance of the Water Bonds, staff will be presenting to the City Council on October 28, 2025 as part of agenda item 7(G) - Water Tanks Construction Agreement, proposed Resolution No. 2025-152

authorizing the reimbursement to the water enterprise fund from bond proceeds (if needed) for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to award a construction contract up to the amount of the advanced funds and begin construction before the bonds' closing. It is expected that a construction contract will be presented to the City Council for approval in November and construction to begin on or about January 1, 2026. An amendment to the construction contract would then be presented to the City Council for approval once the bond proceeds are available for appropriation. Construction of the water tanks is projected to last 36 months.

Wastewater Treatment Facility Improvements

This item is presented for the City Council's consideration and authorization to issue $125M in Sewer Revenue and Refunding bonds for funding the Wastewater Treatment Facility Expansion. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $11M and the term of the bonds will mature on or before December 1, 2047. The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Sewer Activity Enterprise and does not impact the City's general fund. As a part of this financing, the City will also refund and discharge its 2012 Sewer Revenue Refunding Bonds with an outstanding balance of $15.315M that matures on December 1, 2031. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement.

The Wastewater Treatment Facility Improvements are being driven by expected future increases in population and regulatory requirements from the CDPHE that will require significant expansion to the current facility to adequately treat the increase in wastewater and maintain compliance with current and future regulatory requirements. Project drivers include capacity, asset renewal, biosolids, reuse, and regulation. Construction is to begin in 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

This memo will affirm and clarify the planned continuation of the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) programs into the 2026 fiscal year, as outlined in the proposed 2026 Budget for the City and County of Broomfield. These programs are designed first and foremost to support residents experiencing financial burden, while also serving as key components of the City's broader commitment to Council Goals, Financial Sustainability and Resilience, and Organizational Health.

The adjustments provide a summary of operational updates to ensure both programs remain efficient, fiscally responsible, and responsive to community needs within the budgeted resource allocations.

Financial Considerations

2025 Budget - 2nd Amendment

Resolutions 2025-141 and 2025-143-UR outline the financial considerations related to the second amendment to the 2025 budgets for both the City and County of Broomfield and Broomfield Urban Renewal Authority.

2026 Budget

Resolutions 2025-142, 2025-144-UR, and 2025-145-AID outline the financial considerations related to the adoption of the 2026 Budgets for the City and County of Broomfield, the Arista Local Improvement District, and the Broomfield Urban Renewal Authority.

Enterprise Ordinances

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees outlines the financial considerations related to this agenda item.

Bond Ordinances

Ordinance No. 2288 upon approval, authorizes debt financing of up to $80M for the Water Tanks and

approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement related thereto.

Ordinance No. 2289 upon approval, authorizes debt financing of up to $125M for the Wastewater Treatment Facility Improvements and approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement related thereto.

Ordinance No. 2290 upon approval, authorizes debt financing of up to $100M for the Police Building/ Courts Remodel and approves as to form the Preliminary Official Statement, Indenture, Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, Disclosure Certificate, Escrow Agreement related thereto.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

Resolution 2025-153 outlines the financial and programmatic considerations related to the Utility Rate Assistance Fund (URAF) Program.

Resolution 2025-154 outlines the financial and programmatic considerations related to the Partial Property Tax Refund (PPTR) Program.

Prior Council or Other Entity Actions

2025 Budget

October 22, 2024: Council approved Resolution 2024-149 adopting the 2025 CCOB Budget; BURA approved Resolution 2024-150-UR adopting the 2025 City and County of Broomfield Budget
March 11, 2025: Council approved Resolution 2025-44 amending the 2025 CCOB Budget; BURA approved Resolution 2025-52-UR amending the 2025 BURA Budget

2026 Budget

August 19, 2025: Staff provided information and insights to inform the Council on Broomfield's economic and financial outlook, influencing the 2025 revised budget and the 2026 operating and capital proposed budgets.
August 21, 2025: Staff provided an overview of how Broomfield intends to fulfill the community goal of financial sustainability and resilience at the Broomfield 101: Economic and Fiscal Update Community Forum.
September 3, 2025: The City Council received the 2026 Proposed Budget and supporting documentation.
September 4, 2025: The 2026 Proposed Budget and supporting documents were made available for public view and comments on the City's website.
September 18 and September 25, 2025: Study Sessions to discuss the 2026 Proposed Operating & Capital Budgets with department representatives.
October 14, 2025: Public Hearing per Chapter 12.7 of the Charter for the 2026 Operating and Capital Budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District.

Enterprise Ordinances

April 15, 2025: Staff held the first 2025 quarterly Enterprise Funds study session and provided an overview to City Council on the status of the enterprise funds.
May 13, 2025: Creation of FLOW Advisory Committee approved by City Council.
July 15, 2025: Staff held the second 2025 quarterly Enterprise Funds study session, providing an update on the enterprise funds and initial recommendations on utility rate adjustments, along with a presentation by subject matter expert consultant AECOM.
October 14, 2025: First reading of ordinance number 2286.
October 21, 2025: Staff will provide an overview to City Council in a Broomfields Enterprise Funds study session and initial results of additional repair and replacement capital added during the 2025 budget.

Bond Ordinances

August 19, 2025: Staff provided information and insights to City Council on Broomfield's high credit rating

and the organization's "superior ability to repay short-term debt obligations," providing guidance to ensure Broomfield's financial stability while requesting new bonds to finance the 2026 capital improvement projects for the new Police Building / Courts Remodel and Water and Sewer infrastructure improvements.
October 14, 2025: First reading of ordinance numbers 2288, 2298, and 2290.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
November 1, 2022: Council Approved the 2023 PPTR Program with Resolution No. 2022-123.
January 23, 2024: Council Approved the Expansion of the PPTR Program in 2024 with Resolution No. 2024-27.
October 22, 2024: Council Approved the URAF Program with Resolution No.2024-165.
October 22, 2024: Council Approved the 2025 Budget with Resolution No. 2024-149.
December 3, 2024: Council Approved the 2025 PPTR Program with Resolution No. 2024-105.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

2025 and 2026 Budget
If Council desires to approve the proposed 2025 budget amendment, the appropriate motion is...
That Resolution 2025-141 be adopted.

If Council desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-142 be adopted.

If BURA desires to approve the proposed 2025 budget amendment, the appropriate motion is…
That Resolution 2025-143-UR be adopted.

If BURA desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-144-UR be adopted.

If ALID desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-145-AID be adopted.

Amending Enterprise Ordinance

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2286 be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to water, sewer, water reclamation, and stormwater charges and fees as set forth in these ordinances would be effective January 1, 2026.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2288 Issuing Enterprise Revenue Bond (Water Tanks) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2289 Issuing Enterprise Revenue Bond (Wastewater Treatment - Phase 1B) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2290 Issuing Certificates of Participation (Police and Courts Buildings) be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to the issuance of new bonds as set for in the ordinances would be effective January 1, 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program

If the Council desires to proceed with the staff recommendations for the continuation of the Utility Rate Assistance Fund Program in 2026, the appropriate motion is…

That Resolution 2025-153 be adopted.

If the Council desires to proceed with the staff recommendations for the continuation of the Partial Property Tax Refund Program in 2026, the appropriate motion is…

That Resolution 2025-154 be adopted.

Alternatives

Budget

Per Charter, the City Council must adopt a budget. If it fails to do so, the budget will be put on future agenda(s) until such time as it is approved. If Council fails to adopt the budget, the amounts appropriated for the operation of the current fiscal year shall be deemed adopted for the next fiscal year on a month-to-month basis, with all items in it prorated accordingly, until such time as the Council adopts the budget for the next fiscal year.

Amending Enterprise Ordinance

If Council does not approve the recommended utility rate ordinance, the existing fee structure would remain in place. CCOB's Enterprise funds' financial sustainability and resiliency would weaken. The ability to obtain favorable financing for necessary projects, including wastewater treatment facility expansion and water tanks, would be put at risk.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If Council does not approve the recommended two enterprise revenue bonds and police building certificate of participation ordinances, CCOB would not defease the existing certificates of participation and would not move forward with the issuance of the bonds. CCOB would not be able to finance the necessary projects, which include the Wastewater Treatment Facility Expansion, Water Tanks, and new Police Building.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
Do not approve staff recommendations. If not approved, provide an alternative direction.

Background - Budget

Broomfield has grown and evolved significantly over the past twenty years from an emerging suburban community into a large, thriving, and maturing urban-suburban community. Since the consolidation of our community in 2001, Broomfield has provided effective and efficient city and county programs and services. Today, Broomfield is home to nearly 80,000 residents, living in more than 34,000 housing units and thousands of businesses. While much of Broomfield's 34 square miles is built out, there is a continued focus on developing and evolving while maintaining long-term financial sustainability and resilience.

Budget Process and Philosophy

The budget is a planning tool that is used to meet the results of the March 3, 2023, Council Focus Session, where the Community Goals were solidified with an emphasis on Goal #1: Financial Sustainability and Resilience. Therefore, the budget process is flexible and responsive to organizational and community needs and economic conditions.

In addition, staff will continue with a comprehensive, clear, and transparent approach by bringing forth a consolidated number of budget amendments for the Council's review and consideration, and for transparency for Broomfield residents. Each budget amendment is designed to address specific topic areas outlined below.

- **Budget Amendment 1** (Q1): reflects the carryover of capital and grant projects from the prior fiscal year and any additions to operational budgets (i.e., increased cost for Spring Cleanup).

- **Budget Amendment 2** (In conjunction with adopting the following fiscal year's budget; Q4): reflects the current state of actual revenues and expenditures, including any supplemental requests, and sets the foundation for the following year's budget.
  This amendment also includes the prior year's audited financials (actual beginning fund balances), which helps inform the ability to fund future year financial shifts.

- **Budget Amendment 3** (Q4): if needed, addresses grants, which often require financial adjustments based on project or program status of implementation and execution due to the timing of the grant award.

Current and future budgeting processes are designed to ensure operational and capital success, focusing on creating a culture of accountability and intentionality while basing the budget on revenue and expenses. This helps to drive forward a sustainable, disciplined structure of reallocating funds and not continuing to increase expenditures arbitrarily.

Proposed Budgets

2025 Revised Budget Summary

On October 22, 2024, City Council passed Resolution 2024-149 to adopt the 2025 budget for the City and Council of Broomfield. Additionally, the Broomfield Urban Renewal Authority approved resolution 2024-150-UR to adopt the 2025 budget for BURA. Since the adoption, the budgets have been amended one (1) time to reflect capital project rollovers, grant rollovers, and additional capital and operational budget adjustments. As can be seen in the table below, adjustments to the City and County of Broomfield budget in amendment #1 is listed as well as the proposed adjustments in amendment #2.

CITY AND COUNTY OF BROOMFIELD
REVISED BUDGET SUMMARY - ALL FUNDS*

Fund	Original Budget 2025	Budget Amendments #1 2025	Budget Amendment #2 2025	Amended Budget 2025
Beginning Fund Balance	**$ 304,842,581**			**$ 408,834,091**
Revenues				
General Governmental Funds	$ 201,022,977	$ 14,388,112	$ 13,956,978	$ 229,368,067
Governmental Capital Funds	89,039,461	18,228,553	9,687,422	117,955,436
Enterprise Funds	83,761,446	(1,479,300)	(4,564,126)	77,718,020
Fiduciary Funds	223,100,356	-	-	223,100,356
Total Revenues	**$ 596,924,240**	**$ 31,137,365**	**$ 19,080,274**	**$ 648,141,879**
Expenditures				
General Governmental Funds	$ 216,385,986	$ 13,140,495	$ 5,475,993	$ 235,002,474
Governmental Capital Funds	103,310,912	73,107,734	4,355,292	181,773,938
Enterprise Funds	99,516,325	47,506,010	(2,731,036)	144,291,298
Fiduciary Funds	214,122,885	-	-	214,122,885
Total Expenditures	**$ 633,336,108**	**$ 133,754,239**	**$ 7,100,248**	**$ 775,190,595**
Ending Fund Balance	**$ 268,430,713**			**$ 281,785,375**

** Excludes transfers to reserves and interfund transfers*

2025 Operating and Capital Fund Revised Budget

Budget adjustments are made in order to respond to the changing demands of our operations in addition to the continued economic fluctuations occurring at the local, state, and national levels. In 2025, the City and County of Broomfield eliminated what had traditionally been the second amendment of the year. The Finance Department worked directly with departments to discuss needs and work strategically to accommodate needs by reallocating current budgets while continuing to monitor throughout the year to determine if budget adjustments were actually needed. Based on this collaborative effort, staff have been able to reduce the overall workload within the organization and minimize the number of times the budget needs to be reviewed, adjusted and considered by City Council.

The proposed operating fund budget adjustments include both personnel and non-personnel adjustments for programs and initiatives. While capital fund adjustments are the result of revising capital projects due to aspects such as timing or changes in project priorities since the adoption of the 2025 5-Year CIP Plan. The table below includes highlights of operational revisions to the 2025 budget.

2025 Revised Budget Highlights*		
Department or Category	**Description**	**Amount**
City & County Attorney	2025 Increase for Insurance Premiums	$ 70,000
Courts	Above Mid-Point Pay Request: Lead Court Clerk Hire	4,142
Human Resources	New Full-Time FT: HR Project Manager	71,498
Police	Increase to Axon Agreement	234,625

Police	Increase to Inmate Food Services Contract	172,050
Police	Increase to Psychological Support Contract	50,000
Police	Dual Sim Card Monthly Fees with First Net	36,500
Police	Inmate Medicine Expenses	38,252
Police	Outside Fund Award Funded Motorola Service Agreement for Back Up Dispatch Center Equipment	12,775
Police	Brower Resilience Visits	2,500
	Total	**$ 692,342**
*Personnel Highlights are pro-rated for partial year		

The 2025 revised operating budget includes a number of cost increases associated with existing contractual obligations. The 2025 budget process was completed in the middle of 2024, prior to a number of contractual amendments being executed, so adjustments are made during the 2nd amendment to appropriate the additional funds needed to meet these obligations.

In addition to the Budget Highlights noted above, the 2025 revised operating budget also includes a number of non-personnel budget reductions as part of the organization's efforts to optimize budgets. Travel and training budgets were reduced by $859,813 and other identified non-personnel budgets were reduced by $1,041,450. This effort was collaborative across the entire organization, with a focus on maintaining services to residents.

In total, staffing levels and service demands resulted in the addition of 4.13 FTE in 2025, as detailed in the Expenditures: 2025 Personnel Changes table.

Expenditures: 2025 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
City & County Manager	1.00	303,987	Economist (1.0FT), Administrative Analyst (1.0FT), Case Manager II - Housing (-1.0FT)
Community Development	-1.00	(133,296)	Senior Transportation Planner (-1.0FT)
Economic Vitality & Development	-2.00	(254,758)	Economist (-1.0FT), Administrative Analyst (-1.0FT), Administrative Support I/II LTA (2.0FT), Administrative Support I/II LTA (-2.0FT)
Human Resources	1.00	65,533	HR Project Manager (1.0FT)
Human Services	2.80	172,795	Case Managers II LTA (2.0FT), Case Manager II LTA (-2.0FT), Case Manager II (1.0FT) Workforce Specialist II LTA (0.8PT), Human Services Management Analyst (-0.8), Non-Profit & Community Engagement Manager (1.0), Human Services Grants Specialist (0.8)
Library, Arts & History, and CSU Extension	0.33	(1,718)	Creative Technologist (-0.8PT), Patron Services Associate (1.0FT), Creative Technologies (-0.6PT), Patron Services Associate (0.73PT)
Public Health & Environment	0.00	(2,845)	Human Services Management Analyst (-0.2), Human Services Grants Specialist (0.2)
Total	**4.13**	**$ 149,698**	
*Includes internal transfers. Costs prorated for partial year. Public Works to Public Works / Water Utilities reorganization is not included.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and estimated taxes and benefits			

2025 Broomfield Urban Renewal Authority Revised Budget

This is the second amendment to the 2025 BURA budget. This amendment reflects updated revenues and expenditures projected through the end of the year based on year-to-date information. The BURA Budget Tables summarize the 2025 proposed revisions to the budget.

2025 BURA Revenues - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 70,511,588	$ 605,615	$ 71,117,203
Debt Service	5,056,106	(607,935)	4,448,171

2025 BURA Expenditures - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 54,215,747	$ 2,902,954	$ 57,118,701
Debt Service	4,459,171	-	4,459,171

2026 Proposed Budget Summary

Planning for Increased Financial Stability

The City and County are guided by conservative revenue projections, reasonable cost assumptions (expenses), deploying strategic development decisions, effectively managing staffing patterns, and using

data-driven decision-making models to keep operational costs in check.

Transitioning into 2026, Broomfield's economic and financial position is fundamentally sound, but we remain in an ever-increasing volatile environment. This reality reinforces the need for prudent financial flexibility, conservative planning assumptions, and disciplined decision-making to ensure long-term sustainability.

Broomfield's two largest primary revenue sources are property tax and sales/use tax, with sales tax showing minimal growth in 2025 (measured at the halfway point through the year, sales tax is projected to end 1-2% higher than 2024). The minimal sales tax growth is expected to continue to build in 2026, a trend anticipated to continue into 2027. Additional retail and commercial investments in the pipeline begin to come online in 2027 (e.g., Macerich's HiFi area at FlatIron and the initial phase of McWhinney's Center Street area). Conversely, the property tax revenue is expected to fall in 2026 and remain stable in 2027. The property tax revenue reduction is occurring due to State changes in the property assessment rates and the decline in property market values.

Due to decreased property assessment rates, property owners will see lower tax bills, which correlates to the decreased county property tax revenue by approximately $6.5-7.5 million annually. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

The 2026 proposed budget reflects the organization's continued focus on balancing current needs and obligations while preparing to meet the organization's and community's future needs by prioritizing expenditures into Mandates, Obligations, and Critical needs. Broomfield's economic fundamentals continue to provide sustained economic and employment opportunities while ensuring a sound fiscal base for CCOB budgets.

Guiding Principle: Residential Growth and Service Capacity

Broomfield currently has the revenue to sustain current service levels, but each new residential development adds demand and costs to systems already operating near capacity. Sales tax revenue growth—expected as new commercial development comes online in 2027—will help, but will not fully offset rising expenditures. Property taxes remain outside local control and subject to state formulas and market values; those factors created a $6.6M - $7.5 decrease in general fund revenue, which is not anticipated to return.

Balancing Housing Needs with Community Capacity

While the Front Range continues to face an affordable housing shortage that calls for regional solutions, Broomfield must thoughtfully balance this need with our community's existing capacity. Demand for services is strong — recreation programs often fill quickly, fields are well used, the Library serves at or near capacity, and our core utilities, such as the wastewater treatment facility, are preparing for future growth. Broomfield has also made prior commitments to additional residential development through business development agreements. Looking ahead, future decisions will shape how we continue to provide high-quality services, invest in infrastructure, and remain fiscally responsible, while also contributing to broader housing solutions across the region.

Disciplined Development and Long-Term Financial Sustainability

Broomfield continues to take a thoughtful, yet disciplined, approach to development as the foundation for achieving long-term financial strength and sustainability. Our strategy emphasizes balanced growth and a diversified economy—ensuring that both residential and commercial development occur in alignment with community needs and fiscal realities.

Maintaining and strengthening the ratio of residential to commercial development is paramount as we move into the future. A healthy balance not only supports a diversified tax base and resilient economy but also ensures that service demands and infrastructure investments are financially sustainable over time.

By adhering to this disciplined approach, Broomfield positions itself to manage near-term fiscal challenges

while preserving the flexibility to invest in community priorities and future opportunities.

Broomfield recognizes that a strong community is made up of thriving neighborhoods and residential areas, combined with commercial areas and developments home to businesses in key sectors, such as finance, information technology, aerospace, and business/professional services. Broomfield is also successful in attracting and growing businesses in next-generation economic sectors, such as quantum computing, phonetics, and advanced manufacturing. Recent firms choosing and growing in Broomfield include Sierra Space, SiNaptic, Quantinuum, and Raven Space Systems.

Development and increasing redevelopment in the community continue to build on this economic and financial foundation. These developments provide sought-after locations for businesses to locate and grow, places for residents and visitors to shop, dine, and gather, and places where existing and new residents will call home. Current construction is underway around FlatIrons Crossing (the HiFi area: both the Novel FlatIron residential and new commercial space), MidPoint's flex/innovation space (255 Midway), the Simms Technology Park, and Harvest Hill apartments. Horizontal construction will soon start in Baseline's mixed-use Center Street development. Combined, these current developments total nearly 500 new residential units (over 200 income-aligned), about 500,000 square feet of new work space, and over 100,000 square feet of (already leased) shopping and dining space.

The 2026 proposed spending plan recognizes that our community looks to its local government as innovators and leaders. It supports this influential work by refocusing and committing to the identified Community Goals, with the fundamental goal of Fiscal Sustainability remaining paramount to a healthy and robust future.

Emphasis on Prioritizing Needs

As Broomfield continues to maintain economic and fiscal stability, our strategic approach includes a prudent and pragmatic fiscal approach to anticipate and withstand future economic or financial disruptions in the short and long term.

The proposed 2026 budget prioritizes expenditures in the following categories:

- **Mandates**: Regulatory requirements issued by the federal or state level that result in the need for funding.
- **Obligations**: Contractual requirement or agreement.
- **Critical Need**: This is essential to the organization's effective operations. Failure to fund it would threaten public health, the environment, or community safety, or create a more significant liability or risk to the organization.

Any funding request not categorized by a mandate, obligation, or critical need but necessary to provide ongoing programs and services would be defined as an 'other' this year. In 2026, only projects classified as 'other' that were moved forward were partially funded by grants.

The 2026 Recommended Budget reflects a collaborative effort across all departments. New services and their associated costs will be strategically timed for review only when budget flexibility improves – something not anticipated in 2026, and possibly not until the second half of 2027.

All departments determined needs based on the following high-level categories and corresponding thought-provoking questions, serving as the foundational lens through which all budgeting and resource allocation requests were reviewed:

- **Safety**: Eliminating or reducing a hazard/threat
- **Operational Cost vs. Revenue**: Is there a revenue offset that will help reduce costs?
- **Asset Maintenance**: Ability to extend the life cycle of a current asset
- **Comprehensive Plan**: Approach and alignment with existing roadmap

- **Operational Support**: Will the request create additional demand on existing resources or require new support?
- **Alternatives**: Does the alternative require greater resources, financially or otherwise?
- **Cost Sharing Opportunities**: Ability to leverage outside funding awards
- **Urgency**: Is there an immediate need that the request will satisfy?
- **Public Benefit & Quality of Life Impact**: Ability to benefit across various sectors
- **Socio-Economic Equity**: Determining the applicability within Broomfield's vulnerable populations or underrepresented
- **Sustainability**: Ability to address/correct the construct that will benefit the environment

For the fifth consecutive year, staff recommends maintaining Public Safety, Public Works, and Water Utilities as a top priority while continuing to adapt to growth, addressing deferred maintenance while moving forward with an asset management approach, and shifting to new and long-term fiscal realities.

Public Safety

This commitment is demonstrated by keeping the Broomfield Police Department organizationally separate from general employee groups. This approach has enabled the City and County of Broomfield to strengthen its police force effectively, resulting in a substantial increase in essential personnel to better serve the community. The Full-Time Equivalents (FTEs) grew from 242 in 2021 to 277 in 2025, a 14% increase. Concurrently, the police budget expanded from $34 million in 2021 to $44 million in 2025, marking a 27% increase. This investment is directly linked to Broomfield maintaining the lowest crime rate per capita in the metro area.

District Attorney – 17th Judicial District

The proposed budget for Broomfield's population share of the District Attorney's office is based on preliminary calculations received from Adams County in August 2025. On August 12, 2025, the District Attorney submitted his budget documents to Broomfield staff. Following that submission, Broomfield requested a meeting with the Adams County Board of Commissioners and leadership to discuss the request.

This meeting, held in mid-September, included the Mayor, Mayor Pro Tem, City Manager, and City Attorney. The discussion focused on the scope of services included in the DA's request, as well as the Family Justice Center, which is addressed in greater detail below.

Adams County is also in the process of finalizing its budget. On October 1, 2025, the District Attorney presented his budget request to the Adams County Board of Commissioners; however, the Board has not yet approved the request. Broomfield staff attended the presentation and will continue to monitor developments to ensure Broomfield's final budget reflects only its proportional share of approved expenses.

Broomfield's proposed budgeted amount for the DA reflects a budgeted amount that does not include costs for the proposed Family Justice Center (FJC). Per statute, Broomfield is only responsible for its per-population share for "the necessary expenses of maintaining an office for the transaction of official business" of the District Attorney.

While the intent of the FJC is admirable, the District Attorney has indicated that 75% of individuals to be served will be non-judicial clients. This represents not an expansion of existing prosecutorial services, but rather the creation of an entirely new entity, infrastructure, and team, as shown by 9 FTE in his budget request to Adams and Broomfield counties. While there is a connection with the domestic violence case work completed by the DA's office, this is a separate endeavor that warrants further scrutiny and should be subject to discussions about the creation of a regional and distinct intergovernmental entity before Broomfield commits taxpayer resources.

In addition, the revised proposed budgeted amount for the District Attorney does not include the cost of one FTE (an attorney) that Broomfield has solely funded since 2021 to reduce backlog following COVID. This was

a separate agreement with the DA, and three years later, after that backlog has been addressed, that cost should not be part of the base budget.

Public Works and Water Utilities

Our focus on infrastructure over the past several years has led to significant growth in resources dedicated to roads, streets, maintenance, and water. Full-time equivalents (FTEs) increased from 158 in 2021 to 220 in 2025 – a 39% rise (note: this includes 14 FTEs transferred to Public Works/Water Utilities from Community Development and Strategic Initiatives related to Construction Inspections and Energy and Sustainability, respectively). Investments in Public Works and Water Utilities have enabled staff to optimize infrastructure, boost productivity, and better manage assets. This directly impacts overall operations and effectiveness.

Broomfield has made major strides in core infrastructure and utility maintenance over the past five years. The Street Pavement Management Program expanded significantly, with more miles treated and a dramatic increase in crack sealing. Water Utilities strengthened operations with annual waterline replacements, full fire hydrant flushing and maintenance, and near-complete valve maintenance. The Sewer Collections Program has advanced to completing annual program system cleaning and inspection on a regular cycle. Meanwhile, the Stormwater Maintenance Program, established in 2021, now conducts annual program system cleaning and inspections each year. These operational improvements are supported by a five-year financial sustainability plan that ensures the long-term health of infrastructure, high-quality service delivery, and protection of public health and the environment.

Given the challenges and uncertainty in the economy and marketplace, the 2026 Proposed Budget relies on conservative fiscal policies and projections supporting balanced annual spending. The 2026 Proposed Budget was built using a combination of Council direction with existing planning documents, including, but not limited to, the Comprehensive Plan, the Long Range Financial Plan, and financial/economic modeling, to synthesize the work over the past several years of taking a comprehensive methodological approach to Broomfield's future.

2026 Areas of Focus & Key Highlights

- Broomfield has not acquired any additional general obligation (GO) debt since 2017. Broomfield will be defeasing prior debt and remains committed to maintaining and increasing our existing Aa2 bond rating, which means the organization has a "superior ability to repay short-term debt obligations." The rating is one of the highest within the state of Colorado. This high rating is essential. Having debt of 5% of revenues is considered appropriately leveraged and reflects the government's ability to repay debt.
- Broomfield will continue to leverage grant funding as part of efforts to diversify revenue sources. In 2025, overall, less grant revenue was available on the Federal and State levels. As of August 2025, CCOB has received 91 grants, representing an increase from 69 grants in 2024. This total reflects both new grant applications and recurring awards that continue from year to year. In 2025 alone, more than 35 new grant applications have been submitted, with 28 awarded to date. These awards total approximately $5.6 million, compared to $4 million last year. We will continue to seek grants in 2026 to pursue funding from private, local, and state sources. New grant funding to be explored in 2026 includes: Courts' First Defense Counsel Appearance, incentives for Norm Smith UST removal reimbursement, the Recycling Rebate Program, and Special Supplemental Nutritional Funds for Women, Infants, and Children (WIC).
- Police Facility construction is anticipated to begin in early 2026.
- Courts Remodel design to begin in 2026.
- Maintain the achieved goal of 20% reserves into 2026 and future years.
- Continue to explore opportunities for development of the former Event Center site: This development is expected to be a revenue generator for the community.
- Implementation of the selected City and County Enterprise Resource Planning (ERP) Software that will modernize our existing 30+ year manual/spreadsheet system to begin early 2026.
- Update the 2016 Comprehensive Plan in 2026, providing the Council, community, and our

organization an opportunity to play a critical role in shaping the vision for the next decade and beyond.
- Implementing the first organizational strategic plan to guide the 2026 work plan.
- Issuance of three bonds: Quarter one 2026, Certificate of Participation for the PD/Courts, and two in the Enterprise Funds for the Water Tanks & Wastewater Expansion - Phase IB.

This list alone requires us to be especially prudent in the upcoming year and beyond. We are operating in a constrained environment – both financially and with staffing capacity – and must therefore be intentional and strategic in every decision we make. The 2026 and 2027 budgets will require a reallocation methodology, not a reprioritization model – meaning that to add anything, other programs must be reduced or removed to accommodate new or enhanced funding. As we gain clearer insights into programmatic outcomes, we must be willing to have courageous conversations about whether programs and services are being fully maximized, widely utilized, effectively measured, and delivering the intended outcomes. If they are not, we must work together to thoughtfully realign our efforts and resources toward initiatives that deliver the greatest benefit to our community.

2026 Budget Highlights

Revenue Projections

Broomfield's two largest primary revenue sources are property tax and sales/use tax, accounting for 60% of Broomfield's revenue base. Sales tax is showing minimal growth for 2026. The minimal growth in sales tax is a trend anticipated to continue into 2027, while retail and commercial investments in the pipeline begin to come online in late 2027 (ie, Macerich development).

Conversely, the property tax rates are not expected to move in any direction but downward. Due to decreased property assessment rates, property owners will see lower tax bills. This reduction will decrease county property tax revenues by approximately $6.5-7.5 million annually – $3-4 million from residential properties and $3.5 million from commercial properties. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

Across all revenue streams[1], 2026 projected revenues are expected to increase by 5.2% from $332 million to $349 million compared to the 2025 revised budget per Table 1C of the proposed budget. This increase is primarily driven by anticipated revenues from Fiber contracts, building permits and use tax revenues.

The 2026 proposed budget was built with the projected increases in Utility Rates for water, sewer, reclaimed water, and stormwater.

Expenditure Projections

Broomfield continues to monitor the ongoing uncertainties surrounding the economic environment and is prepared to react as needed. The budget process is an example of staff working collaboratively to mitigate the impacts of these uncertainties.

Operational expenditures are expected to increase by 5.8% from the 2025 original budget to the 2026 proposed budget.

Total expenditures (Table 3B), which include the operating, capital, additions to reserves, and debt service obligations across all funds, is an estimated $897 million, excluding inter-fund transfers. This represents an increase of 41% in expenditures from the 2025 original budget to the 2026 proposed budget. This increase is primarily driven by large capital projects, such as the new Police building, Court building remodel, and the Water and Sewer projects.

Personnel

Over the last four years, Broomfield has implemented a market-driven, competitive compensation philosophy to lead the market. This was based on the legal requirements to comply with new federal equal pay mandates and aligned with the City Council's direction on employee compensation. In year five, Broomfield is working to maintain the progress while navigating economic uncertainties. Human Resources completes market evaluations every other year to ensure positions within CCOB are paid competitively against the Denver Metro market. This data is used to project salaries and personnel costs for the proposed budget. In 2026, Human Resources will not be conducting market evaluations.

Ongoing personnel costs and adding new positions to meet the community's needs are the primary drivers of the 5.8% operational budget increase referenced in the expenditures section.

Below is a list of the Personnel Changes implemented as part of the 2026 operating budget.

1Excludes Fiduciary Funds and Budgeted Bond Revenues

Expenditures: 2026 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
Human Services	0.10	13,463	Business Solutions & System Administrator (0.1FT)
Information Technology	-1.00	-	Accessibility Specialist LTA Expiration (-1.0FT)
Parks, Recreation, & Senior Services***	2.25	219,958	Lead Parks Tech (1.0FT), Parks Tech II PT to FT (0.25FT), Preschool Director (1.0FT)
Public Health & Environment	0.40	18,982	Business Solutions & System Administrator (-0.1FT), Administrative Support II PT to FT LTA (0.5FT)
Water Utilities	3.00	334,561	Cross Connection Foreman (1.0FT), Senior Water Utilities Locator (1.0FT), Senior Sewer Utilities Locator (1.0FT)
Total	**4.75**	**$ 586,964**	
*Includes internal transfers.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and est. taxes and benefits; does not include any non-personnel budgets associated with new FTE			
***Department has self-funded these positions with budget realignments - reducing temp and non-personnel budgets			

Non-Personnel

Non-personnel-related expenses include the supplies, equipment, and contractual service costs necessary to provide the programs and services in Broomfield. Some examples include:

- Fuel
- Vehicle Maintenance Supplies (i.e. air & oil filters, tires, etc)
- Electronic Equipment (i.e. telephones, computers, headsets, etc)
- Training and Development of staff
- Professional Services (i.e. outside auditors, specialized legal services)
- Insurance expenses
- Utilities
- Software (Annual License Fees, such as Google)

As part of the annual budget process, the budget staff meets with departments to discuss non-personnel requests and the drivers of individual items. Items like fuel are a basic necessity for the organization to accomplish its work and are subject to market conditions; thus, Broomfield has very little control over this type of expenditure. For other non-personnel items, the organization manages costs by finding alternatives or adjusting work procedures to eliminate or minimize expenses wherever possible.

Operating Budget Highlights

Below is a list of some highlights of the 2026 operating budget.

2026 Operating Budget Highlights		
Department or Category	**Description**	**Amount**
Assessor	One (1) 5-Month Overlap (Assessment Supervisor)	$ 66,708
City and County Clerk	Two (2) 2-Month Overlap (Recording & Motor Vehicle Specialist, Recording & Licensing Specialist)	25,141
City & County Manager	Hazardous Mitigation Plan Update - FEMA Mandate	65,000
Community Development	Two (2) Reclassifications (Senior Landscape Architect to Landscape Manager, Combination Inspector to Landscape Associate/Tech)	54,272
Parks, Recreation, & Senior Services	One (1) FT (Lead Parks Technician)*	-
Parks, Recreation, & Senior Services	One (1) PT to FT (Parks Technician II)*	-
Parks, Recreation, & Senior Services	One (1) TM to FT (Preschool Director)*	21,401
Police	One (1) FT Continuation (Victim Advocate) if Grant is discontinued	112,712
Police	Three (3) Reclassifications (Records Specialist to Records Supervisor, Budget Analyst to Budget Supervisor/Manager, Office Manager to Senior Operations Manager)	73,871
Public Health & Environment	Personnel Costs Transitions	(8,555)
Public Health & Environment	One (1) PT to FT LTA (Admin Support II)	33,899
Public Health & Environment	One (1) Reclassification (Environmental Health Specialist I to Environmental Health Specialist II)	5,953
Water Utilities	Three (3) New FT (Cross Connection Foreman, Senior Water Utility Locator, Senior Sewer Utility Locator)	381,107
Water Utilities	SCADA Environment Security Scanning Software (w/IT)	69,571
	Total	**$ 901,081**
*Department's non-personnel budget will be reduced for the personnel changes		

2026 Capital Improvement Plan Considerations

Using a conservative approach and understanding the constraints of Broomfield's finances, staff will continue to evaluate and prioritize projects based on mission essentials and those that affect the health and safety of the community. To proactively prevent unintended consequences with any changes in the funding of CIP, staff will continue to seek guidance from Council.

The 2026 Five Year Capital Improvement Project (CIP) Plan was developed in a parallel process at the same time as Broomfield's operating budgets. This process included an extensive year-long collaboration across all departments to ensure that all projects and community requests were considered. CIP requests are rated and prioritized using the same "buckets" described earlier in the document. Ensuring that our limited resources are focused on mandates, obligations, and critical infrastructure projects reinforces our financial sustainability and resilience goal. Finally, staff has worked to shift the focus of funding from new capital projects towards preventative maintenance, repair, and rehabilitation to ensure that Broomfield is focusing efforts on adequately addressing its existing infrastructure.

The 2026 budget for Capital Projects includes

- $142.9 million in expenditures for the General Governmental Funds
  - $100 million for the Police Building and Courts remodeling projects
- $217.2 million in expenditures for the Enterprise (Utility) Funds.
  - $70 million for the two new Water Tanks project
  - $114 million for Wastewater Treatment Facility Expansion Project

2026 Broomfield Urban Renewal Authority Budget

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2026 BURA revenues are budgeted at $65.1 million, representing a 7.7% decrease compared to the 2025 original BURA budget. BURA expenditures in 2026 are budgeted at $50.0 million. BURA also pays the City and County of Broomfield to cover administration costs and professional services related to the development of urban renewal areas. The 2026 budget includes $5.5 million for administrative and professional services expenditures.

2026 Arista Local Improvement District Budget

The Arista Local Improvement District (ALID) was established to facilitate the construction of transportation facilities in the Arista Development. The ALID is supported by a 0.2% sales tax collected on all taxable sales within its boundaries, and the revenue generated by the tax has been pledged to support the Arista Metro District's (AMD) debt service on bonds sold to construct the parking structure.

The only allowable use of the revenue is to support the funding of public transportation services or improvements, the 2026 budget for the ALID exists solely to authorize payments to AMD, as noted. The 2026 proposed ALID budget includes $45,000 in sales tax revenue and $45,000 in expenditures related to the AMD debt service for the construction of the parking structure.

Background - Enterprise/Utility Fee

Utilities are funded by four enterprise funds that are specifically dedicated to the Water, Wastewater, Reclaimed, and Stormwater/Flood Management utilities. Each enterprise operates as a self-supporting entity. Revenues generated from monthly utility bills are the largest source of revenue for each utility, accounting for generally between 85% to 90% of revenues in each fund. Other significant sources of funds include development fees and funding from the Mile High Flood District (MHFD). These cumulative funding sources cover day-to-day operations, capital and rehabilitation projects, and annual programs. A robust enterprise fund presents a significant strategic advantage, empowering the city to issue revenue bonds.

This mechanism is crucial for financing substantial capital projects, much like the extensive bonded projects anticipated in 2026. The ability to leverage revenue bonds ensures that vital infrastructure and development initiatives can proceed.

As previously noted, to prepare for critical utility infrastructure needs, Broomfield adjusted water and sewer rates last year. This was, in part, to support two upcoming enterprise bond issues – one to fund two new water storage tanks and another to expand our wastewater treatment facility. Staff has contracted with bond underwriting firms, Stifle & Piper Sandler, who have extensive Colorado market experience in issuing Enterprise Fund bonds. CCOB is still targeting issuance in quarter one 2026.

Staff has provided additional detailed information on how water and sewer rates are directly influenced by the process of repairing and replacing aging infrastructure, known as asset renewal. Here is the linked

document - Water Utilities System Asset Renewal - Key Aspects of Establishing Rates.

In addition to preparing Broomfield to support the two upcoming enterprise bond issues, the rate increase implemented in 2025 was able to be immediately utilized to implement the water meter replacement program and improve maintenance of existing assets, including the following notable improvements:

Potable Water Improvements

- Flushing 483 miles: 100% (vs. 19% in 2022).
- Hydrants 4,478: 100% maintained (vs. 47% in 2021).
- Backflow devices 2,737: 97.17% compliance (exceeds CDPHE 90%).

Sewer and Stormwater Improvements

- Sewer video inspections: Currently at 90%; 100% by year-end (vs. 20% in 2023).
- Sewer cleaning: Currently at 98%; 2-year full-cycle program (vs. 40% in 2022).
- Storm video inspections: Currently at 87%; 100% by year-end (vs. 9.6% in 2021). Cleaning: 100% of 2025 target (vs. 0% in 2021).
- Street sweeping: 3,381 miles swept in 2025 (+95% vs. 2023).

2026 Proposed Recommendations: Water, Sewer, Reclaimed, and Stormwater Rates

As detailed in the budget adopted by the Council in 2025, the five-year plan includes a year two increase totaling $16.89 per month for the average single-family home starting in 2026. This represents a 15% increase for utility rates across all funds, with a 9% ($1.00) increase for stormwater service fees, and aligns with projections presented in the original five-year plan presented in 2024 (also see October 22, 2024, memorandum). Similarly, the non-residential water, sewer, and reclaimed rates will increase by 15% and stormwater service fees will increase by 9%. License fees for water, sewer, and reclaimed water for new development will increase by 4%.

Staff has completed a comprehensive fiscal analysis to evaluate anticipated revenues from utility rates as well as projected expenses based on necessary costs associated with day-to-day operations, capital and rehabilitation projects, and annual maintenance requirements. The fiscal analysis includes multiple interdependent variables, and adjusting any one component impacts several other variables within the model, requiring a holistic re-evaluation of all dependencies within the five-year comprehensive plan.

This increase is essential to ensure the long-term financial sustainability of our enterprise funds while maintaining essential services and infrastructure. The recommended rate structure ensures sufficient funding for both ongoing maintenance of existing water infrastructure and necessary capital improvements. The proposed increase allows the utility to maintain a proactive maintenance schedule consistent with capital improvement planning recommendations, protecting the community's investment in water infrastructure while avoiding more costly emergency repairs. Deferring maintenance on water system components creates significant financial risk, as delayed repairs typically result in substantially higher replacement costs and potential service disruptions that impact the entire community.

It is important to understand why this rate increase cannot easily be reduced to a lesser amount. Each percentage point reduction in the proposed rate change would result in approximately $500,000 less annual revenue to the enterprise fund. Such reductions would necessitate corresponding cuts to maintenance programs, capital projects, or service levels to maintain a balanced budget.

Given the essential nature of water services and the potential for deferred maintenance to compound costs over time, the proposed increase represents the minimum funding level necessary to ensure reliable, long-term service delivery to our community.

In 2025, the increase for the water utility bill was only on the base fees, and there was no increase for the water usage rates. As discussed and presented last year, in 2026, the proposal also includes an increase to the water usage rate, and therefore, the monthly difference in the water bill will be dependent on how much water the residence typically utilizes.

The projected impact on an average monthly bill for a single-family home and a multi-family home are shown in the tables below.

The example provided below uses an average single-family home bill of 9,000 gallons for water and 6,000 gallons for sewer. The 9,000 gallons/month for water is based on a 4-year historical average of 107,000 gallons per year for a typical single-family home. Staff will be providing a Utility Bill Estimator tool and linking it on our website to help residents calculate how the proposed increase would apply to their home utility bill based on their specific household water usage.

Impact on Average Monthly Bill for a Single Family Home (9,000 gal)

	Rates		Average Bill		
Fee Type	2025	2026	2025	2026	Difference
Water Meter Base Charge	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Tier 1 (0-5k gal)	*$2.39*	*$2.75*	*$11.95*	*$13.75*	*$1.80*
Water Usage Tier 2 (6-9k gal)	*$3.82*	*$4.39*	*$15.28*	*$17.56*	*$2.28*
Water Usage Tier 3 (> 9k gal)	*$5.41*	*$6.22*	*$0.00*	*$0.00*	*$0.00*
Sewer Service Charge	$5.44	$6.26	$32.64	$37.56	$4.92
Sewer Fed Mandate Charge	$0.52	$0.52	$3.12	$3.12	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$11.00	$12.00	$11.00	$12.00	$1.00
Total Bill			**$119.90**	**$136.79**	**$16.89**

Projected 4-Year Outlook for Single-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$119.90	$136.79	$146.37	$156.61
Percentage Change		*14%*	*7%*	*7%*

Impact on Average Monthly Bill for a Multi-Family Home (3,000 gal)

	Rates		Average Bill		Difference
Fee Type	2025 Rate	2026 Rate	2025	2026	Difference
Water Base Fee	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Charge	*$2.55*	*$2.93*	*$7.65*	*$8.79*	*$1.14*
Sewer Service Charge	$5.44	$6.26	$21.76	$25.04	$3.28
Sewer Fed Mandate Charge	$0.52	$0.52	$2.08	$2.08	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$6.60	$7.20	$6.60	$7.20	$0.60
Total Bill			**$84.00**	**$95.91**	**$11.91**

Projected 4-Year Outlook for Multi-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$84.00	$95.91	$102.62	$109.81
Percentage Change		*14%*	*7%*	*7%*

The tables below show the proposed non-residential water base and usage rate changes as well as the proposed license fee changes.

Impact on Non-residential Rates

Fee Type	2025	2026	Difference	%
Water Usage Charge	$3.22	$3.70	$0.48	15%
Water Base Charge - 3/4"	$36.91	$42.45	$5.54	15%
Water Base Charge - 1.0"	$61.50	$70.73	$9.23	15%
Water Base Charge - 1.5"	$123.00	$141.46	$18.46	15%
Water Base Charge - 2.0"	$196.79	$226.33	$29.54	15%
Water Base Charge - 3.0"	$369.00	$424.39	$55.39	15%
Water Base Charge - 4.0"	$615.02	$707.33	$92.31	15%
Water Base Charge - 6.0"	$1,230.02	$1,414.64	$184.62	15%
Water Base Charge - 8.0"	$1,968.04	$2,263.43	$295.39	15%
Water Base Charge - 10.0"	$2,829.07	$3,253.70	$424.63	15%

License fees are the fees that are paid by developers and builders for new connections to the water and sanitary sewer systems. The purpose of license fees is to provide funds to pay for the capital costs of expanding the water utility to serve new growth.

Impact on License Fees

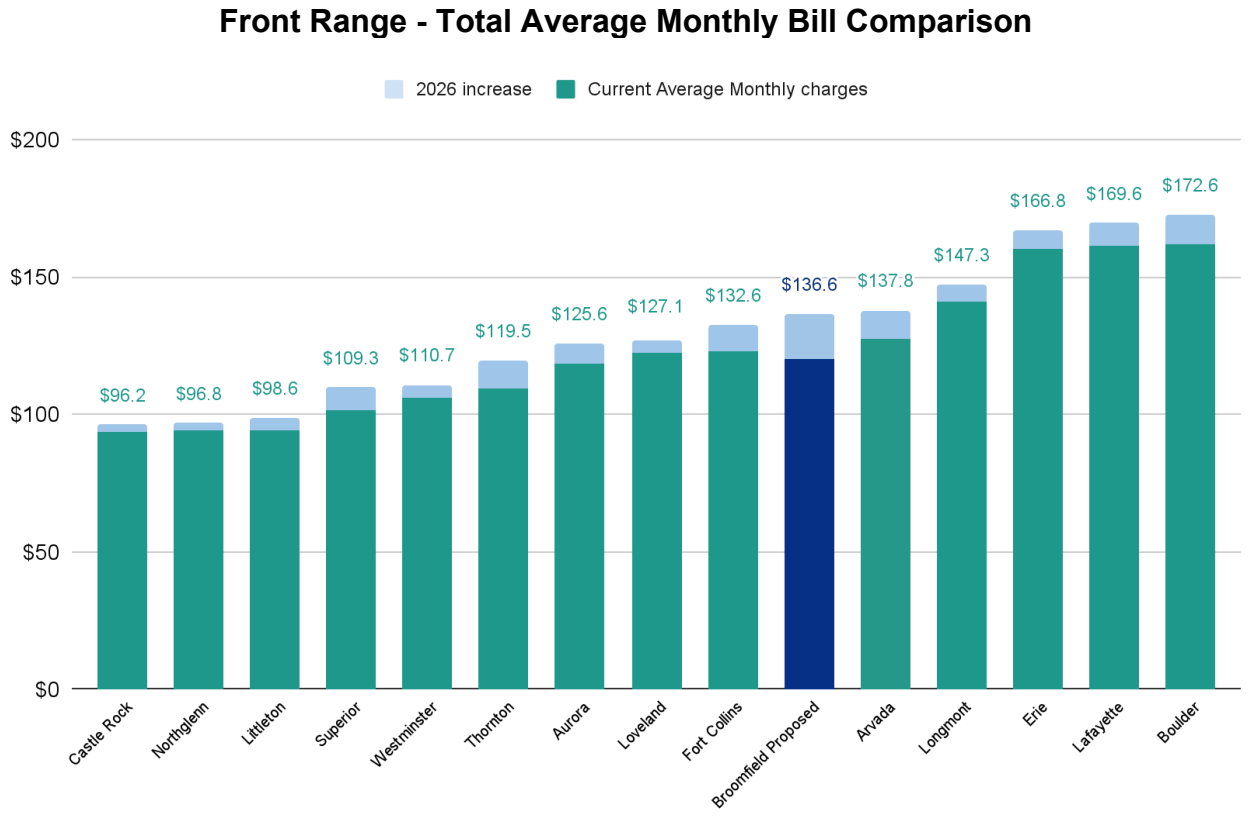
Fee Type	2025	2026	Difference	%
Water License	$37,850	$39,350	$1,500	4%
Sewer License	$14,900	$15,500	$600	4%
Reclaimed License	$13,780	$14,350	$570	4%

Front Range - Average Monthly Bill Comparison

The graph below shows Broomfield's total average monthly utility bill for water, sewer, and stormwater

compared to our neighboring municipalities. The comparison reflects where Broomfield is currently and how it would compare if the Council approves the proposed utility rates. The average monthly bill is normalized across all municipalities based on 9,000 gallons of water usage and 6,000 gallons of Average Winter Consumption (AWC) for sewer charges.

The 2026 rate increases shown in the graph below are not finalized, as the communities are going through a similar budget process as Broomfield, but staff have added the projected/proposed increases for municipalities where a projected increase is available, as shown in the light blue.



The degree to which neighboring municipalities increase their utility rates depends highly on how well they have managed their Enterprise Funds over the past decade, the growth versus expense challenges the municipality faces, and other factors unique to each entity.

Communication Plan:

Staff will be providing information for the community to learn about the proposed fee increase and how it could impact them directly. Updates have been included on the Broomfield.org website, including the proposed rates, estimated impacts for single-family homes and specific types of multifamily residential developments such as apartments, townhomes, and condominiums, and a Utility Bill Estimator tool for residents' use. Staff will also include information on the City and County of Broomfield's communications channels and work with Our Broomfield magazine, which was indicated in the Community Survey as a common place where residents seek to learn about Broomfield information, to share information about the rate change.

Additional information will be shared in late 2025 before the new rates take effect.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program in 2026

The City and County of Broomfield (CCOB) is committed to supporting residents facing financial challenges, particularly with utility costs and property taxes. To this end, two key programs were established: the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) Program.

The PPTR Program, launched in February 2023, was created in response to the increasing burden of property taxes and broader cost-of-living pressures. It provides refunds for seniors aged 65+, veterans with an 80% documented disability, and adult homeowners with 100% documented disabilities.

The URAF Program, launched in 2025 and administered by the Housing Division, helps residents with utility affordability. Building on the operational success of the 2024 PPTR Program signifies a significant step in CCOB's commitment to its residents.

Staff recommends continuing both programs in the 2026 fiscal year and both are included in the proposed 2026 Budget. Both programs will continue to accept new applications through October 30, 2026, or until funding has been exhausted, whichever occurs first. Resolutions 2025-153 and 2025-154 include clarifications and adjustments to the URAF and PPTR programs. These changes aim to ensure the programs remain efficient, fiscally responsible, and responsive to community needs, aligning with Council Goals, Financial Sustainability and Resilience, and Organizational Health.

Utility Rate Assistance Fund (URAF) Program 2025 and 2026 Update

In 2025, City Council Resolution 2024-165 established the Utility Rate Assistance Fund (URAF) program, directing staff to provide quarterly credits or refunds to eligible households with incomes up to 100% of the Area Median Income (AMI).

A review of 2025 URAF applications by the Housing Division revealed that 74% of applicants, the vast majority, had incomes at or below 60% AMI. Consequently, staff recommended reducing the 2026 eligibility threshold to 60% AMI, a change first discussed during the July 2025 second quarterly update for Enterprise Funds.

In 2025, eligible households received monthly reimbursements for utility fees, covering about 50% of the increase from 2024. The maximum annual refund was capped at $240 per household. Reimbursement rates varied by housing type: $20 for single-family detached homes, $18 for townhomes, duplexes, and mobile homes, and $17 for apartments and condominiums. The proposal for 2026 is to maintain these same assistance levels for eligible residents. Eligibility will be based on the total adjusted earnings of all household members aged 18 and older. Residents who pay their water utility bill directly to Broomfield will receive the refund as a credit on their utility account. For residents who pay their water utility as part of rent, via an HOA or other third party, the refund will be issued in check form to the resident.

Broomfield's Housing Division, which also manages the partial property tax refund program, will continue to administer the URAF program, maintaining quarterly payouts based on Council feedback from the July 2025 enterprise funds update.

To support the 2025 URAF program rollout, two nine-month Limited Term Assignment (LTA) full-time staff positions were added to the Housing Division. The 2026 budget does not allocate funds for new staff to

manage the Utility Rate Assistance Fund (URAF). Instead, the administration will leverage current staff within the Housing Division of Economic Vitality. These staff members will track the time and costs associated with administering the program without additional long-term assistance (LTA) capacity. Updates will be provided during quarterly enterprise updates, and the Housing Division will continue to advertise the URAF program via social media, Broomfield's website, Our Broomfield, and alongside other housing initiatives throughout 2026. If additional advertising, postage, or other related expenses are determined to be necessary specifically for URAF, an amendment to the 2026 budget will be requested in 2026.

Utility Rate Assistance Fund (URAF) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 100% AMI	0% - 60% AMI
Payment Frequency	Quarterly	Quarterly

During the October 14, 2025 City Council meeting, a resident reported concern regarding the eligibility of mobile home residents for the URAF program. It should be noted, residents of mobile home communities are eligible for the program. Since their utility bill is typically paid through a third party, the resident would be issued a quarterly check rather than a credit toward their utility bill to ensure the program benefits the resident directly. In 2025, mailers were sent to mobile home residents to inform them about the program. As of October 1, 2025, approximately 12 mobile home residents have applied for and been approved for the URAF. Broomfield staff will continue to focus on outreach to mobile home residents in 2026.

URAF Program Data

URAF Program Data as of September 30, 2025		
URAF - Data Points	2025	2026
Program Budget	Program Credits*: $600,000 Program Checks: $493,100 Personnel: $104,300 URAF specific Advertising: $7,000 URAF Software: $8,300 URAF Equipment: $8,000	Program (credits/checks): $350,000 Personnel: $35,000 URAF specific Advertising: $0 URAF Software: $0 URAF Equipment: $0
Budget Expended	Program Credits: $132,879 Program Checks: $18,639 Personnel: $66,810 URAF Advertising/Postage: $7,620 Software: $8,300 Equipment: $4,492	N/A
Total Payments Processed	Through 2025 Q3: 3833	N/A
Total Applications Processed	1813	N/A
Eligibility	One of the following docs: IRS Tax Form, SS, SNAP, LEAP, etc.	Required - IRS Tax Form No tax filing - Proof of all income (SS, Bank Statements, Paystubs, etc.)
AMIs Served	0-30% ▫ 40% 31-60% ▫ 34% 61-80% ▫ 19% 81-100% ▫ 7%	0-30% 31-60% N/A N/A
Communication Efforts	Phone Calls: 1171 Emails: 446 Consultations: 429 (96 Spanish)	N/A N/A N/A
Outreach Events	31	N/A

*As part of the 2025 Budget - 1st Amendment, program credits were budgeted at $1,479,300; as part of the 2025 Budget - 2nd Amendment, program credits are now budgeted at $600k.

Partial Property Tax Refund (PPTR) Program - 2025 Update and 2026 Recommendation

The Partial Property Tax Refund (PPTR) Program, established by Resolution No. 2022-123 and expanded with Resolution No. 2024-27 and Resolution No. 2024-105, offers financial relief to specific demographics facing increasing property tax burdens and general cost-of-living pressures. Eligible participants include seniors aged 65 and older, veterans with a documented disability of 80% or more, and adult homeowners with 100% documented disabilities.

While the Housing Division will continue to utilize 2021 tax year data as the program's baseline, the 2026 refund is anticipated to be lower than in 2025 due to the recently adopted House Bill 24B-1001. Despite these adjustments, the program is expected to continue providing significant support to qualifying households.

Partial Property Tax Refund (PPTR) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 80% AMI	0% - 80% AMI
Program Final Application Date	October 30, 2025	October 30, 2026

PPTR Program Data

PPTR Program Data as of October 13, 2025		
PPTR - Data Points	2025	2026
Program Budget	Program ≤ 60% AMI: $402,000 Program 61-80%: $100,000	Total Program: $600,000 Anticipated utilization ≤ 60% AMI: $500,000 61-80%: $100,000
Budget Expended	Program ≤ 60% AMI: $401,693 Program 61-80%: $90,016	N/A
Total Payments Processed	963	N/A
Total Applications Processed	1265	N/A
AMIs Served/Processed	0-30% ▫ 41.5% 31-60% ▫ 36.0% 61-80% ▫ 18.5% Ineligible ▫ 4.0%	0-30% 31-60% 61-80%
Communication Efforts	Phone Calls: 517 Emails: 332 Consultations: 397 (77 Spanish)	N/A N/A N/A
Outreach Events	33	N/A

Bond Issuances

Until 2021, Broomfield did not have a formal Debt Policy. Since adopting one, we have aligned with industry and government standards by capping total debt at no more than 10% of the City's assessed value. As of the close of fiscal year 2024, Broomfield's total debt was at 5.25% of assessed value – well below industry standards.

In 2023, debt service accounted for 4.6% of total revenues, and in 2024, that decreased slightly to 4.2%, reflecting our intentional focus on managing and reducing outstanding obligations. For context, debt service levels under 5% of total revenue are typically considered "best in class."

As we look ahead, the staff has strategically timed the issuance of new debt to coincide with the defeasance of the 2017 Certificates of Participation (COP) for the County building. This approach will help offset the impact of new debt issuance for the upcoming Police and Courts facility. While we expect to slightly exceed the 5% debt-to-revenue ratio following issuance, our strong financial standing provides confidence in our ability to manage this responsibly. In the past two years, Broomfield has earned three credit rating upgrades, which is a significant achievement

Conclusion and Next Steps

The 2026 budget represents a disciplined, data-driven approach to maintaining Broomfield's financial sustainability while meeting our community's needs. Through careful stewardship of public resources, strategic infrastructure investments, and thoughtful prioritization of mandates, obligations, and critical needs, this budget positions our organization to navigate current fiscal challenges while preparing for future opportunities.

Key Takeaways

The proposed 2026 budget demonstrates our commitment to:

- **Fiscal Responsibility**: Maintaining 20% reserves and managing debt prudently
- **Infrastructure Investment**: Addressing critical water, sewer, and public safety facility needs
- **Community Support**: Continuing programs like URAF and PPTR to assist residents facing financial challenges
- **Operational Excellence**: Optimizing existing resources before requesting new ones

Action for Council - October 28, 2025

7.A Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-141 - 2025 Budget - 2nd Amendment
- Resolution 2025-142 - 2026 CCOB Budget

7.B Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-143-UR - 2025 BURA Budget - 2nd Amendment
- Resolution 2025-144-UR - 2026 BURA Budget

7.C Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

- Resolution 2025-145-AID - 2026 ALID Budget

7.D Public Hearing - Ordinance Section Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

- Ordinance 2286 - Enterprise Rate Ordinance

7.E Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

- Ordinance 2288 - Water Tanks Bond
- Ordinance 2289 - Wastewater Treatment Bond
- Ordinance 2290 - Police/Courts COP

7.F Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

- Resolution 2025-153 - URAF Program Continuation
- Resolution 2025-154 - PPTR Program Continuation

Looking Ahead

Following the adoption of the 2026 budget, staff will:

- Issue bonds in Q1 2026 for Police/Courts facility and enterprise projects
- Begin construction on the Police building, Water tanks, and Wastewater Expansion Project
- Implement the updated URAF and PPTR programs
- Come before Council Dec. 9th with an amendment focused on grants received in 2025
- Continue quarterly Enterprise Fund updates to Council
- Collaborate with FLOW on recommendations for the 5-Year Water Utilities Capital Improvement Plan (CIP) and rate adjustments for the 2027 budget.
- Monitor economic conditions and provide budget updates as needed
- Prepare for the 2027 budget process with continued emphasis on financial sustainability

Staff remains committed to transparent communication, data-driven decision-making, and collaborative problem-solving as we work together to serve our community and achieve our shared goals.

RESOLUTION NO. 2025-145-AID

A resolution adopting the budget for the Arista Local Improvement District for the fiscal year 2026 and appropriating sums of money

Be it resolved by the Arista Local Improvement District of Broomfield, Colorado:

Section 1.

The following sums of money are hereby appropriated for fiscal year 2026 in the amounts set forth as follows:

Summary of 2026 Budget

Expenditures	
Fund	2026 Proposed Budget
Arista Local Improvement District	$45,000

Section 2. Effective Date

This resolution is effective upon its approval by the Arista Local Improvement District.

Approved on October 28, 2026

Arista Local Improvement District

_____

Chair

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

D. Public Hearing - Ordinance Second Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7D.
Community Goals	

Overview

View Correspondence
View Presentation

The purpose of this memo is to present financial information related to the second amendment of the 2025 City and County of Broomfield and the Broomfield Urban Renewal Authority Budgets, financial information related to the proposed 2026 budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District, information related to the proposed increases to utility rates for the Broomfield Enterprise Funds, information related to the proposal of two enterprise revenue bonds and police building and courts remodel certificate of participation, and information related to the Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) programs.

Attachments

Memo for 10_28_2025_2nd Amd to 2025 Budget; Adoption of 2026 Budget (CCOB, BURA, ALID); Utility Rates Ord; URAF; PPTR; Bond Ords.pdf

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees.pdf

Memo for 2nd Amendment to the 2025 Budget and Adoption of the 2026 CCOB, BURA, and ALID Budgets; second reading of amending water, sewer, reclaimed water and stormwater rate ordinance; second reading of two enterprise revenue bonds and police building certificate of participation ordinances; URAF and PPTR programs for 2026
Prepared By: J. Stephanie Chen, Budget Manager

Summary

View Correspondence
View Presentation

Comprehensive Budget Process

The City and County of Broomfield's budget development is a comprehensive, year-long process designed to ensure fiscal responsibility, transparency, and meaningful community and Council engagement. This memorandum represents the culmination of extensive collaborative work that has unfolded throughout 2025, with multiple touchpoints providing City Council and the community opportunities to review, discuss, and shape the financial direction of our organization. This deliberate, methodical approach ensures that budget decisions are informed by current data, community needs, economic conditions, and strategic priorities while maintaining the highest standards of transparency and public accountability.

The Governmental Accounting Standards Board (GASB) sets the accounting and financial reporting standards that state and local governments must follow. Its purpose is to ensure that financial statements are consistent, transparent, and useful to the public, elected officials, and oversight bodies. GASB standards help governments show how public funds are managed, spent, and accounted for, promoting accountability and public trust. Our Broomfield budgets are built using GASB standards, which means our financial reporting and budgeting processes follow the same professional principles used nationwide to ensure accuracy, consistency, and transparency in how we manage public resources.

Year-Long Budget Development Timeline

The 2026 budget process began in early 2025 and has included the following key milestones:

- January-March 2025: Initial financial forecasting and departmental needs assessment
- March 8, 2025: Council Focus Session - 2.C. Conditions of/and influences on Broomfield's economic and fiscal status, 2.H. Anticipated Development and the impacts on fiscal sustainability
- April 15, 2025: Council Study Session - First Quarterly Enterprise Funds Study Session - Council review of enterprise fund status, capital projects, maintenance programs, 2024 financial results, and long-term financial sustainability strategies
- May 8, 2025: Council Study Session - Early introduction to the 2026 budget process and year-to-date financial information
- July 15, 2025: Council Study Session - Second Quarterly Enterprise Funds Study Session - Council review of enterprise fund updates, development projections, and initial utility rate recommendations with subject matter expert consultant AECOM
- August 19, 2025: Council Study Session - Economic and Fiscal Update and Draft Operating and Capital Budgets Study Session - Comprehensive presentation to Council on Broomfield's economic and financial outlook, including CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments
- August 21, 2025: Community Briefing - Public presentation and opportunity for public questions on Economic Long Range Financial Plan and Financial Status Briefing
- September 3, 2025: City Council received the 2026 Proposed Budget and supporting documentation
- September 4, 2025: 2026 Proposed Budget and supporting documents made available for public review and comment on Broomfield.org/Finance
- September 18 and September 25, 2025: Budget Study Sessions with opportunities for public comment - 2026 Proposed Operating & Capital Budgets with department representatives
- October 14, 2025: City Council Meeting - Public Hearing per Chapter 12.7 of the Charter for the 2026

Operating and Capital Budgets, with first reading of key ordinances
- October 21, 2025: City Council Study Session - Final Quarterly Enterprise Funds update of 2025
- October 28, 2025: City Council Meeting - Second reading of ordinances and adoption of budgets (this meeting) with public hearing

Strategic Context and Fiscal Discipline

1. Financial Sustainability and Resilience - Ensuring Broomfield's long-term fiscal health in an uncertain economic environment
2. Transparency and Public Engagement - Providing multiple opportunities for community input and Council deliberation
3. Data-Driven Decision Making - Utilizing comprehensive financial modeling, economic forecasting, and historical analysis
4. Prioritization of Core Services - Focusing resources on mandates, obligations, and critical needs
5. Infrastructure Investment - Addressing deferred maintenance and preparing for future growth
6. Responsible Debt Management - Maintaining our strong credit rating while financing essential capital projects

Summary of Items for Consideration

The City and County of Broomfields budget includes all government operations as well as Enterprise Funds (Water, Sewer, Stormwater and Reuse). The proposed budgets and related documents were available for public review and comment on Broomfield.org/Finance on September 4, 2025.

The staff memorandum from October 14, 2025 regarding the public hearing for City and County of Broomfield (CCOB), Arista Local Improvement District (ALID), Broomfield Urban Renewal Authority (BURA) budgets; first reading of Ordinance No. 2286 amending water, sewer, reclaimed water and stormwater rate ordinance; first reading of two enterprise revenue bonds and police building certificate of participation ordinances (Ordinances No. 2288, 2289 and 2290), included a detailed discussion of the proposed resolutions and ordinances.

It is important to note that the proposed budget is consistent with the October 14, 2025 memorandum and initial proposed budget, with the exception of one change:

- The operational expenditures are expected to increase by 5.8% as opposed to 5.9% due to the combination of a reduction to the amount recommended for the District Attorney (DA) budget discussed during the hearing on October 14, 2025, and a small increase in the budget used for non-profit distributions under the Human Services Fund.

This change is specific to the proposed 2026 budget for CCOB and is reflected in Resolution 2025-142. It does not alter the proposed budgets for BURA or ALID, the water project agreements, enterprise rate ordinance, or any of the bond ordinances considered on first reading during the October 14, 2025 meeting.

The content of this staff memorandum is consistent with the October 14, 2025 memorandum, with additional information provided for the following:

- Information regarding the 2025R Budget - 2nd Amendment.
- Details regarding the non-residential utility rates and license fees for 2026 are provided to clarify what is included in Ordinance 2286 in response to questions from the October 14, 2025 meeting.
- Additional details regarding how the 2025 rate increase was utilized to directly improve water, sanitary sewer, and stormwater resources for Broomfield residents and businesses.
- Details regarding the Utility Rate Assistance Fund program for 2026 as proposed in Resolution No. 2025-153.
- Details regarding the Partial Property Tax Refund program for 2026 as proposed in Resolution No. 2025-154.

City and County of Broomfield Budget

2025 Budget - 2nd Amendment Summary

- The 2025 City and County budget has been amended one time since its adoption to reflect capital project rollovers, grant rollovers, and operational budget adjustments.
- The following attachments are included with this memo to provide fund level details of the 2025 revised budget adjustments. These tables referenced below reflect cumulative prior amendment #1, in addition to the new adjustments in this proposed second (2nd) amendment to the 2025 budget. Revenue and expenditure adjustments (increases and decreases) are also included for reference.
    - 2025 Revised Budget Summary - General Governmental Funds
    - 2025 Revised Budget Summary - Governmental Capital Funds
    - 2025 Revised Budget Summary - Governmental Debt Service Fund
    - 2025 Revised Budget Summary - Enterprise Funds
    - 2025 Revised Budget Summary - Fiduciary Funds
- The second proposed City and County amendment, Resolution No. 2025-141, sets the final 2025 amended budget to reflect expenditures of $775,190,595.

2026 Budget

- The 2026 Proposed City and County of Broomfield Budget has been prepared to reflect expected revenues and expenditures. A set of summary budget tables are included with the resolutions under consideration.
- The 2026 Proposed Budget for the City and County of Broomfield total expenditures are $844,125,005. This amount includes interfund activities and transfers to reserves.
- Tables 1A-4C summarize the 2026 Proposed Budget for the City and County of Broomfield.
- Proposed Resolution No. 2025-142, if adopted, would approve the 2026 Budget for the City and County.

Broomfield Urban Renewal Authority

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2025 Budget - 2nd Amendment Summary

- The proposed BURA budget amendment, Resolution No. 2025-143-UR, is the second amendment proposed since its adoption and reflects unexpended capital improvement project budgets, and revenue adjustments which impacts expense budgets since the adoption of the fiscal year 2025 budget.
    - The proposed BURA budget amendment also reflects a slight decrease in expenditures for a total of $57,118,701.
    - BURA Budget Tables summarize the 2025 revised budget for BURA.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for BURA. In some URAs, planned uses of fund balance are being used for capital expenditures. The BURA proposed total revenues for 2026 are $65,119,746, and the proposed total expenditures are $49,978,125.
    - Tables 1-13 summarize the 2026 Proposed Budget for the BURA.
    - Proposed Resolution No. 2025-144-UR, if adopted, would approve the 2026 Budget for the Broomfield Urban Renewal Authority.

Arista Local Improvement District

The Arista Local Improvement District (ALID) was established in August 2005 to facilitate the construction of transportation facilities in the Arista Development.

2025 Budget - 2nd Amendment Summary

- The 2025 ALID budgeted expenditures have not changed, therefore, no amendment is required at this time.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for the ALID. Attached is a copy of the budget message and budget tables for the ALID for the 2026 Proposed Budget. Anticipated total revenues for 2026 are $45,000. Proposed total expenditures for 2026 are $45,000.
    - Table 1 summarizes the 2026 Proposed Budget for ALID.
    - Proposed Resolution No. 2025-145-AID, if adopted, would approve the 2026 Budget for the Arista Local Improvement District.

Enterprise Rate Ordinance

City Council held quarterly enterprise study sessions on April 15, 2025, July 15, 2025, and October 21, 2025, to review staff's updates on the status of the enterprise funds. The April meeting covered capital projects, maintenance programs, 2024 financial results, steps for ensuring long-term financial sustainability, and the proposed Fiscal Leadership on Water (FLOW) Advisory Committee. The July meeting covered similar topics as well as an overview of development projections and future rate recommendations. The October meeting included an update regarding ongoing capital and maintenance programs for 2025, as well as a presentation from the FLOW Advisory Committee.

City Council also received updates on the Enterprise Funds during the Economic and Fiscal Update held at a Study Session on August 19, 2025. Topics addressed included CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments.

In 2025, the City and County of Broomfield implemented the first utility rate increase of a comprehensive five-year financial plan to address the financial sustainability of the enterprise funds. This increase was necessary as the costs of providing safe, reliable water service continued to rise due to aging infrastructure requiring increased maintenance and replacement, new regulatory requirements and unfunded mandates,

and a substantial backlog of critical system repairs and upgrades. Recognizing the financial burden this placed on residents, Council established the Utility Rate Assistance Fund (URAF) to help eligible households manage the impact.

The five-year plan includes a year two increase totaling $16.89 per month for the average single-family home (9,000 gallons) starting in 2026. Staff anticipates that continued adjustments in future years should be expected due to the annual application of the utility's long-range model, the criticality of ongoing infrastructure support, and to accommodate costs from unknown, but anticipated, state and federal mandates. The URAF to help eligible households remains in the budget for 2026, with minor adjustments.

Bond Ordinances

Police Building/Courts Remodel

This item is presented for the City Council's consideration and authorization to issue $100M in bonds to fund the Police Building/Courts Remodel. This financing utilizes Certificates of Participation (COPS), where the City will finance the project's construction by collateralizing existing City facilities via a Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, and Escrow Agreement. A Preliminary Offering Statement, Indenture, and Disclosure Certificate are also required. Selected facilities that will be borrowed against include Paul Derda Recreation Center, the Broomfield Community Center, the Detention Center, and the Service Center Administration Building. The anticipated maximum annual debt payment resulting from the financing will not exceed $7.9M and the annual payments will come from the City's general fund; however, the debt does not create a general obligation debt or multiple-year fiscal obligation, as the annual debt service payment is subject to annual appropriation.

As part of the 2023 property tax revenue increase, funding was designated to support the construction of the new Police building. In collaboration with our financial advisors, staff determined that using the set-aside property tax dollars to retire the 2017 Certificates of Participation (COPs) represents a sound long-term financial strategy. By applying these funds and coordinating the payoff of prior debt, the City can help offset the financial impact of issuing new debt for the upcoming Police and Courts facility. Recent credit rating upgrades and the City's strong financial position further reinforce confidence in our ability to manage debt responsibly.

The term of the financing will mature on or before December 31, 2047. The anticipated net effective interest rate will not exceed 5.50%. Additionally, as part of this financing, the City will also pay off its 2017 Certificates of Participation (COP) that have a current outstanding balance of $10.89M utilizing unencumbered cash on hand. The 2017 COPs were to mature on December 1, 2027. They were originally issued in 2010 to fund facilities needed to provide county services and for parks and recreation activities, and were refinanced in 2017.

Water Tanks

This item is presented for the City Council's consideration and authorization to issue $80M in Water Revenue bonds for funding the new water tanks. Broomfield's water system model identifies capital improvements that will be needed as Broomfield develops, including the construction of the proposed Water Tanks. The model specifically focuses on the phased development of the areas north of W. 144th Avenue that are quickly developing. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $5.9M and the term of the bonds will mature on or before December 1, 2047.
The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Water Activity Enterprise and does not impact the City's general fund. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement.

Related to the issuance of the Water Bonds, staff will be presenting to the City Council on October 28, 2025 as part of agenda item 7(G) - Water Tanks Construction Agreement, proposed Resolution No. 2025-152

authorizing the reimbursement to the water enterprise fund from bond proceeds (if needed) for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to award a construction contract up to the amount of the advanced funds and begin construction before the bonds' closing. It is expected that a construction contract will be presented to the City Council for approval in November and construction to begin on or about January 1, 2026. An amendment to the construction contract would then be presented to the City Council for approval once the bond proceeds are available for appropriation. Construction of the water tanks is projected to last 36 months.

Wastewater Treatment Facility Improvements

This item is presented for the City Council's consideration and authorization to issue $125M in Sewer Revenue and Refunding bonds for funding the Wastewater Treatment Facility Expansion. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $11M and the term of the bonds will mature on or before December 1, 2047. The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Sewer Activity Enterprise and does not impact the City's general fund. As a part of this financing, the City will also refund and discharge its 2012 Sewer Revenue Refunding Bonds with an outstanding balance of $15.315M that matures on December 1, 2031. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement.

The Wastewater Treatment Facility Improvements are being driven by expected future increases in population and regulatory requirements from the CDPHE that will require significant expansion to the current facility to adequately treat the increase in wastewater and maintain compliance with current and future regulatory requirements. Project drivers include capacity, asset renewal, biosolids, reuse, and regulation. Construction is to begin in 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

This memo will affirm and clarify the planned continuation of the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) programs into the 2026 fiscal year, as outlined in the proposed 2026 Budget for the City and County of Broomfield. These programs are designed first and foremost to support residents experiencing financial burden, while also serving as key components of the City's broader commitment to Council Goals, Financial Sustainability and Resilience, and Organizational Health.

The adjustments provide a summary of operational updates to ensure both programs remain efficient, fiscally responsible, and responsive to community needs within the budgeted resource allocations.

Financial Considerations

2025 Budget - 2nd Amendment

Resolutions 2025-141 and 2025-143-UR outline the financial considerations related to the second amendment to the 2025 budgets for both the City and County of Broomfield and Broomfield Urban Renewal Authority.

2026 Budget

Resolutions 2025-142, 2025-144-UR, and 2025-145-AID outline the financial considerations related to the adoption of the 2026 Budgets for the City and County of Broomfield, the Arista Local Improvement District, and the Broomfield Urban Renewal Authority.

Enterprise Ordinances

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees outlines the financial considerations related to this agenda item.

Bond Ordinances

Ordinance No. 2288 upon approval, authorizes debt financing of up to $80M for the Water Tanks and

approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement related thereto.

Ordinance No. 2289 upon approval, authorizes debt financing of up to $125M for the Wastewater Treatment Facility Improvements and approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement related thereto.

Ordinance No. 2290 upon approval, authorizes debt financing of up to $100M for the Police Building/ Courts Remodel and approves as to form the Preliminary Official Statement, Indenture, Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, Disclosure Certificate, Escrow Agreement related thereto.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

Resolution 2025-153 outlines the financial and programmatic considerations related to the Utility Rate Assistance Fund (URAF) Program.

Resolution 2025-154 outlines the financial and programmatic considerations related to the Partial Property Tax Refund (PPTR) Program.

Prior Council or Other Entity Actions

2025 Budget

October 22, 2024: Council approved Resolution 2024-149 adopting the 2025 CCOB Budget; BURA approved Resolution 2024-150-UR adopting the 2025 City and County of Broomfield Budget
March 11, 2025: Council approved Resolution 2025-44 amending the 2025 CCOB Budget; BURA approved Resolution 2025-52-UR amending the 2025 BURA Budget

2026 Budget

August 19, 2025: Staff provided information and insights to inform the Council on Broomfield's economic and financial outlook, influencing the 2025 revised budget and the 2026 operating and capital proposed budgets.
August 21, 2025: Staff provided an overview of how Broomfield intends to fulfill the community goal of financial sustainability and resilience at the Broomfield 101: Economic and Fiscal Update Community Forum.
September 3, 2025: The City Council received the 2026 Proposed Budget and supporting documentation.
September 4, 2025: The 2026 Proposed Budget and supporting documents were made available for public view and comments on the City's website.
September 18 and September 25, 2025: Study Sessions to discuss the 2026 Proposed Operating & Capital Budgets with department representatives.
October 14, 2025: Public Hearing per Chapter 12.7 of the Charter for the 2026 Operating and Capital Budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District.

Enterprise Ordinances

April 15, 2025: Staff held the first 2025 quarterly Enterprise Funds study session and provided an overview to City Council on the status of the enterprise funds.
May 13, 2025: Creation of FLOW Advisory Committee approved by City Council.
July 15, 2025: Staff held the second 2025 quarterly Enterprise Funds study session, providing an update on the enterprise funds and initial recommendations on utility rate adjustments, along with a presentation by subject matter expert consultant AECOM.
October 14, 2025: First reading of ordinance number 2286.
October 21, 2025: Staff will provide an overview to City Council in a Broomfields Enterprise Funds study session and initial results of additional repair and replacement capital added during the 2025 budget.

Bond Ordinances

August 19, 2025: Staff provided information and insights to City Council on Broomfield's high credit rating

and the organization's "superior ability to repay short-term debt obligations," providing guidance to ensure Broomfield's financial stability while requesting new bonds to finance the 2026 capital improvement projects for the new Police Building / Courts Remodel and Water and Sewer infrastructure improvements.
October 14, 2025: First reading of ordinance numbers 2288, 2298, and 2290.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
November 1, 2022: Council Approved the 2023 PPTR Program with Resolution No. 2022-123.
January 23, 2024: Council Approved the Expansion of the PPTR Program in 2024 with Resolution No. 2024-27.
October 22, 2024: Council Approved the URAF Program with Resolution No.2024-165.
October 22, 2024: Council Approved the 2025 Budget with Resolution No. 2024-149.
December 3, 2024: Council Approved the 2025 PPTR Program with Resolution No. 2024-105.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

2025 and 2026 Budget
If Council desires to approve the proposed 2025 budget amendment, the appropriate motion is...
That Resolution 2025-141 be adopted.

If Council desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-142 be adopted.

If BURA desires to approve the proposed 2025 budget amendment, the appropriate motion is…
That Resolution 2025-143-UR be adopted.

If BURA desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-144-UR be adopted.

If ALID desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-145-AID be adopted.

Amending Enterprise Ordinance

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2286 be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to water, sewer, water reclamation, and stormwater charges and fees as set forth in these ordinances would be effective January 1, 2026.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2288 Issuing Enterprise Revenue Bond (Water Tanks) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2289 Issuing Enterprise Revenue Bond (Wastewater Treatment - Phase 1B) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2290 Issuing Certificates of Participation (Police and Courts Buildings) be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to the issuance of new bonds as set for in the ordinances would be effective January 1, 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program

If the Council desires to proceed with the staff recommendations for the continuation of the Utility Rate Assistance Fund Program in 2026, the appropriate motion is…

That Resolution 2025-153 be adopted.

If the Council desires to proceed with the staff recommendations for the continuation of the Partial Property Tax Refund Program in 2026, the appropriate motion is…

That Resolution 2025-154 be adopted.

Alternatives

Budget

Per Charter, the City Council must adopt a budget. If it fails to do so, the budget will be put on future agenda(s) until such time as it is approved. If Council fails to adopt the budget, the amounts appropriated for the operation of the current fiscal year shall be deemed adopted for the next fiscal year on a month-to-month basis, with all items in it prorated accordingly, until such time as the Council adopts the budget for the next fiscal year.

Amending Enterprise Ordinance

If Council does not approve the recommended utility rate ordinance, the existing fee structure would remain in place. CCOB's Enterprise funds' financial sustainability and resiliency would weaken. The ability to obtain favorable financing for necessary projects, including wastewater treatment facility expansion and water tanks, would be put at risk.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If Council does not approve the recommended two enterprise revenue bonds and police building certificate of participation ordinances, CCOB would not defease the existing certificates of participation and would not move forward with the issuance of the bonds. CCOB would not be able to finance the necessary projects, which include the Wastewater Treatment Facility Expansion, Water Tanks, and new Police Building.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
Do not approve staff recommendations. If not approved, provide an alternative direction.

Background - Budget

Broomfield has grown and evolved significantly over the past twenty years from an emerging suburban community into a large, thriving, and maturing urban-suburban community. Since the consolidation of our community in 2001, Broomfield has provided effective and efficient city and county programs and services. Today, Broomfield is home to nearly 80,000 residents, living in more than 34,000 housing units and thousands of businesses. While much of Broomfield's 34 square miles is built out, there is a continued focus on developing and evolving while maintaining long-term financial sustainability and resilience.

Budget Process and Philosophy

The budget is a planning tool that is used to meet the results of the March 3, 2023, Council Focus Session, where the Community Goals were solidified with an emphasis on Goal #1: Financial Sustainability and Resilience. Therefore, the budget process is flexible and responsive to organizational and community needs and economic conditions.

In addition, staff will continue with a comprehensive, clear, and transparent approach by bringing forth a consolidated number of budget amendments for the Council's review and consideration, and for transparency for Broomfield residents. Each budget amendment is designed to address specific topic areas outlined below.

- **Budget Amendment 1** (Q1): reflects the carryover of capital and grant projects from the prior fiscal year and any additions to operational budgets (i.e., increased cost for Spring Cleanup).

- **Budget Amendment 2** (In conjunction with adopting the following fiscal year's budget; Q4): reflects the current state of actual revenues and expenditures, including any supplemental requests, and sets the foundation for the following year's budget.
  This amendment also includes the prior year's audited financials (actual beginning fund balances), which helps inform the ability to fund future year financial shifts.

- **Budget Amendment 3** (Q4): if needed, addresses grants, which often require financial adjustments based on project or program status of implementation and execution due to the timing of the grant award.

Current and future budgeting processes are designed to ensure operational and capital success, focusing on creating a culture of accountability and intentionality while basing the budget on revenue and expenses. This helps to drive forward a sustainable, disciplined structure of reallocating funds and not continuing to increase expenditures arbitrarily.

Proposed Budgets

2025 Revised Budget Summary

On October 22, 2024, City Council passed Resolution 2024-149 to adopt the 2025 budget for the City and Council of Broomfield. Additionally, the Broomfield Urban Renewal Authority approved resolution 2024-150-UR to adopt the 2025 budget for BURA. Since the adoption, the budgets have been amended one (1) time to reflect capital project rollovers, grant rollovers, and additional capital and operational budget adjustments. As can be seen in the table below, adjustments to the City and County of Broomfield budget in amendment #1 is listed as well as the proposed adjustments in amendment #2.

CITY AND COUNTY OF BROOMFIELD
REVISED BUDGET SUMMARY - ALL FUNDS*

Fund	Original Budget 2025	Budget Amendments #1 2025	Budget Amendment #2 2025	Amended Budget 2025
Beginning Fund Balance	**$ 304,842,581**			**$ 408,834,091**
Revenues				
General Governmental Funds	$ 201,022,977	$ 14,388,112	$ 13,956,978	$ 229,368,067
Governmental Capital Funds	89,039,461	18,228,553	9,687,422	117,955,436
Enterprise Funds	83,761,446	(1,479,300)	(4,564,126)	77,718,020
Fiduciary Funds	223,100,356	-	-	223,100,356
Total Revenues	**$ 596,924,240**	**$ 31,137,365**	**$ 19,080,274**	**$ 648,141,879**
Expenditures				
General Governmental Funds	$ 216,385,986	$ 13,140,495	$ 5,475,993	$ 235,002,474
Governmental Capital Funds	103,310,912	73,107,734	4,355,292	181,773,938
Enterprise Funds	99,516,325	47,506,010	(2,731,036)	144,291,298
Fiduciary Funds	214,122,885	-	-	214,122,885
Total Expenditures	**$ 633,336,108**	**$ 133,754,239**	**$ 7,100,248**	**$ 775,190,595**
Ending Fund Balance	**$ 268,430,713**			**$ 281,785,375**

** Excludes transfers to reserves and interfund transfers*

2025 Operating and Capital Fund Revised Budget

Budget adjustments are made in order to respond to the changing demands of our operations in addition to the continued economic fluctuations occurring at the local, state, and national levels. In 2025, the City and County of Broomfield eliminated what had traditionally been the second amendment of the year. The Finance Department worked directly with departments to discuss needs and work strategically to accommodate needs by reallocating current budgets while continuing to monitor throughout the year to determine if budget adjustments were actually needed. Based on this collaborative effort, staff have been able to reduce the overall workload within the organization and minimize the number of times the budget needs to be reviewed, adjusted and considered by City Council.

The proposed operating fund budget adjustments include both personnel and non-personnel adjustments for programs and initiatives. While capital fund adjustments are the result of revising capital projects due to aspects such as timing or changes in project priorities since the adoption of the 2025 5-Year CIP Plan. The table below includes highlights of operational revisions to the 2025 budget.

2025 Revised Budget Highlights*		
Department or Category	**Description**	**Amount**
City & County Attorney	2025 Increase for Insurance Premiums	$ 70,000
Courts	Above Mid-Point Pay Request: Lead Court Clerk Hire	4,142
Human Resources	New Full-Time FT: HR Project Manager	71,498
Police	Increase to Axon Agreement	234,625

Police	Increase to Inmate Food Services Contract	172,050
Police	Increase to Psychological Support Contract	50,000
Police	Dual Sim Card Monthly Fees with First Net	36,500
Police	Inmate Medicine Expenses	38,252
Police	Outside Fund Award Funded Motorola Service Agreement for Back Up Dispatch Center Equipment	12,775
Police	Brower Resilience Visits	2,500
	Total	**$ 692,342**
*Personnel Highlights are pro-rated for partial year		

The 2025 revised operating budget includes a number of cost increases associated with existing contractual obligations. The 2025 budget process was completed in the middle of 2024, prior to a number of contractual amendments being executed, so adjustments are made during the 2nd amendment to appropriate the additional funds needed to meet these obligations.

In addition to the Budget Highlights noted above, the 2025 revised operating budget also includes a number of non-personnel budget reductions as part of the organization's efforts to optimize budgets. Travel and training budgets were reduced by $859,813 and other identified non-personnel budgets were reduced by $1,041,450. This effort was collaborative across the entire organization, with a focus on maintaining services to residents.

In total, staffing levels and service demands resulted in the addition of 4.13 FTE in 2025, as detailed in the Expenditures: 2025 Personnel Changes table.

Expenditures: 2025 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
City & County Manager	1.00	303,987	Economist (1.0FT), Administrative Analyst (1.0FT), Case Manager II - Housing (-1.0FT)
Community Development	-1.00	(133,296)	Senior Transportation Planner (-1.0FT)
Economic Vitality & Development	-2.00	(254,758)	Economist (-1.0FT), Administrative Analyst (-1.0FT), Administrative Support I/II LTA (2.0FT), Administrative Support I/II LTA (-2.0FT)
Human Resources	1.00	65,533	HR Project Manager (1.0FT)
Human Services	2.80	172,795	Case Managers II LTA (2.0FT), Case Manager II LTA (-2.0FT), Case Manager II (1.0FT) Workforce Specialist II LTA (0.8PT), Human Services Management Analyst (-0.8), Non-Profit & Community Engagement Manager (1.0), Human Services Grants Specialist (0.8)
Library, Arts & History, and CSU Extension	0.33	(1,718)	Creative Technologist (-0.8PT), Patron Services Associate (1.0FT), Creative Technologies (-0.6PT), Patron Services Associate (0.73PT)
Public Health & Environment	0.00	(2,845)	Human Services Management Analyst (-0.2), Human Services Grants Specialist (0.2)
Total	**4.13**	**$ 149,698**	
*Includes internal transfers. Costs prorated for partial year. Public Works to Public Works / Water Utilities reorganization is not included.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and estimated taxes and benefits			

2025 Broomfield Urban Renewal Authority Revised Budget

This is the second amendment to the 2025 BURA budget. This amendment reflects updated revenues and expenditures projected through the end of the year based on year-to-date information. The BURA Budget Tables summarize the 2025 proposed revisions to the budget.

2025 BURA Revenues - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 70,511,588	$ 605,615	$ 71,117,203
Debt Service	5,056,106	(607,935)	4,448,171

2025 BURA Expenditures - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 54,215,747	$ 2,902,954	$ 57,118,701
Debt Service	4,459,171	-	4,459,171

2026 Proposed Budget Summary

Planning for Increased Financial Stability

The City and County are guided by conservative revenue projections, reasonable cost assumptions (expenses), deploying strategic development decisions, effectively managing staffing patterns, and using

data-driven decision-making models to keep operational costs in check.

Transitioning into 2026, Broomfield's economic and financial position is fundamentally sound, but we remain in an ever-increasing volatile environment. This reality reinforces the need for prudent financial flexibility, conservative planning assumptions, and disciplined decision-making to ensure long-term sustainability.

Broomfield's two largest primary revenue sources are property tax and sales/use tax, with sales tax showing minimal growth in 2025 (measured at the halfway point through the year, sales tax is projected to end 1-2% higher than 2024). The minimal sales tax growth is expected to continue to build in 2026, a trend anticipated to continue into 2027. Additional retail and commercial investments in the pipeline begin to come online in 2027 (e.g., Macerich's HiFi area at FlatIron and the initial phase of McWhinney's Center Street area). Conversely, the property tax revenue is expected to fall in 2026 and remain stable in 2027. The property tax revenue reduction is occurring due to State changes in the property assessment rates and the decline in property market values.

Due to decreased property assessment rates, property owners will see lower tax bills, which correlates to the decreased county property tax revenue by approximately $6.5-7.5 million annually. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

The 2026 proposed budget reflects the organization's continued focus on balancing current needs and obligations while preparing to meet the organization's and community's future needs by prioritizing expenditures into Mandates, Obligations, and Critical needs. Broomfield's economic fundamentals continue to provide sustained economic and employment opportunities while ensuring a sound fiscal base for CCOB budgets.

Guiding Principle: Residential Growth and Service Capacity

Broomfield currently has the revenue to sustain current service levels, but each new residential development adds demand and costs to systems already operating near capacity. Sales tax revenue growth—expected as new commercial development comes online in 2027—will help, but will not fully offset rising expenditures. Property taxes remain outside local control and subject to state formulas and market values; those factors created a $6.6M - $7.5 decrease in general fund revenue, which is not anticipated to return.

Balancing Housing Needs with Community Capacity

While the Front Range continues to face an affordable housing shortage that calls for regional solutions, Broomfield must thoughtfully balance this need with our community's existing capacity. Demand for services is strong — recreation programs often fill quickly, fields are well used, the Library serves at or near capacity, and our core utilities, such as the wastewater treatment facility, are preparing for future growth. Broomfield has also made prior commitments to additional residential development through business development agreements. Looking ahead, future decisions will shape how we continue to provide high-quality services, invest in infrastructure, and remain fiscally responsible, while also contributing to broader housing solutions across the region.

Disciplined Development and Long-Term Financial Sustainability

Broomfield continues to take a thoughtful, yet disciplined, approach to development as the foundation for achieving long-term financial strength and sustainability. Our strategy emphasizes balanced growth and a diversified economy—ensuring that both residential and commercial development occur in alignment with community needs and fiscal realities.

Maintaining and strengthening the ratio of residential to commercial development is paramount as we move into the future. A healthy balance not only supports a diversified tax base and resilient economy but also ensures that service demands and infrastructure investments are financially sustainable over time.

By adhering to this disciplined approach, Broomfield positions itself to manage near-term fiscal challenges

while preserving the flexibility to invest in community priorities and future opportunities.

Broomfield recognizes that a strong community is made up of thriving neighborhoods and residential areas, combined with commercial areas and developments home to businesses in key sectors, such as finance, information technology, aerospace, and business/professional services. Broomfield is also successful in attracting and growing businesses in next-generation economic sectors, such as quantum computing, phonetics, and advanced manufacturing. Recent firms choosing and growing in Broomfield include Sierra Space, SiNaptic, Quantinuum, and Raven Space Systems.

Development and increasing redevelopment in the community continue to build on this economic and financial foundation. These developments provide sought-after locations for businesses to locate and grow, places for residents and visitors to shop, dine, and gather, and places where existing and new residents will call home. Current construction is underway around FlatIrons Crossing (the HiFi area: both the Novel FlatIron residential and new commercial space), MidPoint's flex/innovation space (255 Midway), the Simms Technology Park, and Harvest Hill apartments. Horizontal construction will soon start in Baseline's mixed-use Center Street development. Combined, these current developments total nearly 500 new residential units (over 200 income-aligned), about 500,000 square feet of new work space, and over 100,000 square feet of (already leased) shopping and dining space.

The 2026 proposed spending plan recognizes that our community looks to its local government as innovators and leaders. It supports this influential work by refocusing and committing to the identified Community Goals, with the fundamental goal of Fiscal Sustainability remaining paramount to a healthy and robust future.

Emphasis on Prioritizing Needs

As Broomfield continues to maintain economic and fiscal stability, our strategic approach includes a prudent and pragmatic fiscal approach to anticipate and withstand future economic or financial disruptions in the short and long term.

The proposed 2026 budget prioritizes expenditures in the following categories:

- **Mandates**: Regulatory requirements issued by the federal or state level that result in the need for funding.
- **Obligations**: Contractual requirement or agreement.
- **Critical Need**: This is essential to the organization's effective operations. Failure to fund it would threaten public health, the environment, or community safety, or create a more significant liability or risk to the organization.

Any funding request not categorized by a mandate, obligation, or critical need but necessary to provide ongoing programs and services would be defined as an 'other' this year. In 2026, only projects classified as 'other' that were moved forward were partially funded by grants.

The 2026 Recommended Budget reflects a collaborative effort across all departments. New services and their associated costs will be strategically timed for review only when budget flexibility improves – something not anticipated in 2026, and possibly not until the second half of 2027.

All departments determined needs based on the following high-level categories and corresponding thought-provoking questions, serving as the foundational lens through which all budgeting and resource allocation requests were reviewed:

- **Safety**: Eliminating or reducing a hazard/threat
- **Operational Cost vs. Revenue**: Is there a revenue offset that will help reduce costs?
- **Asset Maintenance**: Ability to extend the life cycle of a current asset
- **Comprehensive Plan**: Approach and alignment with existing roadmap

- **Operational Support**: Will the request create additional demand on existing resources or require new support?
- **Alternatives**: Does the alternative require greater resources, financially or otherwise?
- **Cost Sharing Opportunities**: Ability to leverage outside funding awards
- **Urgency**: Is there an immediate need that the request will satisfy?
- **Public Benefit & Quality of Life Impact**: Ability to benefit across various sectors
- **Socio-Economic Equity**: Determining the applicability within Broomfield's vulnerable populations or underrepresented
- **Sustainability**: Ability to address/correct the construct that will benefit the environment

For the fifth consecutive year, staff recommends maintaining Public Safety, Public Works, and Water Utilities as a top priority while continuing to adapt to growth, addressing deferred maintenance while moving forward with an asset management approach, and shifting to new and long-term fiscal realities.

Public Safety

This commitment is demonstrated by keeping the Broomfield Police Department organizationally separate from general employee groups. This approach has enabled the City and County of Broomfield to strengthen its police force effectively, resulting in a substantial increase in essential personnel to better serve the community. The Full-Time Equivalents (FTEs) grew from 242 in 2021 to 277 in 2025, a 14% increase. Concurrently, the police budget expanded from $34 million in 2021 to $44 million in 2025, marking a 27% increase. This investment is directly linked to Broomfield maintaining the lowest crime rate per capita in the metro area.

District Attorney – 17th Judicial District

The proposed budget for Broomfield's population share of the District Attorney's office is based on preliminary calculations received from Adams County in August 2025. On August 12, 2025, the District Attorney submitted his budget documents to Broomfield staff. Following that submission, Broomfield requested a meeting with the Adams County Board of Commissioners and leadership to discuss the request.

This meeting, held in mid-September, included the Mayor, Mayor Pro Tem, City Manager, and City Attorney. The discussion focused on the scope of services included in the DA's request, as well as the Family Justice Center, which is addressed in greater detail below.

Adams County is also in the process of finalizing its budget. On October 1, 2025, the District Attorney presented his budget request to the Adams County Board of Commissioners; however, the Board has not yet approved the request. Broomfield staff attended the presentation and will continue to monitor developments to ensure Broomfield's final budget reflects only its proportional share of approved expenses.

Broomfield's proposed budgeted amount for the DA reflects a budgeted amount that does not include costs for the proposed Family Justice Center (FJC). Per statute, Broomfield is only responsible for its per-population share for "the necessary expenses of maintaining an office for the transaction of official business" of the District Attorney.

While the intent of the FJC is admirable, the District Attorney has indicated that 75% of individuals to be served will be non-judicial clients. This represents not an expansion of existing prosecutorial services, but rather the creation of an entirely new entity, infrastructure, and team, as shown by 9 FTE in his budget request to Adams and Broomfield counties. While there is a connection with the domestic violence case work completed by the DA's office, this is a separate endeavor that warrants further scrutiny and should be subject to discussions about the creation of a regional and distinct intergovernmental entity before Broomfield commits taxpayer resources.

In addition, the revised proposed budgeted amount for the District Attorney does not include the cost of one FTE (an attorney) that Broomfield has solely funded since 2021 to reduce backlog following COVID. This was

a separate agreement with the DA, and three years later, after that backlog has been addressed, that cost should not be part of the base budget.

Public Works and Water Utilities

Our focus on infrastructure over the past several years has led to significant growth in resources dedicated to roads, streets, maintenance, and water. Full-time equivalents (FTEs) increased from 158 in 2021 to 220 in 2025 – a 39% rise (note: this includes 14 FTEs transferred to Public Works/Water Utilities from Community Development and Strategic Initiatives related to Construction Inspections and Energy and Sustainability, respectively). Investments in Public Works and Water Utilities have enabled staff to optimize infrastructure, boost productivity, and better manage assets. This directly impacts overall operations and effectiveness.

Broomfield has made major strides in core infrastructure and utility maintenance over the past five years. The Street Pavement Management Program expanded significantly, with more miles treated and a dramatic increase in crack sealing. Water Utilities strengthened operations with annual waterline replacements, full fire hydrant flushing and maintenance, and near-complete valve maintenance. The Sewer Collections Program has advanced to completing annual program system cleaning and inspection on a regular cycle. Meanwhile, the Stormwater Maintenance Program, established in 2021, now conducts annual program system cleaning and inspections each year. These operational improvements are supported by a five-year financial sustainability plan that ensures the long-term health of infrastructure, high-quality service delivery, and protection of public health and the environment.

Given the challenges and uncertainty in the economy and marketplace, the 2026 Proposed Budget relies on conservative fiscal policies and projections supporting balanced annual spending. The 2026 Proposed Budget was built using a combination of Council direction with existing planning documents, including, but not limited to, the Comprehensive Plan, the Long Range Financial Plan, and financial/economic modeling, to synthesize the work over the past several years of taking a comprehensive methodological approach to Broomfield's future.

2026 Areas of Focus & Key Highlights

- Broomfield has not acquired any additional general obligation (GO) debt since 2017. Broomfield will be defeasing prior debt and remains committed to maintaining and increasing our existing Aa2 bond rating, which means the organization has a "superior ability to repay short-term debt obligations." The rating is one of the highest within the state of Colorado. This high rating is essential. Having debt of 5% of revenues is considered appropriately leveraged and reflects the government's ability to repay debt.
- Broomfield will continue to leverage grant funding as part of efforts to diversify revenue sources. In 2025, overall, less grant revenue was available on the Federal and State levels. As of August 2025, CCOB has received 91 grants, representing an increase from 69 grants in 2024. This total reflects both new grant applications and recurring awards that continue from year to year. In 2025 alone, more than 35 new grant applications have been submitted, with 28 awarded to date. These awards total approximately $5.6 million, compared to $4 million last year. We will continue to seek grants in 2026 to pursue funding from private, local, and state sources. New grant funding to be explored in 2026 includes: Courts' First Defense Counsel Appearance, incentives for Norm Smith UST removal reimbursement, the Recycling Rebate Program, and Special Supplemental Nutritional Funds for Women, Infants, and Children (WIC).
- Police Facility construction is anticipated to begin in early 2026.
- Courts Remodel design to begin in 2026.
- Maintain the achieved goal of 20% reserves into 2026 and future years.
- Continue to explore opportunities for development of the former Event Center site: This development is expected to be a revenue generator for the community.
- Implementation of the selected City and County Enterprise Resource Planning (ERP) Software that will modernize our existing 30+ year manual/spreadsheet system to begin early 2026.
- Update the 2016 Comprehensive Plan in 2026, providing the Council, community, and our

organization an opportunity to play a critical role in shaping the vision for the next decade and beyond.
- Implementing the first organizational strategic plan to guide the 2026 work plan.
- Issuance of three bonds: Quarter one 2026, Certificate of Participation for the PD/Courts, and two in the Enterprise Funds for the Water Tanks & Wastewater Expansion - Phase IB.

This list alone requires us to be especially prudent in the upcoming year and beyond. We are operating in a constrained environment – both financially and with staffing capacity – and must therefore be intentional and strategic in every decision we make. The 2026 and 2027 budgets will require a reallocation methodology, not a reprioritization model – meaning that to add anything, other programs must be reduced or removed to accommodate new or enhanced funding. As we gain clearer insights into programmatic outcomes, we must be willing to have courageous conversations about whether programs and services are being fully maximized, widely utilized, effectively measured, and delivering the intended outcomes. If they are not, we must work together to thoughtfully realign our efforts and resources toward initiatives that deliver the greatest benefit to our community.

2026 Budget Highlights

Revenue Projections

Broomfield's two largest primary revenue sources are property tax and sales/use tax, accounting for 60% of Broomfield's revenue base. Sales tax is showing minimal growth for 2026. The minimal growth in sales tax is a trend anticipated to continue into 2027, while retail and commercial investments in the pipeline begin to come online in late 2027 (ie, Macerich development).

Conversely, the property tax rates are not expected to move in any direction but downward. Due to decreased property assessment rates, property owners will see lower tax bills. This reduction will decrease county property tax revenues by approximately $6.5-7.5 million annually – $3-4 million from residential properties and $3.5 million from commercial properties. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

Across all revenue streams[1], 2026 projected revenues are expected to increase by 5.2% from $332 million to $349 million compared to the 2025 revised budget per Table 1C of the proposed budget. This increase is primarily driven by anticipated revenues from Fiber contracts, building permits and use tax revenues.

The 2026 proposed budget was built with the projected increases in Utility Rates for water, sewer, reclaimed water, and stormwater.

Expenditure Projections

Broomfield continues to monitor the ongoing uncertainties surrounding the economic environment and is prepared to react as needed. The budget process is an example of staff working collaboratively to mitigate the impacts of these uncertainties.

Operational expenditures are expected to increase by 5.8% from the 2025 original budget to the 2026 proposed budget.

Total expenditures (Table 3B), which include the operating, capital, additions to reserves, and debt service obligations across all funds, is an estimated $897 million, excluding inter-fund transfers. This represents an increase of 41% in expenditures from the 2025 original budget to the 2026 proposed budget. This increase is primarily driven by large capital projects, such as the new Police building, Court building remodel, and the Water and Sewer projects.

Personnel

Over the last four years, Broomfield has implemented a market-driven, competitive compensation philosophy to lead the market. This was based on the legal requirements to comply with new federal equal pay mandates and aligned with the City Council's direction on employee compensation. In year five, Broomfield is working to maintain the progress while navigating economic uncertainties. Human Resources completes market evaluations every other year to ensure positions within CCOB are paid competitively against the Denver Metro market. This data is used to project salaries and personnel costs for the proposed budget. In 2026, Human Resources will not be conducting market evaluations.

Ongoing personnel costs and adding new positions to meet the community's needs are the primary drivers of the 5.8% operational budget increase referenced in the expenditures section.

Below is a list of the Personnel Changes implemented as part of the 2026 operating budget.

1Excludes Fiduciary Funds and Budgeted Bond Revenues

Expenditures: 2026 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
Human Services	0.10	13,463	Business Solutions & System Administrator (0.1FT)
Information Technology	-1.00	-	Accessibility Specialist LTA Expiration (-1.0FT)
Parks, Recreation, & Senior Services***	2.25	219,958	Lead Parks Tech (1.0FT), Parks Tech II PT to FT (0.25FT), Preschool Director (1.0FT)
Public Health & Environment	0.40	18,982	Business Solutions & System Administrator (-0.1FT), Administrative Support II PT to FT LTA (0.5FT)
Water Utilities	3.00	334,561	Cross Connection Foreman (1.0FT), Senior Water Utilities Locator (1.0FT), Senior Sewer Utilities Locator (1.0FT)
Total	**4.75**	**$ 586,964**	
*Includes internal transfers.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and est. taxes and benefits; does not include any non-personnel budgets associated with new FTE			
***Department has self-funded these positions with budget realignments - reducing temp and non-personnel budgets			

Non-Personnel

Non-personnel-related expenses include the supplies, equipment, and contractual service costs necessary to provide the programs and services in Broomfield. Some examples include:

- Fuel
- Vehicle Maintenance Supplies (i.e. air & oil filters, tires, etc)
- Electronic Equipment (i.e. telephones, computers, headsets, etc)
- Training and Development of staff
- Professional Services (i.e. outside auditors, specialized legal services)
- Insurance expenses
- Utilities
- Software (Annual License Fees, such as Google)

As part of the annual budget process, the budget staff meets with departments to discuss non-personnel requests and the drivers of individual items. Items like fuel are a basic necessity for the organization to accomplish its work and are subject to market conditions; thus, Broomfield has very little control over this type of expenditure. For other non-personnel items, the organization manages costs by finding alternatives or adjusting work procedures to eliminate or minimize expenses wherever possible.

Operating Budget Highlights

Below is a list of some highlights of the 2026 operating budget.

2026 Operating Budget Highlights		
Department or Category	**Description**	**Amount**
Assessor	One (1) 5-Month Overlap (Assessment Supervisor)	$ 66,708
City and County Clerk	Two (2) 2-Month Overlap (Recording & Motor Vehicle Specialist, Recording & Licensing Specialist)	25,141
City & County Manager	Hazardous Mitigation Plan Update - FEMA Mandate	65,000
Community Development	Two (2) Reclassifications (Senior Landscape Architect to Landscape Manager, Combination Inspector to Landscape Associate/Tech)	54,272
Parks, Recreation, & Senior Services	One (1) FT (Lead Parks Technician)*	-
Parks, Recreation, & Senior Services	One (1) PT to FT (Parks Technician II)*	-
Parks, Recreation, & Senior Services	One (1) TM to FT (Preschool Director)*	21,401
Police	One (1) FT Continuation (Victim Advocate) if Grant is discontinued	112,712
Police	Three (3) Reclassifications (Records Specialist to Records Supervisor, Budget Analyst to Budget Supervisor/Manager, Office Manager to Senior Operations Manager)	73,871
Public Health & Environment	Personnel Costs Transitions	(8,555)
Public Health & Environment	One (1) PT to FT LTA (Admin Support II)	33,899
Public Health & Environment	One (1) Reclassification (Environmental Health Specialist I to Environmental Health Specialist II)	5,953
Water Utilities	Three (3) New FT (Cross Connection Foreman, Senior Water Utility Locator, Senior Sewer Utility Locator)	381,107
Water Utilities	SCADA Environment Security Scanning Software (w/IT)	69,571
	Total	**$ 901,081**
*Department's non-personnel budget will be reduced for the personnel changes		

2026 Capital Improvement Plan Considerations

Using a conservative approach and understanding the constraints of Broomfield's finances, staff will continue to evaluate and prioritize projects based on mission essentials and those that affect the health and safety of the community. To proactively prevent unintended consequences with any changes in the funding of CIP, staff will continue to seek guidance from Council.

The 2026 Five Year Capital Improvement Project (CIP) Plan was developed in a parallel process at the same time as Broomfield's operating budgets. This process included an extensive year-long collaboration across all departments to ensure that all projects and community requests were considered. CIP requests are rated and prioritized using the same "buckets" described earlier in the document. Ensuring that our limited resources are focused on mandates, obligations, and critical infrastructure projects reinforces our financial sustainability and resilience goal. Finally, staff has worked to shift the focus of funding from new capital projects towards preventative maintenance, repair, and rehabilitation to ensure that Broomfield is focusing efforts on adequately addressing its existing infrastructure.

The 2026 budget for Capital Projects includes

- $142.9 million in expenditures for the General Governmental Funds
  - $100 million for the Police Building and Courts remodeling projects
- $217.2 million in expenditures for the Enterprise (Utility) Funds.
  - $70 million for the two new Water Tanks project
  - $114 million for Wastewater Treatment Facility Expansion Project

2026 Broomfield Urban Renewal Authority Budget

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2026 BURA revenues are budgeted at $65.1 million, representing a 7.7% decrease compared to the 2025 original BURA budget. BURA expenditures in 2026 are budgeted at $50.0 million. BURA also pays the City and County of Broomfield to cover administration costs and professional services related to the development of urban renewal areas. The 2026 budget includes $5.5 million for administrative and professional services expenditures.

2026 Arista Local Improvement District Budget

The Arista Local Improvement District (ALID) was established to facilitate the construction of transportation facilities in the Arista Development. The ALID is supported by a 0.2% sales tax collected on all taxable sales within its boundaries, and the revenue generated by the tax has been pledged to support the Arista Metro District's (AMD) debt service on bonds sold to construct the parking structure.

The only allowable use of the revenue is to support the funding of public transportation services or improvements, the 2026 budget for the ALID exists solely to authorize payments to AMD, as noted. The 2026 proposed ALID budget includes $45,000 in sales tax revenue and $45,000 in expenditures related to the AMD debt service for the construction of the parking structure.

Background - Enterprise/Utility Fee

Utilities are funded by four enterprise funds that are specifically dedicated to the Water, Wastewater, Reclaimed, and Stormwater/Flood Management utilities. Each enterprise operates as a self-supporting entity. Revenues generated from monthly utility bills are the largest source of revenue for each utility, accounting for generally between 85% to 90% of revenues in each fund. Other significant sources of funds include development fees and funding from the Mile High Flood District (MHFD). These cumulative funding sources cover day-to-day operations, capital and rehabilitation projects, and annual programs. A robust enterprise fund presents a significant strategic advantage, empowering the city to issue revenue bonds.

This mechanism is crucial for financing substantial capital projects, much like the extensive bonded projects anticipated in 2026. The ability to leverage revenue bonds ensures that vital infrastructure and development initiatives can proceed.

As previously noted, to prepare for critical utility infrastructure needs, Broomfield adjusted water and sewer rates last year. This was, in part, to support two upcoming enterprise bond issues – one to fund two new water storage tanks and another to expand our wastewater treatment facility. Staff has contracted with bond underwriting firms, Stifle & Piper Sandler, who have extensive Colorado market experience in issuing Enterprise Fund bonds. CCOB is still targeting issuance in quarter one 2026.

Staff has provided additional detailed information on how water and sewer rates are directly influenced by the process of repairing and replacing aging infrastructure, known as asset renewal. Here is the linked

document - Water Utilities System Asset Renewal - Key Aspects of Establishing Rates.

In addition to preparing Broomfield to support the two upcoming enterprise bond issues, the rate increase implemented in 2025 was able to be immediately utilized to implement the water meter replacement program and improve maintenance of existing assets, including the following notable improvements:

Potable Water Improvements

- Flushing 483 miles: 100% (vs. 19% in 2022).
- Hydrants 4,478: 100% maintained (vs. 47% in 2021).
- Backflow devices 2,737: 97.17% compliance (exceeds CDPHE 90%).

Sewer and Stormwater Improvements

- Sewer video inspections: Currently at 90%; 100% by year-end (vs. 20% in 2023).
- Sewer cleaning: Currently at 98%; 2-year full-cycle program (vs. 40% in 2022).
- Storm video inspections: Currently at 87%; 100% by year-end (vs. 9.6% in 2021). Cleaning: 100% of 2025 target (vs. 0% in 2021).
- Street sweeping: 3,381 miles swept in 2025 (+95% vs. 2023).

2026 Proposed Recommendations: Water, Sewer, Reclaimed, and Stormwater Rates

As detailed in the budget adopted by the Council in 2025, the five-year plan includes a year two increase totaling $16.89 per month for the average single-family home starting in 2026. This represents a 15% increase for utility rates across all funds, with a 9% ($1.00) increase for stormwater service fees, and aligns with projections presented in the original five-year plan presented in 2024 (also see October 22, 2024, memorandum). Similarly, the non-residential water, sewer, and reclaimed rates will increase by 15% and stormwater service fees will increase by 9%. License fees for water, sewer, and reclaimed water for new development will increase by 4%.

Staff has completed a comprehensive fiscal analysis to evaluate anticipated revenues from utility rates as well as projected expenses based on necessary costs associated with day-to-day operations, capital and rehabilitation projects, and annual maintenance requirements. The fiscal analysis includes multiple interdependent variables, and adjusting any one component impacts several other variables within the model, requiring a holistic re-evaluation of all dependencies within the five-year comprehensive plan.

This increase is essential to ensure the long-term financial sustainability of our enterprise funds while maintaining essential services and infrastructure. The recommended rate structure ensures sufficient funding for both ongoing maintenance of existing water infrastructure and necessary capital improvements. The proposed increase allows the utility to maintain a proactive maintenance schedule consistent with capital improvement planning recommendations, protecting the community's investment in water infrastructure while avoiding more costly emergency repairs. Deferring maintenance on water system components creates significant financial risk, as delayed repairs typically result in substantially higher replacement costs and potential service disruptions that impact the entire community.

It is important to understand why this rate increase cannot easily be reduced to a lesser amount. Each percentage point reduction in the proposed rate change would result in approximately $500,000 less annual revenue to the enterprise fund. Such reductions would necessitate corresponding cuts to maintenance programs, capital projects, or service levels to maintain a balanced budget.

Given the essential nature of water services and the potential for deferred maintenance to compound costs over time, the proposed increase represents the minimum funding level necessary to ensure reliable, long-term service delivery to our community.

In 2025, the increase for the water utility bill was only on the base fees, and there was no increase for the water usage rates. As discussed and presented last year, in 2026, the proposal also includes an increase to the water usage rate, and therefore, the monthly difference in the water bill will be dependent on how much water the residence typically utilizes.

The projected impact on an average monthly bill for a single-family home and a multi-family home are shown in the tables below.

The example provided below uses an average single-family home bill of 9,000 gallons for water and 6,000 gallons for sewer. The 9,000 gallons/month for water is based on a 4-year historical average of 107,000 gallons per year for a typical single-family home. Staff will be providing a Utility Bill Estimator tool and linking it on our website to help residents calculate how the proposed increase would apply to their home utility bill based on their specific household water usage.

Impact on Average Monthly Bill for a Single Family Home (9,000 gal)

	Rates		Average Bill		
Fee Type	2025	2026	2025	2026	Difference
Water Meter Base Charge	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Tier 1 (0-5k gal)	*$2.39*	*$2.75*	*$11.95*	*$13.75*	*$1.80*
Water Usage Tier 2 (6-9k gal)	*$3.82*	*$4.39*	*$15.28*	*$17.56*	*$2.28*
Water Usage Tier 3 (> 9k gal)	*$5.41*	*$6.22*	*$0.00*	*$0.00*	*$0.00*
Sewer Service Charge	$5.44	$6.26	$32.64	$37.56	$4.92
Sewer Fed Mandate Charge	$0.52	$0.52	$3.12	$3.12	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$11.00	$12.00	$11.00	$12.00	$1.00
Total Bill			**$119.90**	**$136.79**	**$16.89**

Projected 4-Year Outlook for Single-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$119.90	$136.79	$146.37	$156.61
Percentage Change		*14%*	*7%*	*7%*

Impact on Average Monthly Bill for a Multi-Family Home (3,000 gal)

	Rates		Average Bill		Difference
Fee Type	2025 Rate	2026 Rate	2025	2026	Difference
Water Base Fee	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Charge	*$2.55*	*$2.93*	*$7.65*	*$8.79*	*$1.14*
Sewer Service Charge	$5.44	$6.26	$21.76	$25.04	$3.28
Sewer Fed Mandate Charge	$0.52	$0.52	$2.08	$2.08	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$6.60	$7.20	$6.60	$7.20	$0.60
Total Bill			**$84.00**	**$95.91**	**$11.91**

Projected 4-Year Outlook for Multi-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$84.00	$95.91	$102.62	$109.81
Percentage Change		*14%*	*7%*	*7%*

The tables below show the proposed non-residential water base and usage rate changes as well as the proposed license fee changes.

Impact on Non-residential Rates

Fee Type	2025	2026	Difference	%
Water Usage Charge	$3.22	$3.70	$0.48	15%
Water Base Charge - 3/4"	$36.91	$42.45	$5.54	15%
Water Base Charge - 1.0"	$61.50	$70.73	$9.23	15%
Water Base Charge - 1.5"	$123.00	$141.46	$18.46	15%
Water Base Charge - 2.0"	$196.79	$226.33	$29.54	15%
Water Base Charge - 3.0"	$369.00	$424.39	$55.39	15%
Water Base Charge - 4.0"	$615.02	$707.33	$92.31	15%
Water Base Charge - 6.0"	$1,230.02	$1,414.64	$184.62	15%
Water Base Charge - 8.0"	$1,968.04	$2,263.43	$295.39	15%
Water Base Charge - 10.0"	$2,829.07	$3,253.70	$424.63	15%

License fees are the fees that are paid by developers and builders for new connections to the water and sanitary sewer systems. The purpose of license fees is to provide funds to pay for the capital costs of expanding the water utility to serve new growth.

Impact on License Fees

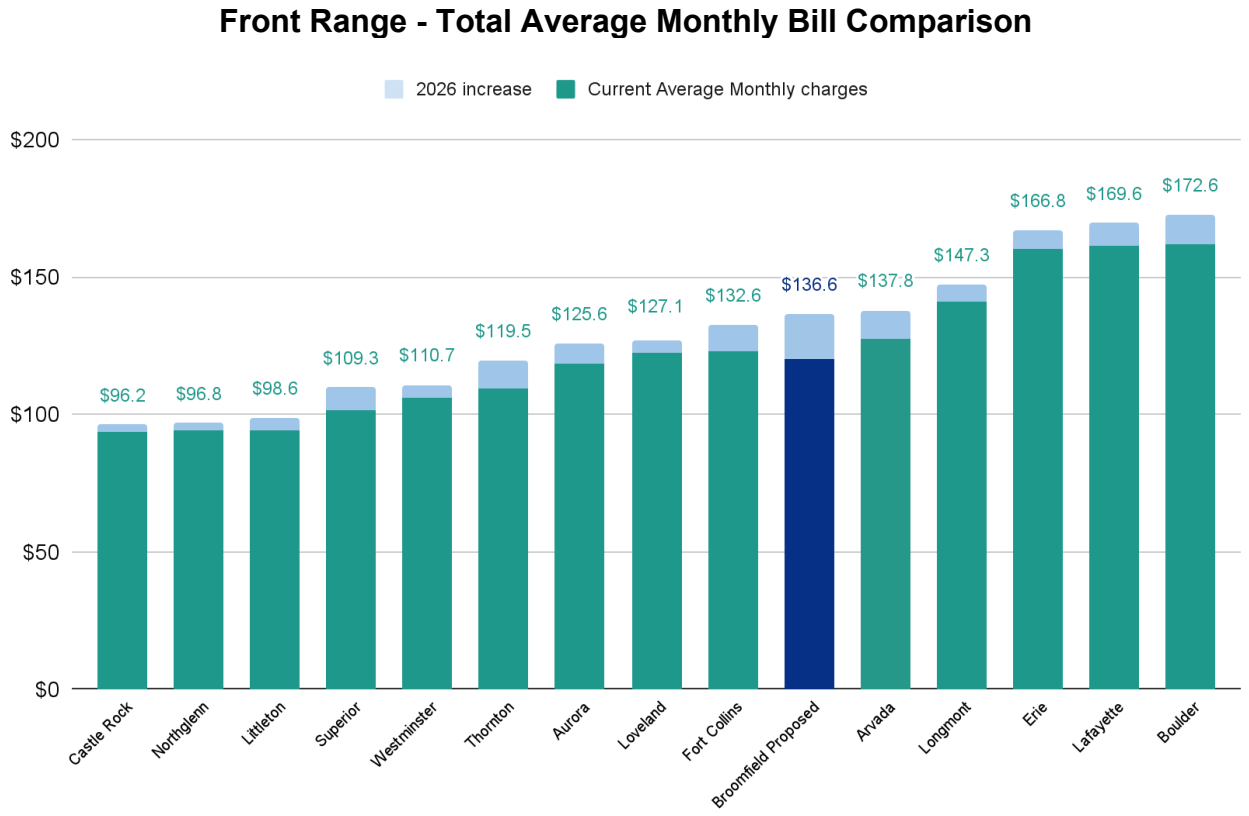
Fee Type	2025	2026	Difference	%
Water License	$37,850	$39,350	$1,500	4%
Sewer License	$14,900	$15,500	$600	4%
Reclaimed License	$13,780	$14,350	$570	4%

Front Range - Average Monthly Bill Comparison

The graph below shows Broomfield's total average monthly utility bill for water, sewer, and stormwater

compared to our neighboring municipalities. The comparison reflects where Broomfield is currently and how it would compare if the Council approves the proposed utility rates. The average monthly bill is normalized across all municipalities based on 9,000 gallons of water usage and 6,000 gallons of Average Winter Consumption (AWC) for sewer charges.

The 2026 rate increases shown in the graph below are not finalized, as the communities are going through a similar budget process as Broomfield, but staff have added the projected/proposed increases for municipalities where a projected increase is available, as shown in the light blue.



The degree to which neighboring municipalities increase their utility rates depends highly on how well they have managed their Enterprise Funds over the past decade, the growth versus expense challenges the municipality faces, and other factors unique to each entity.

Communication Plan:

Staff will be providing information for the community to learn about the proposed fee increase and how it could impact them directly. Updates have been included on the Broomfield.org website, including the proposed rates, estimated impacts for single-family homes and specific types of multifamily residential developments such as apartments, townhomes, and condominiums, and a Utility Bill Estimator tool for residents' use. Staff will also include information on the City and County of Broomfield's communications channels and work with Our Broomfield magazine, which was indicated in the Community Survey as a common place where residents seek to learn about Broomfield information, to share information about the rate change.

Additional information will be shared in late 2025 before the new rates take effect.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program in 2026

The City and County of Broomfield (CCOB) is committed to supporting residents facing financial challenges, particularly with utility costs and property taxes. To this end, two key programs were established: the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) Program.

The PPTR Program, launched in February 2023, was created in response to the increasing burden of property taxes and broader cost-of-living pressures. It provides refunds for seniors aged 65+, veterans with an 80% documented disability, and adult homeowners with 100% documented disabilities.

The URAF Program, launched in 2025 and administered by the Housing Division, helps residents with utility affordability. Building on the operational success of the 2024 PPTR Program signifies a significant step in CCOB's commitment to its residents.

Staff recommends continuing both programs in the 2026 fiscal year and both are included in the proposed 2026 Budget. Both programs will continue to accept new applications through October 30, 2026, or until funding has been exhausted, whichever occurs first. Resolutions 2025-153 and 2025-154 include clarifications and adjustments to the URAF and PPTR programs. These changes aim to ensure the programs remain efficient, fiscally responsible, and responsive to community needs, aligning with Council Goals, Financial Sustainability and Resilience, and Organizational Health.

Utility Rate Assistance Fund (URAF) Program 2025 and 2026 Update

In 2025, City Council Resolution 2024-165 established the Utility Rate Assistance Fund (URAF) program, directing staff to provide quarterly credits or refunds to eligible households with incomes up to 100% of the Area Median Income (AMI).

A review of 2025 URAF applications by the Housing Division revealed that 74% of applicants, the vast majority, had incomes at or below 60% AMI. Consequently, staff recommended reducing the 2026 eligibility threshold to 60% AMI, a change first discussed during the July 2025 second quarterly update for Enterprise Funds.

In 2025, eligible households received monthly reimbursements for utility fees, covering about 50% of the increase from 2024. The maximum annual refund was capped at $240 per household. Reimbursement rates varied by housing type: $20 for single-family detached homes, $18 for townhomes, duplexes, and mobile homes, and $17 for apartments and condominiums. The proposal for 2026 is to maintain these same assistance levels for eligible residents. Eligibility will be based on the total adjusted earnings of all household members aged 18 and older. Residents who pay their water utility bill directly to Broomfield will receive the refund as a credit on their utility account. For residents who pay their water utility as part of rent, via an HOA or other third party, the refund will be issued in check form to the resident.

Broomfield's Housing Division, which also manages the partial property tax refund program, will continue to administer the URAF program, maintaining quarterly payouts based on Council feedback from the July 2025 enterprise funds update.

To support the 2025 URAF program rollout, two nine-month Limited Term Assignment (LTA) full-time staff positions were added to the Housing Division. The 2026 budget does not allocate funds for new staff to

manage the Utility Rate Assistance Fund (URAF). Instead, the administration will leverage current staff within the Housing Division of Economic Vitality. These staff members will track the time and costs associated with administering the program without additional long-term assistance (LTA) capacity. Updates will be provided during quarterly enterprise updates, and the Housing Division will continue to advertise the URAF program via social media, Broomfield's website, Our Broomfield, and alongside other housing initiatives throughout 2026. If additional advertising, postage, or other related expenses are determined to be necessary specifically for URAF, an amendment to the 2026 budget will be requested in 2026.

Utility Rate Assistance Fund (URAF) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 100% AMI	0% - 60% AMI
Payment Frequency	Quarterly	Quarterly

During the October 14, 2025 City Council meeting, a resident reported concern regarding the eligibility of mobile home residents for the URAF program. It should be noted, residents of mobile home communities are eligible for the program. Since their utility bill is typically paid through a third party, the resident would be issued a quarterly check rather than a credit toward their utility bill to ensure the program benefits the resident directly. In 2025, mailers were sent to mobile home residents to inform them about the program. As of October 1, 2025, approximately 12 mobile home residents have applied for and been approved for the URAF. Broomfield staff will continue to focus on outreach to mobile home residents in 2026.

URAF Program Data

URAF Program Data as of September 30, 2025		
URAF - Data Points	2025	2026
Program Budget	Program Credits*: $600,000 Program Checks: $493,100 Personnel: $104,300 URAF specific Advertising: $7,000 URAF Software: $8,300 URAF Equipment: $8,000	Program (credits/checks): $350,000 Personnel: $35,000 URAF specific Advertising: $0 URAF Software: $0 URAF Equipment: $0
Budget Expended	Program Credits: $132,879 Program Checks: $18,639 Personnel: $66,810 URAF Advertising/Postage: $7,620 Software: $8,300 Equipment: $4,492	N/A
Total Payments Processed	Through 2025 Q3: 3833	N/A
Total Applications Processed	1813	N/A
Eligibility	One of the following docs: IRS Tax Form, SS, SNAP, LEAP, etc.	Required - IRS Tax Form No tax filing - Proof of all income (SS, Bank Statements, Paystubs, etc.)
AMIs Served	0-30% ▫ 40% 31-60% ▫ 34% 61-80% ▫ 19% 81-100% ▫ 7%	0-30% 31-60% N/A N/A
Communication Efforts	Phone Calls: 1171 Emails: 446 Consultations: 429 (96 Spanish)	N/A N/A N/A
Outreach Events	31	N/A

*As part of the 2025 Budget - 1st Amendment, program credits were budgeted at $1,479,300; as part of the 2025 Budget - 2nd Amendment, program credits are now budgeted at $600k.

Partial Property Tax Refund (PPTR) Program - 2025 Update and 2026 Recommendation

The Partial Property Tax Refund (PPTR) Program, established by Resolution No. 2022-123 and expanded with Resolution No. 2024-27 and Resolution No. 2024-105, offers financial relief to specific demographics facing increasing property tax burdens and general cost-of-living pressures. Eligible participants include seniors aged 65 and older, veterans with a documented disability of 80% or more, and adult homeowners with 100% documented disabilities.

While the Housing Division will continue to utilize 2021 tax year data as the program's baseline, the 2026 refund is anticipated to be lower than in 2025 due to the recently adopted House Bill 24B-1001. Despite these adjustments, the program is expected to continue providing significant support to qualifying households.

Partial Property Tax Refund (PPTR) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 80% AMI	0% - 80% AMI
Program Final Application Date	October 30, 2025	October 30, 2026

PPTR Program Data

PPTR Program Data as of October 13, 2025		
PPTR - Data Points	2025	2026
Program Budget	Program ≤ 60% AMI: $402,000 Program 61-80%: $100,000	Total Program: $600,000 Anticipated utilization ≤ 60% AMI: $500,000 61-80%: $100,000
Budget Expended	Program ≤ 60% AMI: $401,693 Program 61-80%: $90,016	N/A
Total Payments Processed	963	N/A
Total Applications Processed	1265	N/A
AMIs Served/Processed	0-30% ▫ 41.5% 31-60% ▫ 36.0% 61-80% ▫ 18.5% Ineligible ▫ 4.0%	0-30% 31-60% 61-80%
Communication Efforts	Phone Calls: 517 Emails: 332 Consultations: 397 (77 Spanish)	N/A N/A N/A
Outreach Events	33	N/A

Bond Issuances

Until 2021, Broomfield did not have a formal Debt Policy. Since adopting one, we have aligned with industry and government standards by capping total debt at no more than 10% of the City's assessed value. As of the close of fiscal year 2024, Broomfield's total debt was at 5.25% of assessed value – well below industry standards.

In 2023, debt service accounted for 4.6% of total revenues, and in 2024, that decreased slightly to 4.2%, reflecting our intentional focus on managing and reducing outstanding obligations. For context, debt service levels under 5% of total revenue are typically considered "best in class."

As we look ahead, the staff has strategically timed the issuance of new debt to coincide with the defeasance of the 2017 Certificates of Participation (COP) for the County building. This approach will help offset the impact of new debt issuance for the upcoming Police and Courts facility. While we expect to slightly exceed the 5% debt-to-revenue ratio following issuance, our strong financial standing provides confidence in our ability to manage this responsibly. In the past two years, Broomfield has earned three credit rating upgrades, which is a significant achievement

Conclusion and Next Steps

The 2026 budget represents a disciplined, data-driven approach to maintaining Broomfield's financial sustainability while meeting our community's needs. Through careful stewardship of public resources, strategic infrastructure investments, and thoughtful prioritization of mandates, obligations, and critical needs, this budget positions our organization to navigate current fiscal challenges while preparing for future opportunities.

Key Takeaways

The proposed 2026 budget demonstrates our commitment to:

- **Fiscal Responsibility**: Maintaining 20% reserves and managing debt prudently
- **Infrastructure Investment**: Addressing critical water, sewer, and public safety facility needs
- **Community Support**: Continuing programs like URAF and PPTR to assist residents facing financial challenges
- **Operational Excellence**: Optimizing existing resources before requesting new ones

Action for Council - October 28, 2025

7.A Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-141 - 2025 Budget - 2nd Amendment
- Resolution 2025-142 - 2026 CCOB Budget

7.B Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-143-UR - 2025 BURA Budget - 2nd Amendment
- Resolution 2025-144-UR - 2026 BURA Budget

7.C Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

- Resolution 2025-145-AID - 2026 ALID Budget

7.D Public Hearing - Ordinance Section Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

- Ordinance 2286 - Enterprise Rate Ordinance

7.E Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

- Ordinance 2288 - Water Tanks Bond
- Ordinance 2289 - Wastewater Treatment Bond
- Ordinance 2290 - Police/Courts COP

7.F Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

- Resolution 2025-153 - URAF Program Continuation
- Resolution 2025-154 - PPTR Program Continuation

Looking Ahead

Following the adoption of the 2026 budget, staff will:

- Issue bonds in Q1 2026 for Police/Courts facility and enterprise projects
- Begin construction on the Police building, Water tanks, and Wastewater Expansion Project
- Implement the updated URAF and PPTR programs
- Come before Council Dec. 9th with an amendment focused on grants received in 2025
- Continue quarterly Enterprise Fund updates to Council
- Collaborate with FLOW on recommendations for the 5-Year Water Utilities Capital Improvement Plan (CIP) and rate adjustments for the 2027 budget.
- Monitor economic conditions and provide budget updates as needed
- Prepare for the 2027 budget process with continued emphasis on financial sustainability

Staff remains committed to transparent communication, data-driven decision-making, and collaborative problem-solving as we work together to serve our community and achieve our shared goals.

Bold type indicates new material to be added to the Broomfield Municipal Code
~~Strikethrough type~~ indicates deletions from the Broomfield Municipal Code

ORDINANCE NO.2286

An ordinance Amending Title 13 of the Broomfield Municipal Code to change water, wastewater, reclaimed wastewater, and stormwater fees and service charges

Be it ordained by the City Council of the City and County of Broomfield, Colorado:

Section 1. Water License

Section 13-02-020 of the Broomfield Municipal Code is hereby amended to read as follows:

13-02-020 Water license fee.

Water licenses may be purchased from the city at a fee of ~~$37,850.00~~ **$39,350.00** per three-quarter-inch equivalent tap. Tap fees and meter fees are separate and additional.

Section 2. Sewer License

Section 13-08-020 of the Broomfield Municipal Code is hereby amended to read as follows:

13-08-020 Sewer license fee.

Sewer licenses may be purchased from the city at a fee of ~~$14,900.00~~ **$15,500.00** per equivalent sewer tap.

Section 3. Water Service Charges

Section 13-12-010 of the Broomfield Municipal Code is hereby amended to read as follows:

13-12-010 Monthly water service charges.

(A) Residential water service charges. Residential customers shall be charged a flat monthly charge and for the monthly volume of water used from the city water system as set forth below:

(1) Flat monthly charge (no gallonage included):

Customer Type	Flat Monthly Charge

Single-Family ¾ inch	~~$ 36.91~~ **$42.45**
Single-Family 1 inch	~~$ 36.91~~ **$42.45**
Multi-Family (per dwelling unit)	~~$ 36.91~~ **$42.45**

(2) Charge for all water use:

Monthly Volume of Water Used	Charge (per 1,000 gallons)
1,000-5,999 gallons: defined as the first 5,999 gallons of water used in one month	~~$ 2.39~~ **$2.75**
6,000-9,999	~~$ 3.82~~ **$4.39**
>9,000 gallons	~~$ 5.41~~ **$6.22**
Multi-Family - All Use	~~$ 2.55~~ **$2.93**

(B) Nonresidential water service charges. All nonresidential customers shall be charged a flat monthly charge and for the monthly volume of water used from the city water system. A standby fire protection charge will also be imposed. The nonresidential water service charges are as set forth below:

(1) Flat monthly charge (no gallonage included):

Connection Size	Flat Monthly Charge
¾”	~~$ 36.91~~ **$42.45**
1”	~~$ 61.50~~ **$70.73**
1 ½”	~~$ 123.00~~ **$141.46**
2”	~~$ 196.79~~ **$226.33**
3”	~~$ 369.00~~ **$424.39**
4”	~~$ 615.02~~ **$707.33**
6”	~~$ 1,230.02~~ **$1,414.64**
8”	~~$ 1,968.04~~ **$2,263.43**
10”	~~$ 2,829.07~~ **$3,253.70**

(2) Charge for all water use: ~~$3.22~~ **$3.70** per 1,000 gallons. Nonresidential accounts shall include schools, churches, public or institutional buildings, parks, and irrigation accounts.

(3) Standby fire protection charges:

Connection Size	Flat Monthly Charge
2”	~~$ 35.69~~ **$41.04**
3”	~~$ 66.93~~ **$76.96**
4”	~~$ 111.56~~ **$128.28**
6”	~~$ 223.10~~ **$256.55**
8”	~~$ 356.96~~ **$410.47**
10”	~~$ 513.13~~ **$590.05**

(D) Rates effective until changed. All monthly water service charges and nonresidential water service charges established by this section 13-12-010 shall be in accordance with the schedule set forth herein and shall remain in effect until said charges are amended or changed by the city council.

Section 4. Sewer Service Charges

Section 13-12-020 of the Broomfield Municipal Code is hereby amended to read as follows:

13-12-020 Monthly sewer service charges.

(A) Residential sewer service charges.

(1) All residential accounts shall be charged a gallonage charge based on average winter water consumption. The monthly charge is ~~$5.44~~ **$6.26** per 1,000 gallons, or ~~$21.76~~ **$25.02** per dwelling unit, whichever is greater.

(2) Any new occupant of a residential unit served by a separate connection and any new residential unit shall be charged a ~~$32.64~~ **$37.56** monthly sewer charge until average winter water consumption is established.

(3) Any new multi-unit account shall be charged a monthly sewer charge of ~~$32.64~~ **$37.56** per dwelling unit until average winter water consumption is established.

(4) Average winter water consumption shall be the average water consumption for the monthly bills reflecting usage between November 1 and the following March 31, depending on the billing cycle. The average winter water consumption for each account shall be calculated once annually and shall be the basis for determining charges for the following twelve months.

(B) Nonresidential sewer service charge.

(1) Each nonresidential account shall be assigned by the director of public works to the most appropriate category listed in Table 13-12A, attached hereto and incorporated herein by reference. Values for concentration of BOD, COD, and TSS, as those terms are defined in chapter 13-28 of this code, will be as set forth in Table 13-12A, unless values are determined by the director of public works based on actual sampling of the effluent. Any sample taken for such purposes shall be a composite sample, as defined in chapter 13-28, B.M.C. Analysis shall be done in accordance with the procedures described in the latest edition of "Standard Methods for the Examination of Water and Wastewater," as published by the American Public Health Association, the American Water Works Association, and the Water Pollution Control Federation. Such individual sampling and analysis will be offered by the department of public works on request of the user, at such user's expense and if requested, the sample will be split and half of the sample will be given to such user for analysis by an independent laboratory. If analysis ordered by the department of public works and that obtained by user are significantly different, the director of public works may accept the user's analysis, or may order a new sample and analysis done at city expense. Each nonresidential customer must provide suitable access for sampling purposes.

(2) The monthly charge for each nonresidential account shall consist of the following elements:

a. A gallonage charge based on year-round non irrigation water consumption. The charge is ~~$5.44~~ **$6.26** per 1,000 gallons, or ~~$21.76~~ **$25.02** per equivalent sewer tap, whichever is greater.

b. A surcharge for excess BOD, COD, and TSS, as determined by whichever of the following formulae produces the higher surcharge:

S = Q (0.00833ARA + 0.00833 CRC) or where:

S = Q (0.00833BRB + 0.00833 CRC)
S = Amount of surcharge (cannot be less than zero)
Q = 100% of year-round non irrigation water consumption for the account, expressed in thousands of gallons per month (until year-round non irrigation water consumption is established, Q = 100% of total water consumption).
A = Average BOD strength of wastewater expressed in mg/l minus 200 mg/l
B = Average COD strength of wastewater expressed in mg/l minus 300 mg/l
C = Average TSS strength of wastewater expressed in mg/l minus 200 mg/l
RA = $0.27 per pound of excess BOD
RB = $0.27 per pound of excess COD
RC = $0.19 per pound of excess TSS

(3) Any new nonresidential account shall be charged a monthly gallonage charge of ~~$32.64~~ **$37.56** for each equivalent sewer tap until year-round non irrigation water consumption is established. In addition, any surcharges under subparagraph (2)b. above shall apply.

(4) Year-round non irrigation water consumption shall be based on the average water consumption for the monthly bills reflecting usage between November 1 and the following March 31, depending on the billing cycle, calculated once annually and used as the basis for determining charges for the following twelve months. As an alternative, it may be based on the consumption shown on a metering system indicating non irrigation use only.

(5) Equivalent sewer tap shall be as defined in chapter 13-08, B.M.C.

(C) Annual notification. Each user will be notified, at least annually, in conjunction with a regular bill of the rate and that portion of the user charges which are attributable to wastewater treatment services.

(D) All residential and nonresidential accounts shall be charged an unfunded mandate charge based on average winter water consumption of $0.52 per 1,000 gallons.

(E) All residential and nonresidential accounts shall be charged a monthly environmental compliance fee based on ~~$9.00~~ **$10.35** per equivalent sewer tap.

(F) Rates Effective Until Changed. All sewer charges established by this Section 13-12-020 shall be in accordance with the schedule set forth herein and shall remain in effect until said charges are amended or changed by the city council.

Section 5. Reclaimed Wastewater

Section 13-32-060 of the Broomfield Municipal Code is hereby amended to read as follows:

13-32-060 - Connection fee.

For all reclaimed wastewater contracts following adoption of this chapter, the connection fee for reclaimed wastewater service shall be ~~$13,780.00~~ **$14,350.00**.

Section 6. Stormwater Service Charges

Section 13-38-010 of the Broomfield Municipal Code is hereby amended to read as follows:

13-38-020 - Monthly stormwater service charges.

(A) Residential stormwater service charges.

(1) Flat monthly charge shall be charged as set forth below:

Customer Type	Flat Monthly Charge
Single-Family Home	~~$ 11.00~~ **$12.00**
Multi-Family: Townhome I Duplex	~~$ 8.80~~ **$9.60**
Multi-Family: Apartment	~~$ 6.60~~ **$7.20**

(B) Nonresidential stormwater service charges. All nonresidential customers shall be charged monthly based on the amount of impervious square feet on the customer's property. The monthly charge will be equal to ~~$2.50~~ **$2.88** per 1,000 impervious square feet.

(C) Rates effective until changed. All monthly stormwater service charges and nonresidential stormwater service charges established by this chapter 13-38 shall be in accordance with the rates and schedule set forth herein and shall remain in effect until said charges are amended or changed by the city council.

Section 7.

This ordinance shall be published following final passage and shall be effective beginning on January 1, 2026.

Introduced and approved after first reading on October 14, 2025, and ordered published in full.

Introduced a second time and approved on October 28, 2025, and ordered published.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

E. Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7E.

Presented By
Graham Clark, Director of Finance

Community Goals
☑ Financial Sustainability and Resilience ☑ Organizational Health

Overview

View Correspondence
View Presentation

The purpose of this memo is to present financial information related to the second amendment of the 2025 City and County of Broomfield and the Broomfield Urban Renewal Authority Budgets, financial information related to the proposed 2026 budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District, information related to the proposed increases to utility rates for the Broomfield Enterprise Funds, information related to the proposal of two enterprise revenue bonds and police building and courts remodel certificate of participation, and information related to the Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) programs.

Attachments

Memo for 10_28_2025_2nd Amd to 2025 Budget; Adoption of 2026 Budget (CCOB, BURA, ALID); Utility Rates Ord; URAF; PPTR; Bond Ords.pdf

Ordinance No. 2288 Authorizing Water Activity Enterprise Water Revenue Bonds, Series 2026 (Water Tanks).pdf

Ordinance No. 2289 Authorizing Sewer Activity Enterprise Revenue and Refunding Bonds, Series 2026 (Wastewater Treatment - Phase 1B).pdf

Ordinance No. 2290 Certificate of Participation Financing for Police and Courts Buildings .pdf

Memo for 2nd Amendment to the 2025 Budget and Adoption of the 2026 CCOB, BURA, and ALID Budgets; second reading of amending water, sewer, reclaimed water and stormwater rate ordinance; second reading of two enterprise revenue bonds and police building certificate of participation ordinances; URAF and PPTR programs for 2026
Prepared By: J. Stephanie Chen, Budget Manager

Summary

View Correspondence
View Presentation

Comprehensive Budget Process

The City and County of Broomfield's budget development is a comprehensive, year-long process designed to ensure fiscal responsibility, transparency, and meaningful community and Council engagement. This memorandum represents the culmination of extensive collaborative work that has unfolded throughout 2025, with multiple touchpoints providing City Council and the community opportunities to review, discuss, and shape the financial direction of our organization. This deliberate, methodical approach ensures that budget decisions are informed by current data, community needs, economic conditions, and strategic priorities while maintaining the highest standards of transparency and public accountability.

The Governmental Accounting Standards Board (GASB) sets the accounting and financial reporting standards that state and local governments must follow. Its purpose is to ensure that financial statements are consistent, transparent, and useful to the public, elected officials, and oversight bodies. GASB standards help governments show how public funds are managed, spent, and accounted for, promoting accountability and public trust. Our Broomfield budgets are built using GASB standards, which means our financial reporting and budgeting processes follow the same professional principles used nationwide to ensure accuracy, consistency, and transparency in how we manage public resources.

Year-Long Budget Development Timeline

The 2026 budget process began in early 2025 and has included the following key milestones:

- January-March 2025: Initial financial forecasting and departmental needs assessment
- March 8, 2025: Council Focus Session - 2.C. Conditions of/and influences on Broomfield's economic and fiscal status, 2.H. Anticipated Development and the impacts on fiscal sustainability
- April 15, 2025: Council Study Session - First Quarterly Enterprise Funds Study Session - Council review of enterprise fund status, capital projects, maintenance programs, 2024 financial results, and long-term financial sustainability strategies
- May 8, 2025: Council Study Session - Early introduction to the 2026 budget process and year-to-date financial information
- July 15, 2025: Council Study Session - Second Quarterly Enterprise Funds Study Session - Council review of enterprise fund updates, development projections, and initial utility rate recommendations with subject matter expert consultant AECOM
- August 19, 2025: Council Study Session - Economic and Fiscal Update and Draft Operating and Capital Budgets Study Session - Comprehensive presentation to Council on Broomfield's economic and financial outlook, including CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments
- August 21, 2025: Community Briefing - Public presentation and opportunity for public questions on Economic Long Range Financial Plan and Financial Status Briefing
- September 3, 2025: City Council received the 2026 Proposed Budget and supporting documentation
- September 4, 2025: 2026 Proposed Budget and supporting documents made available for public review and comment on Broomfield.org/Finance
- September 18 and September 25, 2025: Budget Study Sessions with opportunities for public comment - 2026 Proposed Operating & Capital Budgets with department representatives
- October 14, 2025: City Council Meeting - Public Hearing per Chapter 12.7 of the Charter for the 2026

Operating and Capital Budgets, with first reading of key ordinances
- October 21, 2025: City Council Study Session - Final Quarterly Enterprise Funds update of 2025
- October 28, 2025: City Council Meeting - Second reading of ordinances and adoption of budgets (this meeting) with public hearing

Strategic Context and Fiscal Discipline

1. Financial Sustainability and Resilience - Ensuring Broomfield's long-term fiscal health in an uncertain economic environment
2. Transparency and Public Engagement - Providing multiple opportunities for community input and Council deliberation
3. Data-Driven Decision Making - Utilizing comprehensive financial modeling, economic forecasting, and historical analysis
4. Prioritization of Core Services - Focusing resources on mandates, obligations, and critical needs
5. Infrastructure Investment - Addressing deferred maintenance and preparing for future growth
6. Responsible Debt Management - Maintaining our strong credit rating while financing essential capital projects

Summary of Items for Consideration

The City and County of Broomfields budget includes all government operations as well as Enterprise Funds (Water, Sewer, Stormwater and Reuse). The proposed budgets and related documents were available for public review and comment on Broomfield.org/Finance on September 4, 2025.

The staff memorandum from October 14, 2025 regarding the public hearing for City and County of Broomfield (CCOB), Arista Local Improvement District (ALID), Broomfield Urban Renewal Authority (BURA) budgets; first reading of Ordinance No. 2286 amending water, sewer, reclaimed water and stormwater rate ordinance; first reading of two enterprise revenue bonds and police building certificate of participation ordinances (Ordinances No. 2288, 2289 and 2290), included a detailed discussion of the proposed resolutions and ordinances.

It is important to note that the proposed budget is consistent with the October 14, 2025 memorandum and initial proposed budget, with the exception of one change:

- The operational expenditures are expected to increase by 5.8% as opposed to 5.9% due to the combination of a reduction to the amount recommended for the District Attorney (DA) budget discussed during the hearing on October 14, 2025, and a small increase in the budget used for non-profit distributions under the Human Services Fund.

This change is specific to the proposed 2026 budget for CCOB and is reflected in Resolution 2025-142. It does not alter the proposed budgets for BURA or ALID, the water project agreements, enterprise rate ordinance, or any of the bond ordinances considered on first reading during the October 14, 2025 meeting.

The content of this staff memorandum is consistent with the October 14, 2025 memorandum, with additional information provided for the following:

- Information regarding the 2025R Budget - 2nd Amendment.
- Details regarding the non-residential utility rates and license fees for 2026 are provided to clarify what is included in Ordinance 2286 in response to questions from the October 14, 2025 meeting.
- Additional details regarding how the 2025 rate increase was utilized to directly improve water, sanitary sewer, and stormwater resources for Broomfield residents and businesses.
- Details regarding the Utility Rate Assistance Fund program for 2026 as proposed in Resolution No. 2025-153.
- Details regarding the Partial Property Tax Refund program for 2026 as proposed in Resolution No. 2025-154.

City and County of Broomfield Budget

2025 Budget - 2nd Amendment Summary

- The 2025 City and County budget has been amended one time since its adoption to reflect capital project rollovers, grant rollovers, and operational budget adjustments.
- The following attachments are included with this memo to provide fund level details of the 2025 revised budget adjustments. These tables referenced below reflect cumulative prior amendment #1, in addition to the new adjustments in this proposed second (2nd) amendment to the 2025 budget. Revenue and expenditure adjustments (increases and decreases) are also included for reference.
    - 2025 Revised Budget Summary - General Governmental Funds
    - 2025 Revised Budget Summary - Governmental Capital Funds
    - 2025 Revised Budget Summary - Governmental Debt Service Fund
    - 2025 Revised Budget Summary - Enterprise Funds
    - 2025 Revised Budget Summary - Fiduciary Funds
- The second proposed City and County amendment, Resolution No. 2025-141, sets the final 2025 amended budget to reflect expenditures of $775,190,595.

2026 Budget

- The 2026 Proposed City and County of Broomfield Budget has been prepared to reflect expected revenues and expenditures. A set of summary budget tables are included with the resolutions under consideration.
- The 2026 Proposed Budget for the City and County of Broomfield total expenditures are $844,125,005. This amount includes interfund activities and transfers to reserves.
- Tables 1A-4C summarize the 2026 Proposed Budget for the City and County of Broomfield.
- Proposed Resolution No. 2025-142, if adopted, would approve the 2026 Budget for the City and County.

Broomfield Urban Renewal Authority

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2025 Budget - 2nd Amendment Summary

- The proposed BURA budget amendment, Resolution No. 2025-143-UR, is the second amendment proposed since its adoption and reflects unexpended capital improvement project budgets, and revenue adjustments which impacts expense budgets since the adoption of the fiscal year 2025 budget.
    - The proposed BURA budget amendment also reflects a slight decrease in expenditures for a total of $57,118,701.
    - BURA Budget Tables summarize the 2025 revised budget for BURA.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for BURA. In some URAs, planned uses of fund balance are being used for capital expenditures. The BURA proposed total revenues for 2026 are $65,119,746, and the proposed total expenditures are $49,978,125.
    - Tables 1-13 summarize the 2026 Proposed Budget for the BURA.
    - Proposed Resolution No. 2025-144-UR, if adopted, would approve the 2026 Budget for the Broomfield Urban Renewal Authority.

Arista Local Improvement District

The Arista Local Improvement District (ALID) was established in August 2005 to facilitate the construction of transportation facilities in the Arista Development.

2025 Budget - 2nd Amendment Summary

- The 2025 ALID budgeted expenditures have not changed, therefore, no amendment is required at this time.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for the ALID. Attached is a copy of the budget message and budget tables for the ALID for the 2026 Proposed Budget. Anticipated total revenues for 2026 are $45,000. Proposed total expenditures for 2026 are $45,000.
    - Table 1 summarizes the 2026 Proposed Budget for ALID.
    - Proposed Resolution No. 2025-145-AID, if adopted, would approve the 2026 Budget for the Arista Local Improvement District.

Enterprise Rate Ordinance

City Council held quarterly enterprise study sessions on April 15, 2025, July 15, 2025, and October 21, 2025, to review staff's updates on the status of the enterprise funds. The April meeting covered capital projects, maintenance programs, 2024 financial results, steps for ensuring long-term financial sustainability, and the proposed Fiscal Leadership on Water (FLOW) Advisory Committee. The July meeting covered similar topics as well as an overview of development projections and future rate recommendations. The October meeting included an update regarding ongoing capital and maintenance programs for 2025, as well as a presentation from the FLOW Advisory Committee.

City Council also received updates on the Enterprise Funds during the Economic and Fiscal Update held at a Study Session on August 19, 2025. Topics addressed included CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments.

In 2025, the City and County of Broomfield implemented the first utility rate increase of a comprehensive five-year financial plan to address the financial sustainability of the enterprise funds. This increase was necessary as the costs of providing safe, reliable water service continued to rise due to aging infrastructure requiring increased maintenance and replacement, new regulatory requirements and unfunded mandates,

and a substantial backlog of critical system repairs and upgrades. Recognizing the financial burden this placed on residents, Council established the Utility Rate Assistance Fund (URAF) to help eligible households manage the impact.

The five-year plan includes a year two increase totaling $16.89 per month for the average single-family home (9,000 gallons) starting in 2026. Staff anticipates that continued adjustments in future years should be expected due to the annual application of the utility's long-range model, the criticality of ongoing infrastructure support, and to accommodate costs from unknown, but anticipated, state and federal mandates. The URAF to help eligible households remains in the budget for 2026, with minor adjustments.

Bond Ordinances

Police Building/Courts Remodel

This item is presented for the City Council's consideration and authorization to issue $100M in bonds to fund the Police Building/Courts Remodel. This financing utilizes Certificates of Participation (COPS), where the City will finance the project's construction by collateralizing existing City facilities via a Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, and Escrow Agreement. A Preliminary Offering Statement, Indenture, and Disclosure Certificate are also required. Selected facilities that will be borrowed against include Paul Derda Recreation Center, the Broomfield Community Center, the Detention Center, and the Service Center Administration Building. The anticipated maximum annual debt payment resulting from the financing will not exceed $7.9M and the annual payments will come from the City's general fund; however, the debt does not create a general obligation debt or multiple-year fiscal obligation, as the annual debt service payment is subject to annual appropriation.

As part of the 2023 property tax revenue increase, funding was designated to support the construction of the new Police building. In collaboration with our financial advisors, staff determined that using the set-aside property tax dollars to retire the 2017 Certificates of Participation (COPs) represents a sound long-term financial strategy. By applying these funds and coordinating the payoff of prior debt, the City can help offset the financial impact of issuing new debt for the upcoming Police and Courts facility. Recent credit rating upgrades and the City's strong financial position further reinforce confidence in our ability to manage debt responsibly.

The term of the financing will mature on or before December 31, 2047. The anticipated net effective interest rate will not exceed 5.50%. Additionally, as part of this financing, the City will also pay off its 2017 Certificates of Participation (COP) that have a current outstanding balance of $10.89M utilizing unencumbered cash on hand. The 2017 COPs were to mature on December 1, 2027. They were originally issued in 2010 to fund facilities needed to provide county services and for parks and recreation activities, and were refinanced in 2017.

Water Tanks

This item is presented for the City Council's consideration and authorization to issue $80M in Water Revenue bonds for funding the new water tanks. Broomfield's water system model identifies capital improvements that will be needed as Broomfield develops, including the construction of the proposed Water Tanks. The model specifically focuses on the phased development of the areas north of W. 144th Avenue that are quickly developing. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $5.9M and the term of the bonds will mature on or before December 1, 2047.
The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Water Activity Enterprise and does not impact the City's general fund. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement.

Related to the issuance of the Water Bonds, staff will be presenting to the City Council on October 28, 2025 as part of agenda item 7(G) - Water Tanks Construction Agreement, proposed Resolution No. 2025-152

authorizing the reimbursement to the water enterprise fund from bond proceeds (if needed) for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to award a construction contract up to the amount of the advanced funds and begin construction before the bonds' closing. It is expected that a construction contract will be presented to the City Council for approval in November and construction to begin on or about January 1, 2026. An amendment to the construction contract would then be presented to the City Council for approval once the bond proceeds are available for appropriation. Construction of the water tanks is projected to last 36 months.

Wastewater Treatment Facility Improvements

This item is presented for the City Council's consideration and authorization to issue $125M in Sewer Revenue and Refunding bonds for funding the Wastewater Treatment Facility Expansion. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $11M and the term of the bonds will mature on or before December 1, 2047. The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Sewer Activity Enterprise and does not impact the City's general fund. As a part of this financing, the City will also refund and discharge its 2012 Sewer Revenue Refunding Bonds with an outstanding balance of $15.315M that matures on December 1, 2031. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement.

The Wastewater Treatment Facility Improvements are being driven by expected future increases in population and regulatory requirements from the CDPHE that will require significant expansion to the current facility to adequately treat the increase in wastewater and maintain compliance with current and future regulatory requirements. Project drivers include capacity, asset renewal, biosolids, reuse, and regulation. Construction is to begin in 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

This memo will affirm and clarify the planned continuation of the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) programs into the 2026 fiscal year, as outlined in the proposed 2026 Budget for the City and County of Broomfield. These programs are designed first and foremost to support residents experiencing financial burden, while also serving as key components of the City's broader commitment to Council Goals, Financial Sustainability and Resilience, and Organizational Health.

The adjustments provide a summary of operational updates to ensure both programs remain efficient, fiscally responsible, and responsive to community needs within the budgeted resource allocations.

Financial Considerations

2025 Budget - 2nd Amendment

Resolutions 2025-141 and 2025-143-UR outline the financial considerations related to the second amendment to the 2025 budgets for both the City and County of Broomfield and Broomfield Urban Renewal Authority.

2026 Budget

Resolutions 2025-142, 2025-144-UR, and 2025-145-AID outline the financial considerations related to the adoption of the 2026 Budgets for the City and County of Broomfield, the Arista Local Improvement District, and the Broomfield Urban Renewal Authority.

Enterprise Ordinances

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees outlines the financial considerations related to this agenda item.

Bond Ordinances

Ordinance No. 2288 upon approval, authorizes debt financing of up to $80M for the Water Tanks and

approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement related thereto.

Ordinance No. 2289 upon approval, authorizes debt financing of up to $125M for the Wastewater Treatment Facility Improvements and approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement related thereto.

Ordinance No. 2290 upon approval, authorizes debt financing of up to $100M for the Police Building/ Courts Remodel and approves as to form the Preliminary Official Statement, Indenture, Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, Disclosure Certificate, Escrow Agreement related thereto.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

Resolution 2025-153 outlines the financial and programmatic considerations related to the Utility Rate Assistance Fund (URAF) Program.

Resolution 2025-154 outlines the financial and programmatic considerations related to the Partial Property Tax Refund (PPTR) Program.

Prior Council or Other Entity Actions

2025 Budget

October 22, 2024: Council approved Resolution 2024-149 adopting the 2025 CCOB Budget; BURA approved Resolution 2024-150-UR adopting the 2025 City and County of Broomfield Budget
March 11, 2025: Council approved Resolution 2025-44 amending the 2025 CCOB Budget; BURA approved Resolution 2025-52-UR amending the 2025 BURA Budget

2026 Budget

August 19, 2025: Staff provided information and insights to inform the Council on Broomfield's economic and financial outlook, influencing the 2025 revised budget and the 2026 operating and capital proposed budgets.
August 21, 2025: Staff provided an overview of how Broomfield intends to fulfill the community goal of financial sustainability and resilience at the Broomfield 101: Economic and Fiscal Update Community Forum.
September 3, 2025: The City Council received the 2026 Proposed Budget and supporting documentation.
September 4, 2025: The 2026 Proposed Budget and supporting documents were made available for public view and comments on the City's website.
September 18 and September 25, 2025: Study Sessions to discuss the 2026 Proposed Operating & Capital Budgets with department representatives.
October 14, 2025: Public Hearing per Chapter 12.7 of the Charter for the 2026 Operating and Capital Budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District.

Enterprise Ordinances

April 15, 2025: Staff held the first 2025 quarterly Enterprise Funds study session and provided an overview to City Council on the status of the enterprise funds.
May 13, 2025: Creation of FLOW Advisory Committee approved by City Council.
July 15, 2025: Staff held the second 2025 quarterly Enterprise Funds study session, providing an update on the enterprise funds and initial recommendations on utility rate adjustments, along with a presentation by subject matter expert consultant AECOM.
October 14, 2025: First reading of ordinance number 2286.
October 21, 2025: Staff will provide an overview to City Council in a Broomfields Enterprise Funds study session and initial results of additional repair and replacement capital added during the 2025 budget.

Bond Ordinances

August 19, 2025: Staff provided information and insights to City Council on Broomfield's high credit rating

and the organization's "superior ability to repay short-term debt obligations," providing guidance to ensure Broomfield's financial stability while requesting new bonds to finance the 2026 capital improvement projects for the new Police Building / Courts Remodel and Water and Sewer infrastructure improvements.
October 14, 2025: First reading of ordinance numbers 2288, 2298, and 2290.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
November 1, 2022: Council Approved the 2023 PPTR Program with Resolution No. 2022-123.
January 23, 2024: Council Approved the Expansion of the PPTR Program in 2024 with Resolution No. 2024-27.
October 22, 2024: Council Approved the URAF Program with Resolution No.2024-165.
October 22, 2024: Council Approved the 2025 Budget with Resolution No. 2024-149.
December 3, 2024: Council Approved the 2025 PPTR Program with Resolution No. 2024-105.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

2025 and 2026 Budget
If Council desires to approve the proposed 2025 budget amendment, the appropriate motion is...
That Resolution 2025-141 be adopted.

If Council desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-142 be adopted.

If BURA desires to approve the proposed 2025 budget amendment, the appropriate motion is…
That Resolution 2025-143-UR be adopted.

If BURA desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-144-UR be adopted.

If ALID desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-145-AID be adopted.

Amending Enterprise Ordinance

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2286 be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to water, sewer, water reclamation, and stormwater charges and fees as set forth in these ordinances would be effective January 1, 2026.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2288 Issuing Enterprise Revenue Bond (Water Tanks) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2289 Issuing Enterprise Revenue Bond (Wastewater Treatment - Phase 1B) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2290 Issuing Certificates of Participation (Police and Courts Buildings) be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to the issuance of new bonds as set for in the ordinances would be effective January 1, 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program

If the Council desires to proceed with the staff recommendations for the continuation of the Utility Rate Assistance Fund Program in 2026, the appropriate motion is…

That Resolution 2025-153 be adopted.

If the Council desires to proceed with the staff recommendations for the continuation of the Partial Property Tax Refund Program in 2026, the appropriate motion is…

That Resolution 2025-154 be adopted.

Alternatives

Budget

Per Charter, the City Council must adopt a budget. If it fails to do so, the budget will be put on future agenda(s) until such time as it is approved. If Council fails to adopt the budget, the amounts appropriated for the operation of the current fiscal year shall be deemed adopted for the next fiscal year on a month-to-month basis, with all items in it prorated accordingly, until such time as the Council adopts the budget for the next fiscal year.

Amending Enterprise Ordinance

If Council does not approve the recommended utility rate ordinance, the existing fee structure would remain in place. CCOB's Enterprise funds' financial sustainability and resiliency would weaken. The ability to obtain favorable financing for necessary projects, including wastewater treatment facility expansion and water tanks, would be put at risk.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If Council does not approve the recommended two enterprise revenue bonds and police building certificate of participation ordinances, CCOB would not defease the existing certificates of participation and would not move forward with the issuance of the bonds. CCOB would not be able to finance the necessary projects, which include the Wastewater Treatment Facility Expansion, Water Tanks, and new Police Building.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
Do not approve staff recommendations. If not approved, provide an alternative direction.

Background - Budget

Broomfield has grown and evolved significantly over the past twenty years from an emerging suburban community into a large, thriving, and maturing urban-suburban community. Since the consolidation of our community in 2001, Broomfield has provided effective and efficient city and county programs and services. Today, Broomfield is home to nearly 80,000 residents, living in more than 34,000 housing units and thousands of businesses. While much of Broomfield's 34 square miles is built out, there is a continued focus on developing and evolving while maintaining long-term financial sustainability and resilience.

Budget Process and Philosophy

The budget is a planning tool that is used to meet the results of the March 3, 2023, Council Focus Session, where the Community Goals were solidified with an emphasis on Goal #1: Financial Sustainability and Resilience. Therefore, the budget process is flexible and responsive to organizational and community needs and economic conditions.

In addition, staff will continue with a comprehensive, clear, and transparent approach by bringing forth a consolidated number of budget amendments for the Council's review and consideration, and for transparency for Broomfield residents. Each budget amendment is designed to address specific topic areas outlined below.

- **Budget Amendment 1** (Q1): reflects the carryover of capital and grant projects from the prior fiscal year and any additions to operational budgets (i.e., increased cost for Spring Cleanup).

- **Budget Amendment 2** (In conjunction with adopting the following fiscal year's budget; Q4): reflects the current state of actual revenues and expenditures, including any supplemental requests, and sets the foundation for the following year's budget.
  This amendment also includes the prior year's audited financials (actual beginning fund balances), which helps inform the ability to fund future year financial shifts.

- **Budget Amendment 3** (Q4): if needed, addresses grants, which often require financial adjustments based on project or program status of implementation and execution due to the timing of the grant award.

Current and future budgeting processes are designed to ensure operational and capital success, focusing on creating a culture of accountability and intentionality while basing the budget on revenue and expenses. This helps to drive forward a sustainable, disciplined structure of reallocating funds and not continuing to increase expenditures arbitrarily.

Proposed Budgets

2025 Revised Budget Summary

On October 22, 2024, City Council passed Resolution 2024-149 to adopt the 2025 budget for the City and Council of Broomfield. Additionally, the Broomfield Urban Renewal Authority approved resolution 2024-150-UR to adopt the 2025 budget for BURA. Since the adoption, the budgets have been amended one (1) time to reflect capital project rollovers, grant rollovers, and additional capital and operational budget adjustments. As can be seen in the table below, adjustments to the City and County of Broomfield budget in amendment #1 is listed as well as the proposed adjustments in amendment #2.

CITY AND COUNTY OF BROOMFIELD
REVISED BUDGET SUMMARY - ALL FUNDS*

Fund	Original Budget 2025	Budget Amendments #1 2025	Budget Amendment #2 2025	Amended Budget 2025
Beginning Fund Balance	**$ 304,842,581**			**$ 408,834,091**
Revenues				
General Governmental Funds	$ 201,022,977	$ 14,388,112	$ 13,956,978	$ 229,368,067
Governmental Capital Funds	89,039,461	18,228,553	9,687,422	117,955,436
Enterprise Funds	83,761,446	(1,479,300)	(4,564,126)	77,718,020
Fiduciary Funds	223,100,356	-	-	223,100,356
Total Revenues	**$ 596,924,240**	**$ 31,137,365**	**$ 19,080,274**	**$ 648,141,879**
Expenditures				
General Governmental Funds	$ 216,385,986	$ 13,140,495	$ 5,475,993	$ 235,002,474
Governmental Capital Funds	103,310,912	73,107,734	4,355,292	181,773,938
Enterprise Funds	99,516,325	47,506,010	(2,731,036)	144,291,298
Fiduciary Funds	214,122,885	-	-	214,122,885
Total Expenditures	**$ 633,336,108**	**$ 133,754,239**	**$ 7,100,248**	**$ 775,190,595**
Ending Fund Balance	**$ 268,430,713**			**$ 281,785,375**

** Excludes transfers to reserves and interfund transfers*

2025 Operating and Capital Fund Revised Budget

Budget adjustments are made in order to respond to the changing demands of our operations in addition to the continued economic fluctuations occurring at the local, state, and national levels. In 2025, the City and County of Broomfield eliminated what had traditionally been the second amendment of the year. The Finance Department worked directly with departments to discuss needs and work strategically to accommodate needs by reallocating current budgets while continuing to monitor throughout the year to determine if budget adjustments were actually needed. Based on this collaborative effort, staff have been able to reduce the overall workload within the organization and minimize the number of times the budget needs to be reviewed, adjusted and considered by City Council.

The proposed operating fund budget adjustments include both personnel and non-personnel adjustments for programs and initiatives. While capital fund adjustments are the result of revising capital projects due to aspects such as timing or changes in project priorities since the adoption of the 2025 5-Year CIP Plan. The table below includes highlights of operational revisions to the 2025 budget.

2025 Revised Budget Highlights*		
Department or Category	**Description**	**Amount**
City & County Attorney	2025 Increase for Insurance Premiums	$ 70,000
Courts	Above Mid-Point Pay Request: Lead Court Clerk Hire	4,142
Human Resources	New Full-Time FT: HR Project Manager	71,498
Police	Increase to Axon Agreement	234,625

Police	Increase to Inmate Food Services Contract	172,050
Police	Increase to Psychological Support Contract	50,000
Police	Dual Sim Card Monthly Fees with First Net	36,500
Police	Inmate Medicine Expenses	38,252
Police	Outside Fund Award Funded Motorola Service Agreement for Back Up Dispatch Center Equipment	12,775
Police	Brower Resilience Visits	2,500
	Total	**$ 692,342**
*Personnel Highlights are pro-rated for partial year		

The 2025 revised operating budget includes a number of cost increases associated with existing contractual obligations. The 2025 budget process was completed in the middle of 2024, prior to a number of contractual amendments being executed, so adjustments are made during the 2nd amendment to appropriate the additional funds needed to meet these obligations.

In addition to the Budget Highlights noted above, the 2025 revised operating budget also includes a number of non-personnel budget reductions as part of the organization's efforts to optimize budgets. Travel and training budgets were reduced by $859,813 and other identified non-personnel budgets were reduced by $1,041,450. This effort was collaborative across the entire organization, with a focus on maintaining services to residents.

In total, staffing levels and service demands resulted in the addition of 4.13 FTE in 2025, as detailed in the Expenditures: 2025 Personnel Changes table.

Expenditures: 2025 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
City & County Manager	1.00	303,987	Economist (1.0FT), Administrative Analyst (1.0FT), Case Manager II - Housing (-1.0FT)
Community Development	-1.00	(133,296)	Senior Transportation Planner (-1.0FT)
Economic Vitality & Development	-2.00	(254,758)	Economist (-1.0FT), Administrative Analyst (-1.0FT), Administrative Support I/II LTA (2.0FT), Administrative Support I/II LTA (-2.0FT)
Human Resources	1.00	65,533	HR Project Manager (1.0FT)
Human Services	2.80	172,795	Case Managers II LTA (2.0FT), Case Manager II LTA (-2.0FT), Case Manager II (1.0FT) Workforce Specialist II LTA (0.8PT), Human Services Management Analyst (-0.8), Non-Profit & Community Engagement Manager (1.0), Human Services Grants Specialist (0.8)
Library, Arts & History, and CSU Extension	0.33	(1,718)	Creative Technologist (-0.8PT), Patron Services Associate (1.0FT), Creative Technologies (-0.6PT), Patron Services Associate (0.73PT)
Public Health & Environment	0.00	(2,845)	Human Services Management Analyst (-0.2), Human Services Grants Specialist (0.2)
Total	**4.13**	**$ 149,698**	
*Includes internal transfers. Costs prorated for partial year. Public Works to Public Works / Water Utilities reorganization is not included.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and estimated taxes and benefits			

2025 Broomfield Urban Renewal Authority Revised Budget

This is the second amendment to the 2025 BURA budget. This amendment reflects updated revenues and expenditures projected through the end of the year based on year-to-date information. The BURA Budget Tables summarize the 2025 proposed revisions to the budget.

2025 BURA Revenues - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 70,511,588	$ 605,615	$ 71,117,203
Debt Service	5,056,106	(607,935)	4,448,171

2025 BURA Expenditures - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 54,215,747	$ 2,902,954	$ 57,118,701
Debt Service	4,459,171	-	4,459,171

2026 Proposed Budget Summary

Planning for Increased Financial Stability

The City and County are guided by conservative revenue projections, reasonable cost assumptions (expenses), deploying strategic development decisions, effectively managing staffing patterns, and using

data-driven decision-making models to keep operational costs in check.

Transitioning into 2026, Broomfield's economic and financial position is fundamentally sound, but we remain in an ever-increasing volatile environment. This reality reinforces the need for prudent financial flexibility, conservative planning assumptions, and disciplined decision-making to ensure long-term sustainability.

Broomfield's two largest primary revenue sources are property tax and sales/use tax, with sales tax showing minimal growth in 2025 (measured at the halfway point through the year, sales tax is projected to end 1-2% higher than 2024). The minimal sales tax growth is expected to continue to build in 2026, a trend anticipated to continue into 2027. Additional retail and commercial investments in the pipeline begin to come online in 2027 (e.g., Macerich's HiFi area at FlatIron and the initial phase of McWhinney's Center Street area). Conversely, the property tax revenue is expected to fall in 2026 and remain stable in 2027. The property tax revenue reduction is occurring due to State changes in the property assessment rates and the decline in property market values.

Due to decreased property assessment rates, property owners will see lower tax bills, which correlates to the decreased county property tax revenue by approximately $6.5-7.5 million annually. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

The 2026 proposed budget reflects the organization's continued focus on balancing current needs and obligations while preparing to meet the organization's and community's future needs by prioritizing expenditures into Mandates, Obligations, and Critical needs. Broomfield's economic fundamentals continue to provide sustained economic and employment opportunities while ensuring a sound fiscal base for CCOB budgets.

Guiding Principle: Residential Growth and Service Capacity

Broomfield currently has the revenue to sustain current service levels, but each new residential development adds demand and costs to systems already operating near capacity. Sales tax revenue growth—expected as new commercial development comes online in 2027—will help, but will not fully offset rising expenditures. Property taxes remain outside local control and subject to state formulas and market values; those factors created a $6.6M - $7.5 decrease in general fund revenue, which is not anticipated to return.

Balancing Housing Needs with Community Capacity

While the Front Range continues to face an affordable housing shortage that calls for regional solutions, Broomfield must thoughtfully balance this need with our community's existing capacity. Demand for services is strong — recreation programs often fill quickly, fields are well used, the Library serves at or near capacity, and our core utilities, such as the wastewater treatment facility, are preparing for future growth. Broomfield has also made prior commitments to additional residential development through business development agreements. Looking ahead, future decisions will shape how we continue to provide high-quality services, invest in infrastructure, and remain fiscally responsible, while also contributing to broader housing solutions across the region.

Disciplined Development and Long-Term Financial Sustainability

Broomfield continues to take a thoughtful, yet disciplined, approach to development as the foundation for achieving long-term financial strength and sustainability. Our strategy emphasizes balanced growth and a diversified economy—ensuring that both residential and commercial development occur in alignment with community needs and fiscal realities.

Maintaining and strengthening the ratio of residential to commercial development is paramount as we move into the future. A healthy balance not only supports a diversified tax base and resilient economy but also ensures that service demands and infrastructure investments are financially sustainable over time.

By adhering to this disciplined approach, Broomfield positions itself to manage near-term fiscal challenges

while preserving the flexibility to invest in community priorities and future opportunities.

Broomfield recognizes that a strong community is made up of thriving neighborhoods and residential areas, combined with commercial areas and developments home to businesses in key sectors, such as finance, information technology, aerospace, and business/professional services. Broomfield is also successful in attracting and growing businesses in next-generation economic sectors, such as quantum computing, phonetics, and advanced manufacturing. Recent firms choosing and growing in Broomfield include Sierra Space, SiNaptic, Quantinuum, and Raven Space Systems.

Development and increasing redevelopment in the community continue to build on this economic and financial foundation. These developments provide sought-after locations for businesses to locate and grow, places for residents and visitors to shop, dine, and gather, and places where existing and new residents will call home. Current construction is underway around FlatIrons Crossing (the HiFi area: both the Novel FlatIron residential and new commercial space), MidPoint's flex/innovation space (255 Midway), the Simms Technology Park, and Harvest Hill apartments. Horizontal construction will soon start in Baseline's mixed-use Center Street development. Combined, these current developments total nearly 500 new residential units (over 200 income-aligned), about 500,000 square feet of new work space, and over 100,000 square feet of (already leased) shopping and dining space.

The 2026 proposed spending plan recognizes that our community looks to its local government as innovators and leaders. It supports this influential work by refocusing and committing to the identified Community Goals, with the fundamental goal of Fiscal Sustainability remaining paramount to a healthy and robust future.

Emphasis on Prioritizing Needs

As Broomfield continues to maintain economic and fiscal stability, our strategic approach includes a prudent and pragmatic fiscal approach to anticipate and withstand future economic or financial disruptions in the short and long term.

The proposed 2026 budget prioritizes expenditures in the following categories:

- **Mandates**: Regulatory requirements issued by the federal or state level that result in the need for funding.
- **Obligations**: Contractual requirement or agreement.
- **Critical Need**: This is essential to the organization's effective operations. Failure to fund it would threaten public health, the environment, or community safety, or create a more significant liability or risk to the organization.

Any funding request not categorized by a mandate, obligation, or critical need but necessary to provide ongoing programs and services would be defined as an 'other' this year. In 2026, only projects classified as 'other' that were moved forward were partially funded by grants.

The 2026 Recommended Budget reflects a collaborative effort across all departments. New services and their associated costs will be strategically timed for review only when budget flexibility improves – something not anticipated in 2026, and possibly not until the second half of 2027.

All departments determined needs based on the following high-level categories and corresponding thought-provoking questions, serving as the foundational lens through which all budgeting and resource allocation requests were reviewed:

- **Safety**: Eliminating or reducing a hazard/threat
- **Operational Cost vs. Revenue**: Is there a revenue offset that will help reduce costs?
- **Asset Maintenance**: Ability to extend the life cycle of a current asset
- **Comprehensive Plan**: Approach and alignment with existing roadmap

- **Operational Support**: Will the request create additional demand on existing resources or require new support?
- **Alternatives**: Does the alternative require greater resources, financially or otherwise?
- **Cost Sharing Opportunities**: Ability to leverage outside funding awards
- **Urgency**: Is there an immediate need that the request will satisfy?
- **Public Benefit & Quality of Life Impact**: Ability to benefit across various sectors
- **Socio-Economic Equity**: Determining the applicability within Broomfield's vulnerable populations or underrepresented
- **Sustainability**: Ability to address/correct the construct that will benefit the environment

For the fifth consecutive year, staff recommends maintaining Public Safety, Public Works, and Water Utilities as a top priority while continuing to adapt to growth, addressing deferred maintenance while moving forward with an asset management approach, and shifting to new and long-term fiscal realities.

Public Safety

This commitment is demonstrated by keeping the Broomfield Police Department organizationally separate from general employee groups. This approach has enabled the City and County of Broomfield to strengthen its police force effectively, resulting in a substantial increase in essential personnel to better serve the community. The Full-Time Equivalents (FTEs) grew from 242 in 2021 to 277 in 2025, a 14% increase. Concurrently, the police budget expanded from $34 million in 2021 to $44 million in 2025, marking a 27% increase. This investment is directly linked to Broomfield maintaining the lowest crime rate per capita in the metro area.

District Attorney – 17th Judicial District

The proposed budget for Broomfield's population share of the District Attorney's office is based on preliminary calculations received from Adams County in August 2025. On August 12, 2025, the District Attorney submitted his budget documents to Broomfield staff. Following that submission, Broomfield requested a meeting with the Adams County Board of Commissioners and leadership to discuss the request.

This meeting, held in mid-September, included the Mayor, Mayor Pro Tem, City Manager, and City Attorney. The discussion focused on the scope of services included in the DA's request, as well as the Family Justice Center, which is addressed in greater detail below.

Adams County is also in the process of finalizing its budget. On October 1, 2025, the District Attorney presented his budget request to the Adams County Board of Commissioners; however, the Board has not yet approved the request. Broomfield staff attended the presentation and will continue to monitor developments to ensure Broomfield's final budget reflects only its proportional share of approved expenses.

Broomfield's proposed budgeted amount for the DA reflects a budgeted amount that does not include costs for the proposed Family Justice Center (FJC). Per statute, Broomfield is only responsible for its per-population share for "the necessary expenses of maintaining an office for the transaction of official business" of the District Attorney.

While the intent of the FJC is admirable, the District Attorney has indicated that 75% of individuals to be served will be non-judicial clients. This represents not an expansion of existing prosecutorial services, but rather the creation of an entirely new entity, infrastructure, and team, as shown by 9 FTE in his budget request to Adams and Broomfield counties. While there is a connection with the domestic violence case work completed by the DA's office, this is a separate endeavor that warrants further scrutiny and should be subject to discussions about the creation of a regional and distinct intergovernmental entity before Broomfield commits taxpayer resources.

In addition, the revised proposed budgeted amount for the District Attorney does not include the cost of one FTE (an attorney) that Broomfield has solely funded since 2021 to reduce backlog following COVID. This was

a separate agreement with the DA, and three years later, after that backlog has been addressed, that cost should not be part of the base budget.

Public Works and Water Utilities

Our focus on infrastructure over the past several years has led to significant growth in resources dedicated to roads, streets, maintenance, and water. Full-time equivalents (FTEs) increased from 158 in 2021 to 220 in 2025 – a 39% rise (note: this includes 14 FTEs transferred to Public Works/Water Utilities from Community Development and Strategic Initiatives related to Construction Inspections and Energy and Sustainability, respectively). Investments in Public Works and Water Utilities have enabled staff to optimize infrastructure, boost productivity, and better manage assets. This directly impacts overall operations and effectiveness.

Broomfield has made major strides in core infrastructure and utility maintenance over the past five years. The Street Pavement Management Program expanded significantly, with more miles treated and a dramatic increase in crack sealing. Water Utilities strengthened operations with annual waterline replacements, full fire hydrant flushing and maintenance, and near-complete valve maintenance. The Sewer Collections Program has advanced to completing annual program system cleaning and inspection on a regular cycle. Meanwhile, the Stormwater Maintenance Program, established in 2021, now conducts annual program system cleaning and inspections each year. These operational improvements are supported by a five-year financial sustainability plan that ensures the long-term health of infrastructure, high-quality service delivery, and protection of public health and the environment.

Given the challenges and uncertainty in the economy and marketplace, the 2026 Proposed Budget relies on conservative fiscal policies and projections supporting balanced annual spending. The 2026 Proposed Budget was built using a combination of Council direction with existing planning documents, including, but not limited to, the Comprehensive Plan, the Long Range Financial Plan, and financial/economic modeling, to synthesize the work over the past several years of taking a comprehensive methodological approach to Broomfield's future.

2026 Areas of Focus & Key Highlights

- Broomfield has not acquired any additional general obligation (GO) debt since 2017. Broomfield will be defeasing prior debt and remains committed to maintaining and increasing our existing Aa2 bond rating, which means the organization has a "superior ability to repay short-term debt obligations." The rating is one of the highest within the state of Colorado. This high rating is essential. Having debt of 5% of revenues is considered appropriately leveraged and reflects the government's ability to repay debt.
- Broomfield will continue to leverage grant funding as part of efforts to diversify revenue sources. In 2025, overall, less grant revenue was available on the Federal and State levels. As of August 2025, CCOB has received 91 grants, representing an increase from 69 grants in 2024. This total reflects both new grant applications and recurring awards that continue from year to year. In 2025 alone, more than 35 new grant applications have been submitted, with 28 awarded to date. These awards total approximately $5.6 million, compared to $4 million last year. We will continue to seek grants in 2026 to pursue funding from private, local, and state sources. New grant funding to be explored in 2026 includes: Courts' First Defense Counsel Appearance, incentives for Norm Smith UST removal reimbursement, the Recycling Rebate Program, and Special Supplemental Nutritional Funds for Women, Infants, and Children (WIC).
- Police Facility construction is anticipated to begin in early 2026.
- Courts Remodel design to begin in 2026.
- Maintain the achieved goal of 20% reserves into 2026 and future years.
- Continue to explore opportunities for development of the former Event Center site: This development is expected to be a revenue generator for the community.
- Implementation of the selected City and County Enterprise Resource Planning (ERP) Software that will modernize our existing 30+ year manual/spreadsheet system to begin early 2026.
- Update the 2016 Comprehensive Plan in 2026, providing the Council, community, and our

organization an opportunity to play a critical role in shaping the vision for the next decade and beyond.
- Implementing the first organizational strategic plan to guide the 2026 work plan.
- Issuance of three bonds: Quarter one 2026, Certificate of Participation for the PD/Courts, and two in the Enterprise Funds for the Water Tanks & Wastewater Expansion - Phase IB.

This list alone requires us to be especially prudent in the upcoming year and beyond. We are operating in a constrained environment – both financially and with staffing capacity – and must therefore be intentional and strategic in every decision we make. The 2026 and 2027 budgets will require a reallocation methodology, not a reprioritization model – meaning that to add anything, other programs must be reduced or removed to accommodate new or enhanced funding. As we gain clearer insights into programmatic outcomes, we must be willing to have courageous conversations about whether programs and services are being fully maximized, widely utilized, effectively measured, and delivering the intended outcomes. If they are not, we must work together to thoughtfully realign our efforts and resources toward initiatives that deliver the greatest benefit to our community.

2026 Budget Highlights

Revenue Projections

Broomfield's two largest primary revenue sources are property tax and sales/use tax, accounting for 60% of Broomfield's revenue base. Sales tax is showing minimal growth for 2026. The minimal growth in sales tax is a trend anticipated to continue into 2027, while retail and commercial investments in the pipeline begin to come online in late 2027 (ie, Macerich development).

Conversely, the property tax rates are not expected to move in any direction but downward. Due to decreased property assessment rates, property owners will see lower tax bills. This reduction will decrease county property tax revenues by approximately $6.5-7.5 million annually – $3-4 million from residential properties and $3.5 million from commercial properties. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

Across all revenue streams[1], 2026 projected revenues are expected to increase by 5.2% from $332 million to $349 million compared to the 2025 revised budget per Table 1C of the proposed budget. This increase is primarily driven by anticipated revenues from Fiber contracts, building permits and use tax revenues.

The 2026 proposed budget was built with the projected increases in Utility Rates for water, sewer, reclaimed water, and stormwater.

Expenditure Projections

Broomfield continues to monitor the ongoing uncertainties surrounding the economic environment and is prepared to react as needed. The budget process is an example of staff working collaboratively to mitigate the impacts of these uncertainties.

Operational expenditures are expected to increase by 5.8% from the 2025 original budget to the 2026 proposed budget.

Total expenditures (Table 3B), which include the operating, capital, additions to reserves, and debt service obligations across all funds, is an estimated $897 million, excluding inter-fund transfers. This represents an increase of 41% in expenditures from the 2025 original budget to the 2026 proposed budget. This increase is primarily driven by large capital projects, such as the new Police building, Court building remodel, and the Water and Sewer projects.

Personnel

Over the last four years, Broomfield has implemented a market-driven, competitive compensation philosophy to lead the market. This was based on the legal requirements to comply with new federal equal pay mandates and aligned with the City Council's direction on employee compensation. In year five, Broomfield is working to maintain the progress while navigating economic uncertainties. Human Resources completes market evaluations every other year to ensure positions within CCOB are paid competitively against the Denver Metro market. This data is used to project salaries and personnel costs for the proposed budget. In 2026, Human Resources will not be conducting market evaluations.

Ongoing personnel costs and adding new positions to meet the community's needs are the primary drivers of the 5.8% operational budget increase referenced in the expenditures section.

Below is a list of the Personnel Changes implemented as part of the 2026 operating budget.

1Excludes Fiduciary Funds and Budgeted Bond Revenues

Expenditures: 2026 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
Human Services	0.10	13,463	Business Solutions & System Administrator (0.1FT)
Information Technology	-1.00	-	Accessibility Specialist LTA Expiration (-1.0FT)
Parks, Recreation, & Senior Services***	2.25	219,958	Lead Parks Tech (1.0FT), Parks Tech II PT to FT (0.25FT), Preschool Director (1.0FT)
Public Health & Environment	0.40	18,982	Business Solutions & System Administrator (-0.1FT), Administrative Support II PT to FT LTA (0.5FT)
Water Utilities	3.00	334,561	Cross Connection Foreman (1.0FT), Senior Water Utilities Locator (1.0FT), Senior Sewer Utilities Locator (1.0FT)
Total	**4.75**	**$ 586,964**	
*Includes internal transfers.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and est. taxes and benefits; does not include any non-personnel budgets associated with new FTE			
***Department has self-funded these positions with budget realignments - reducing temp and non-personnel budgets			

Non-Personnel

Non-personnel-related expenses include the supplies, equipment, and contractual service costs necessary to provide the programs and services in Broomfield. Some examples include:

- Fuel
- Vehicle Maintenance Supplies (i.e. air & oil filters, tires, etc)
- Electronic Equipment (i.e. telephones, computers, headsets, etc)
- Training and Development of staff
- Professional Services (i.e. outside auditors, specialized legal services)
- Insurance expenses
- Utilities
- Software (Annual License Fees, such as Google)

As part of the annual budget process, the budget staff meets with departments to discuss non-personnel requests and the drivers of individual items. Items like fuel are a basic necessity for the organization to accomplish its work and are subject to market conditions; thus, Broomfield has very little control over this type of expenditure. For other non-personnel items, the organization manages costs by finding alternatives or adjusting work procedures to eliminate or minimize expenses wherever possible.

Operating Budget Highlights

Below is a list of some highlights of the 2026 operating budget.

2026 Operating Budget Highlights		
Department or Category	**Description**	**Amount**
Assessor	One (1) 5-Month Overlap (Assessment Supervisor)	$ 66,708
City and County Clerk	Two (2) 2-Month Overlap (Recording & Motor Vehicle Specialist, Recording & Licensing Specialist)	25,141
City & County Manager	Hazardous Mitigation Plan Update - FEMA Mandate	65,000
Community Development	Two (2) Reclassifications (Senior Landscape Architect to Landscape Manager, Combination Inspector to Landscape Associate/Tech)	54,272
Parks, Recreation, & Senior Services	One (1) FT (Lead Parks Technician)*	-
Parks, Recreation, & Senior Services	One (1) PT to FT (Parks Technician II)*	-
Parks, Recreation, & Senior Services	One (1) TM to FT (Preschool Director)*	21,401
Police	One (1) FT Continuation (Victim Advocate) if Grant is discontinued	112,712
Police	Three (3) Reclassifications (Records Specialist to Records Supervisor, Budget Analyst to Budget Supervisor/Manager, Office Manager to Senior Operations Manager)	73,871
Public Health & Environment	Personnel Costs Transitions	(8,555)
Public Health & Environment	One (1) PT to FT LTA (Admin Support II)	33,899
Public Health & Environment	One (1) Reclassification (Environmental Health Specialist I to Environmental Health Specialist II)	5,953
Water Utilities	Three (3) New FT (Cross Connection Foreman, Senior Water Utility Locator, Senior Sewer Utility Locator)	381,107
Water Utilities	SCADA Environment Security Scanning Software (w/IT)	69,571
	Total	**$ 901,081**
*Department's non-personnel budget will be reduced for the personnel changes		

2026 Capital Improvement Plan Considerations

Using a conservative approach and understanding the constraints of Broomfield's finances, staff will continue to evaluate and prioritize projects based on mission essentials and those that affect the health and safety of the community. To proactively prevent unintended consequences with any changes in the funding of CIP, staff will continue to seek guidance from Council.

The 2026 Five Year Capital Improvement Project (CIP) Plan was developed in a parallel process at the same time as Broomfield's operating budgets. This process included an extensive year-long collaboration across all departments to ensure that all projects and community requests were considered. CIP requests are rated and prioritized using the same "buckets" described earlier in the document. Ensuring that our limited resources are focused on mandates, obligations, and critical infrastructure projects reinforces our financial sustainability and resilience goal. Finally, staff has worked to shift the focus of funding from new capital projects towards preventative maintenance, repair, and rehabilitation to ensure that Broomfield is focusing efforts on adequately addressing its existing infrastructure.

The 2026 budget for Capital Projects includes

- $142.9 million in expenditures for the General Governmental Funds
  - $100 million for the Police Building and Courts remodeling projects
- $217.2 million in expenditures for the Enterprise (Utility) Funds.
  - $70 million for the two new Water Tanks project
  - $114 million for Wastewater Treatment Facility Expansion Project

2026 Broomfield Urban Renewal Authority Budget

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2026 BURA revenues are budgeted at $65.1 million, representing a 7.7% decrease compared to the 2025 original BURA budget. BURA expenditures in 2026 are budgeted at $50.0 million. BURA also pays the City and County of Broomfield to cover administration costs and professional services related to the development of urban renewal areas. The 2026 budget includes $5.5 million for administrative and professional services expenditures.

2026 Arista Local Improvement District Budget

The Arista Local Improvement District (ALID) was established to facilitate the construction of transportation facilities in the Arista Development. The ALID is supported by a 0.2% sales tax collected on all taxable sales within its boundaries, and the revenue generated by the tax has been pledged to support the Arista Metro District's (AMD) debt service on bonds sold to construct the parking structure.

The only allowable use of the revenue is to support the funding of public transportation services or improvements, the 2026 budget for the ALID exists solely to authorize payments to AMD, as noted. The 2026 proposed ALID budget includes $45,000 in sales tax revenue and $45,000 in expenditures related to the AMD debt service for the construction of the parking structure.

Background - Enterprise/Utility Fee

Utilities are funded by four enterprise funds that are specifically dedicated to the Water, Wastewater, Reclaimed, and Stormwater/Flood Management utilities. Each enterprise operates as a self-supporting entity. Revenues generated from monthly utility bills are the largest source of revenue for each utility, accounting for generally between 85% to 90% of revenues in each fund. Other significant sources of funds include development fees and funding from the Mile High Flood District (MHFD). These cumulative funding sources cover day-to-day operations, capital and rehabilitation projects, and annual programs. A robust enterprise fund presents a significant strategic advantage, empowering the city to issue revenue bonds.

This mechanism is crucial for financing substantial capital projects, much like the extensive bonded projects anticipated in 2026. The ability to leverage revenue bonds ensures that vital infrastructure and development initiatives can proceed.

As previously noted, to prepare for critical utility infrastructure needs, Broomfield adjusted water and sewer rates last year. This was, in part, to support two upcoming enterprise bond issues – one to fund two new water storage tanks and another to expand our wastewater treatment facility. Staff has contracted with bond underwriting firms, Stifle & Piper Sandler, who have extensive Colorado market experience in issuing Enterprise Fund bonds. CCOB is still targeting issuance in quarter one 2026.

Staff has provided additional detailed information on how water and sewer rates are directly influenced by the process of repairing and replacing aging infrastructure, known as asset renewal. Here is the linked

document - Water Utilities System Asset Renewal - Key Aspects of Establishing Rates.

In addition to preparing Broomfield to support the two upcoming enterprise bond issues, the rate increase implemented in 2025 was able to be immediately utilized to implement the water meter replacement program and improve maintenance of existing assets, including the following notable improvements:

Potable Water Improvements

- Flushing 483 miles: 100% (vs. 19% in 2022).
- Hydrants 4,478: 100% maintained (vs. 47% in 2021).
- Backflow devices 2,737: 97.17% compliance (exceeds CDPHE 90%).

Sewer and Stormwater Improvements

- Sewer video inspections: Currently at 90%; 100% by year-end (vs. 20% in 2023).
- Sewer cleaning: Currently at 98%; 2-year full-cycle program (vs. 40% in 2022).
- Storm video inspections: Currently at 87%; 100% by year-end (vs. 9.6% in 2021). Cleaning: 100% of 2025 target (vs. 0% in 2021).
- Street sweeping: 3,381 miles swept in 2025 (+95% vs. 2023).

2026 Proposed Recommendations: Water, Sewer, Reclaimed, and Stormwater Rates

As detailed in the budget adopted by the Council in 2025, the five-year plan includes a year two increase totaling $16.89 per month for the average single-family home starting in 2026. This represents a 15% increase for utility rates across all funds, with a 9% ($1.00) increase for stormwater service fees, and aligns with projections presented in the original five-year plan presented in 2024 (also see October 22, 2024, memorandum). Similarly, the non-residential water, sewer, and reclaimed rates will increase by 15% and stormwater service fees will increase by 9%. License fees for water, sewer, and reclaimed water for new development will increase by 4%.

Staff has completed a comprehensive fiscal analysis to evaluate anticipated revenues from utility rates as well as projected expenses based on necessary costs associated with day-to-day operations, capital and rehabilitation projects, and annual maintenance requirements. The fiscal analysis includes multiple interdependent variables, and adjusting any one component impacts several other variables within the model, requiring a holistic re-evaluation of all dependencies within the five-year comprehensive plan.

This increase is essential to ensure the long-term financial sustainability of our enterprise funds while maintaining essential services and infrastructure. The recommended rate structure ensures sufficient funding for both ongoing maintenance of existing water infrastructure and necessary capital improvements. The proposed increase allows the utility to maintain a proactive maintenance schedule consistent with capital improvement planning recommendations, protecting the community's investment in water infrastructure while avoiding more costly emergency repairs. Deferring maintenance on water system components creates significant financial risk, as delayed repairs typically result in substantially higher replacement costs and potential service disruptions that impact the entire community.

It is important to understand why this rate increase cannot easily be reduced to a lesser amount. Each percentage point reduction in the proposed rate change would result in approximately $500,000 less annual revenue to the enterprise fund. Such reductions would necessitate corresponding cuts to maintenance programs, capital projects, or service levels to maintain a balanced budget.

Given the essential nature of water services and the potential for deferred maintenance to compound costs over time, the proposed increase represents the minimum funding level necessary to ensure reliable, long-term service delivery to our community.

In 2025, the increase for the water utility bill was only on the base fees, and there was no increase for the water usage rates. As discussed and presented last year, in 2026, the proposal also includes an increase to the water usage rate, and therefore, the monthly difference in the water bill will be dependent on how much water the residence typically utilizes.

The projected impact on an average monthly bill for a single-family home and a multi-family home are shown in the tables below.

The example provided below uses an average single-family home bill of 9,000 gallons for water and 6,000 gallons for sewer. The 9,000 gallons/month for water is based on a 4-year historical average of 107,000 gallons per year for a typical single-family home. Staff will be providing a Utility Bill Estimator tool and linking it on our website to help residents calculate how the proposed increase would apply to their home utility bill based on their specific household water usage.

Impact on Average Monthly Bill for a Single Family Home (9,000 gal)

	Rates		Average Bill		
Fee Type	2025	2026	2025	2026	Difference
Water Meter Base Charge	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Tier 1 (0-5k gal)	*$2.39*	*$2.75*	*$11.95*	*$13.75*	*$1.80*
Water Usage Tier 2 (6-9k gal)	*$3.82*	*$4.39*	*$15.28*	*$17.56*	*$2.28*
Water Usage Tier 3 (> 9k gal)	*$5.41*	*$6.22*	*$0.00*	*$0.00*	*$0.00*
Sewer Service Charge	$5.44	$6.26	$32.64	$37.56	$4.92
Sewer Fed Mandate Charge	$0.52	$0.52	$3.12	$3.12	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$11.00	$12.00	$11.00	$12.00	$1.00
Total Bill			**$119.90**	**$136.79**	**$16.89**

Projected 4-Year Outlook for Single-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$119.90	$136.79	$146.37	$156.61
Percentage Change		*14%*	*7%*	*7%*

Impact on Average Monthly Bill for a Multi-Family Home (3,000 gal)

	Rates		Average Bill		Difference
Fee Type	2025 Rate	2026 Rate	2025	2026	Difference
Water Base Fee	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Charge	*$2.55*	*$2.93*	*$7.65*	*$8.79*	*$1.14*
Sewer Service Charge	$5.44	$6.26	$21.76	$25.04	$3.28
Sewer Fed Mandate Charge	$0.52	$0.52	$2.08	$2.08	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$6.60	$7.20	$6.60	$7.20	$0.60
Total Bill			**$84.00**	**$95.91**	**$11.91**

Projected 4-Year Outlook for Multi-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$84.00	$95.91	$102.62	$109.81
Percentage Change		*14%*	*7%*	*7%*

The tables below show the proposed non-residential water base and usage rate changes as well as the proposed license fee changes.

Impact on Non-residential Rates

Fee Type	2025	2026	Difference	%
Water Usage Charge	$3.22	$3.70	$0.48	15%
Water Base Charge - 3/4"	$36.91	$42.45	$5.54	15%
Water Base Charge - 1.0"	$61.50	$70.73	$9.23	15%
Water Base Charge - 1.5"	$123.00	$141.46	$18.46	15%
Water Base Charge - 2.0"	$196.79	$226.33	$29.54	15%
Water Base Charge - 3.0"	$369.00	$424.39	$55.39	15%
Water Base Charge - 4.0"	$615.02	$707.33	$92.31	15%
Water Base Charge - 6.0"	$1,230.02	$1,414.64	$184.62	15%
Water Base Charge - 8.0"	$1,968.04	$2,263.43	$295.39	15%
Water Base Charge - 10.0"	$2,829.07	$3,253.70	$424.63	15%

License fees are the fees that are paid by developers and builders for new connections to the water and sanitary sewer systems. The purpose of license fees is to provide funds to pay for the capital costs of expanding the water utility to serve new growth.

Impact on License Fees

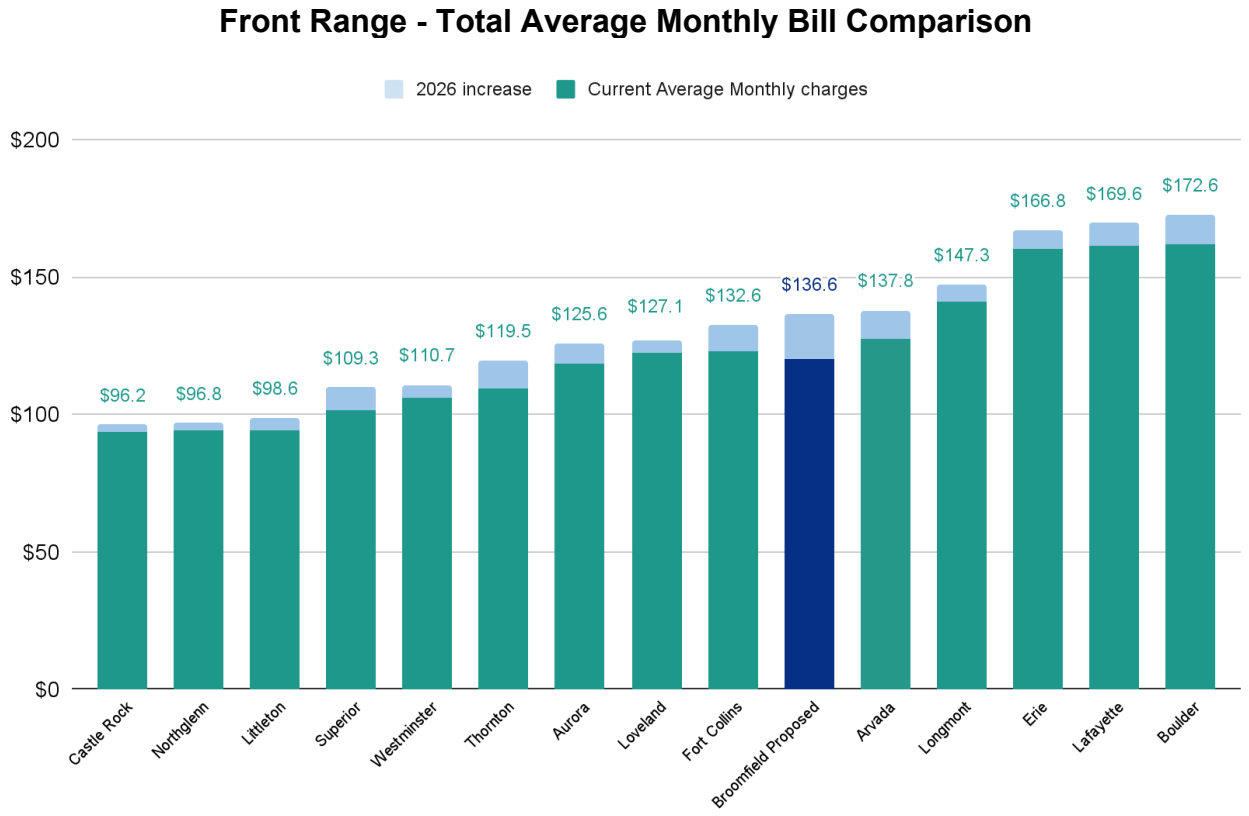
Fee Type	2025	2026	Difference	%
Water License	$37,850	$39,350	$1,500	4%
Sewer License	$14,900	$15,500	$600	4%
Reclaimed License	$13,780	$14,350	$570	4%

Front Range - Average Monthly Bill Comparison

The graph below shows Broomfield's total average monthly utility bill for water, sewer, and stormwater

compared to our neighboring municipalities. The comparison reflects where Broomfield is currently and how it would compare if the Council approves the proposed utility rates. The average monthly bill is normalized across all municipalities based on 9,000 gallons of water usage and 6,000 gallons of Average Winter Consumption (AWC) for sewer charges.

The 2026 rate increases shown in the graph below are not finalized, as the communities are going through a similar budget process as Broomfield, but staff have added the projected/proposed increases for municipalities where a projected increase is available, as shown in the light blue.



The degree to which neighboring municipalities increase their utility rates depends highly on how well they have managed their Enterprise Funds over the past decade, the growth versus expense challenges the municipality faces, and other factors unique to each entity.

Communication Plan:

Staff will be providing information for the community to learn about the proposed fee increase and how it could impact them directly. Updates have been included on the Broomfield.org website, including the proposed rates, estimated impacts for single-family homes and specific types of multifamily residential developments such as apartments, townhomes, and condominiums, and a Utility Bill Estimator tool for residents' use. Staff will also include information on the City and County of Broomfield's communications channels and work with Our Broomfield magazine, which was indicated in the Community Survey as a common place where residents seek to learn about Broomfield information, to share information about the rate change.

Additional information will be shared in late 2025 before the new rates take effect.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program in 2026

The City and County of Broomfield (CCOB) is committed to supporting residents facing financial challenges, particularly with utility costs and property taxes. To this end, two key programs were established: the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) Program.

The PPTR Program, launched in February 2023, was created in response to the increasing burden of property taxes and broader cost-of-living pressures. It provides refunds for seniors aged 65+, veterans with an 80% documented disability, and adult homeowners with 100% documented disabilities.

The URAF Program, launched in 2025 and administered by the Housing Division, helps residents with utility affordability. Building on the operational success of the 2024 PPTR Program signifies a significant step in CCOB's commitment to its residents.

Staff recommends continuing both programs in the 2026 fiscal year and both are included in the proposed 2026 Budget. Both programs will continue to accept new applications through October 30, 2026, or until funding has been exhausted, whichever occurs first. Resolutions 2025-153 and 2025-154 include clarifications and adjustments to the URAF and PPTR programs. These changes aim to ensure the programs remain efficient, fiscally responsible, and responsive to community needs, aligning with Council Goals, Financial Sustainability and Resilience, and Organizational Health.

Utility Rate Assistance Fund (URAF) Program 2025 and 2026 Update

In 2025, City Council Resolution 2024-165 established the Utility Rate Assistance Fund (URAF) program, directing staff to provide quarterly credits or refunds to eligible households with incomes up to 100% of the Area Median Income (AMI).

A review of 2025 URAF applications by the Housing Division revealed that 74% of applicants, the vast majority, had incomes at or below 60% AMI. Consequently, staff recommended reducing the 2026 eligibility threshold to 60% AMI, a change first discussed during the July 2025 second quarterly update for Enterprise Funds.

In 2025, eligible households received monthly reimbursements for utility fees, covering about 50% of the increase from 2024. The maximum annual refund was capped at $240 per household. Reimbursement rates varied by housing type: $20 for single-family detached homes, $18 for townhomes, duplexes, and mobile homes, and $17 for apartments and condominiums. The proposal for 2026 is to maintain these same assistance levels for eligible residents. Eligibility will be based on the total adjusted earnings of all household members aged 18 and older. Residents who pay their water utility bill directly to Broomfield will receive the refund as a credit on their utility account. For residents who pay their water utility as part of rent, via an HOA or other third party, the refund will be issued in check form to the resident.

Broomfield's Housing Division, which also manages the partial property tax refund program, will continue to administer the URAF program, maintaining quarterly payouts based on Council feedback from the July 2025 enterprise funds update.

To support the 2025 URAF program rollout, two nine-month Limited Term Assignment (LTA) full-time staff positions were added to the Housing Division. The 2026 budget does not allocate funds for new staff to

manage the Utility Rate Assistance Fund (URAF). Instead, the administration will leverage current staff within the Housing Division of Economic Vitality. These staff members will track the time and costs associated with administering the program without additional long-term assistance (LTA) capacity. Updates will be provided during quarterly enterprise updates, and the Housing Division will continue to advertise the URAF program via social media, Broomfield's website, Our Broomfield, and alongside other housing initiatives throughout 2026. If additional advertising, postage, or other related expenses are determined to be necessary specifically for URAF, an amendment to the 2026 budget will be requested in 2026.

Utility Rate Assistance Fund (URAF) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 100% AMI	0% - 60% AMI
Payment Frequency	Quarterly	Quarterly

During the October 14, 2025 City Council meeting, a resident reported concern regarding the eligibility of mobile home residents for the URAF program. It should be noted, residents of mobile home communities are eligible for the program. Since their utility bill is typically paid through a third party, the resident would be issued a quarterly check rather than a credit toward their utility bill to ensure the program benefits the resident directly. In 2025, mailers were sent to mobile home residents to inform them about the program. As of October 1, 2025, approximately 12 mobile home residents have applied for and been approved for the URAF. Broomfield staff will continue to focus on outreach to mobile home residents in 2026.

URAF Program Data

URAF Program Data as of September 30, 2025		
URAF - Data Points	2025	2026
Program Budget	Program Credits*: $600,000 Program Checks: $493,100 Personnel: $104,300 URAF specific Advertising: $7,000 URAF Software: $8,300 URAF Equipment: $8,000	Program (credits/checks): $350,000 Personnel: $35,000 URAF specific Advertising: $0 URAF Software: $0 URAF Equipment: $0
Budget Expended	Program Credits: $132,879 Program Checks: $18,639 Personnel: $66,810 URAF Advertising/Postage: $7,620 Software: $8,300 Equipment: $4,492	N/A
Total Payments Processed	Through 2025 Q3: 3833	N/A
Total Applications Processed	1813	N/A
Eligibility	One of the following docs: IRS Tax Form, SS, SNAP, LEAP, etc.	Required - IRS Tax Form No tax filing - Proof of all income (SS, Bank Statements, Paystubs, etc.)
AMIs Served	0-30% ▫ 40% 31-60% ▫ 34% 61-80% ▫ 19% 81-100% ▫ 7%	0-30% 31-60% N/A N/A
Communication Efforts	Phone Calls: 1171 Emails: 446 Consultations: 429 (96 Spanish)	N/A N/A N/A
Outreach Events	31	N/A

*As part of the 2025 Budget - 1st Amendment, program credits were budgeted at $1,479,300; as part of the 2025 Budget - 2nd Amendment, program credits are now budgeted at $600k.

Partial Property Tax Refund (PPTR) Program - 2025 Update and 2026 Recommendation

The Partial Property Tax Refund (PPTR) Program, established by Resolution No. 2022-123 and expanded with Resolution No. 2024-27 and Resolution No. 2024-105, offers financial relief to specific demographics facing increasing property tax burdens and general cost-of-living pressures. Eligible participants include seniors aged 65 and older, veterans with a documented disability of 80% or more, and adult homeowners with 100% documented disabilities.

While the Housing Division will continue to utilize 2021 tax year data as the program's baseline, the 2026 refund is anticipated to be lower than in 2025 due to the recently adopted House Bill 24B-1001. Despite these adjustments, the program is expected to continue providing significant support to qualifying households.

Partial Property Tax Refund (PPTR) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 80% AMI	0% - 80% AMI
Program Final Application Date	October 30, 2025	October 30, 2026

PPTR Program Data

PPTR Program Data as of October 13, 2025		
PPTR - Data Points	2025	2026
Program Budget	Program ≤ 60% AMI: $402,000 Program 61-80%: $100,000	Total Program: $600,000 Anticipated utilization ≤ 60% AMI: $500,000 61-80%: $100,000
Budget Expended	Program ≤ 60% AMI: $401,693 Program 61-80%: $90,016	N/A
Total Payments Processed	963	N/A
Total Applications Processed	1265	N/A
AMIs Served/Processed	0-30% ▫ 41.5% 31-60% ▫ 36.0% 61-80% ▫ 18.5% Ineligible ▫ 4.0%	0-30% 31-60% 61-80%
Communication Efforts	Phone Calls: 517 Emails: 332 Consultations: 397 (77 Spanish)	N/A N/A N/A
Outreach Events	33	N/A

Bond Issuances

Until 2021, Broomfield did not have a formal Debt Policy. Since adopting one, we have aligned with industry and government standards by capping total debt at no more than 10% of the City's assessed value. As of the close of fiscal year 2024, Broomfield's total debt was at 5.25% of assessed value – well below industry standards.

In 2023, debt service accounted for 4.6% of total revenues, and in 2024, that decreased slightly to 4.2%, reflecting our intentional focus on managing and reducing outstanding obligations. For context, debt service levels under 5% of total revenue are typically considered "best in class."

As we look ahead, the staff has strategically timed the issuance of new debt to coincide with the defeasance of the 2017 Certificates of Participation (COP) for the County building. This approach will help offset the impact of new debt issuance for the upcoming Police and Courts facility. While we expect to slightly exceed the 5% debt-to-revenue ratio following issuance, our strong financial standing provides confidence in our ability to manage this responsibly. In the past two years, Broomfield has earned three credit rating upgrades, which is a significant achievement

Conclusion and Next Steps

The 2026 budget represents a disciplined, data-driven approach to maintaining Broomfield's financial sustainability while meeting our community's needs. Through careful stewardship of public resources, strategic infrastructure investments, and thoughtful prioritization of mandates, obligations, and critical needs, this budget positions our organization to navigate current fiscal challenges while preparing for future opportunities.

Key Takeaways

The proposed 2026 budget demonstrates our commitment to:

- **Fiscal Responsibility**: Maintaining 20% reserves and managing debt prudently
- **Infrastructure Investment**: Addressing critical water, sewer, and public safety facility needs
- **Community Support**: Continuing programs like URAF and PPTR to assist residents facing financial challenges
- **Operational Excellence**: Optimizing existing resources before requesting new ones

Action for Council - October 28, 2025

7.A Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-141 - 2025 Budget - 2nd Amendment
- Resolution 2025-142 - 2026 CCOB Budget

7.B Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-143-UR - 2025 BURA Budget - 2nd Amendment
- Resolution 2025-144-UR - 2026 BURA Budget

7.C Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

- Resolution 2025-145-AID - 2026 ALID Budget

7.D Public Hearing - Ordinance Section Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

- Ordinance 2286 - Enterprise Rate Ordinance

7.E Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

- Ordinance 2288 - Water Tanks Bond
- Ordinance 2289 - Wastewater Treatment Bond
- Ordinance 2290 - Police/Courts COP

7.F Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

- Resolution 2025-153 - URAF Program Continuation
- Resolution 2025-154 - PPTR Program Continuation

Looking Ahead

Following the adoption of the 2026 budget, staff will:

- Issue bonds in Q1 2026 for Police/Courts facility and enterprise projects
- Begin construction on the Police building, Water tanks, and Wastewater Expansion Project
- Implement the updated URAF and PPTR programs
- Come before Council Dec. 9th with an amendment focused on grants received in 2025
- Continue quarterly Enterprise Fund updates to Council
- Collaborate with FLOW on recommendations for the 5-Year Water Utilities Capital Improvement Plan (CIP) and rate adjustments for the 2027 budget.
- Monitor economic conditions and provide budget updates as needed
- Prepare for the 2027 budget process with continued emphasis on financial sustainability

Staff remains committed to transparent communication, data-driven decision-making, and collaborative problem-solving as we work together to serve our community and achieve our shared goals.

ORDINANCE NO. 2288

An ordinance authorizing the issuance of the City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026

Recitals.

Whereas, the City and County of Broomfield (the "City") is a political subdivision of the State of Colorado (the "State") a body corporate and politic, a home-rule city and county pursuant to Article XX of the constitution and a city and county pursuant to Sections 10, 11, 12 and 13 of Article XX of the constitution;

Whereas, the members of the City Council of the City (the "Council") have been duly elected or appointed and qualified;

Whereas, pursuant to Chapter XVII of the Charter and Chapter 3-30 of the City Municipal Code (the "Code"), the Council has established the City of Broomfield, Colorado, Water Activity Enterprise (the "Enterprise"), governed by the Council and having all lawful powers consistent with the Charter and ordinances of the City, including, without limitation, the power to issue and reissue bonds, notes, and other obligations, in the name of the City, payable solely from lawful revenues available to the enterprise for the purpose of operating the water system (the "System");

Whereas, the Council has determined and hereby determines that the System constitutes an enterprise pursuant to Article X, Section 20 of the Colorado Constitution ("TABOR") and Title 37, Article 45.1, C.R.S. (the "Enterprise Act");

Whereas, pursuant to Section 14.4 of the Charter, the City is authorized, pursuant to ordinance, and without an election, to borrow money, issue bonds, or otherwise extend its credit for purchasing, constructing, condemning, otherwise acquiring, extending or improving a water, electric, gas or sewer system, or other public facility or income-producing project or for any other capital improvement; provided that the bonds or other obligations shall be made payable from the net revenues derived from the operation of such system, utility or other such project or capital improvement, and provided, further, that any two or more of such systems, utilities, projects or capital improvements may be combined, operated and maintained as joint municipal systems, utilities, projects or capital improvements, in which case such bonds or other obligations shall be made payable out of the net revenue derived from the operation of such joint systems, utilities or capital improvements;

Whereas, the Council proposes to extend, better, otherwise improve and equip the System, including the financing a portion of the costs of the constructing and/or acquiring water storage tanks (as more fully described herein, the "Project");

Whereas, the City intends to issue certain water activity enterprise revenue bonds (the "Bonds") to defray in part the costs of the Project;

Whereas, the City has previously issued its Water Activity Enterprise Water Enterprise Revenue Bonds, Series 2021 (the "2021 Bonds"), which 2021 Bonds are currently outstanding in the aggregate principal amount of $119,325,000;

Whereas, except for the 2021 Bonds, the City has not pledged nor hypothecated the revenues derived or to be derived from the operation of the System, or any part thereof, to the payment of any outstanding bonds or other financial obligations or for any other purpose, with the result that the Net Pledged Revenues (defined below) may now be pledged lawfully and irrevocably for the payment of the Bonds on a parity with the Series 2021 Bonds, and the Bonds may be made payable from the Net Pledged Revenues;

Whereas, there are on file with the City Clerk: (i) the form of the Preliminary Official Statement for the Bonds; (ii) the form of the Paying Agent Agreement; (iii) the form of the Disclosure Certificate; (iv) the form of Bond Purchase Agreement;

Whereas, pursuant to Section 11-57-203, C.R.S., the City desires to delegate to the City Manager and the Director of Finance the independent authority to accept the proposal to purchase the Bonds by execution of the Bond Purchase Agreement and to make final determinations relating to the Bonds, subject to the parameters contained in Section 213 of this Ordinance;

Whereas, it is necessary to provide for the form of the Bonds, Bond details, the payment of the Bonds, and other provisions relating to the authorization, issuance, and sale of the Bonds.

Now, therefore, be it ordained by the City Council of the City and County of Broomfield, Colorado:

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ARTICLE I
DEFINITIONS, INTERPRETATION, RATIFICATION AND EFFECTIVE DATE

Section 101. Meanings and Construction.

A. Definitions. The terms in this Section for all purposes of this Ordinance and of any ordinance amendatory hereof or supplemental hereto, or relating hereto, and of any other ordinance or any other document pertaining hereto, except where the context by clear implication otherwise requires, shall have the meanings herein specified:

"acquire" or "acquisition" means the opening, laying out, establishment, purchase, construction, securing, installation, reconstruction, lease, gift, grant from the Federal Government, the State, any body corporate and politic therein, or any other Person, the endowment, bequest, devise, transfer, assignment, option to purchase, other contract, or other acquisition, or any combination thereof, of any properties pertaining to the System, or an interest therein, or any other properties herein designated.

"Bond Counsel" means an attorney or a firm of attorneys, designated by the City of nationally recognized standing in matters pertaining to the tax status of interest on bonds issued by states and their political subdivisions, duly admitted to the practice of law before the highest court of any state of the United States of America or the District of Columbia.

"Bond Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Bond Fund" created pursuant to Section 505 hereof.

"Bond Purchase Agreement" means the Bond Purchase Agreement concerning the purchase of the Bonds, between the City and the Purchaser.

"Bond Requirements" means the principal of, any prior redemption premiums due in connection with, and the interest on the Bonds, any Parity Bonds, or other securities payable from the Net Pledged Revenues and heretofore or hereafter issued, if any, or such part of such securities as may be designated.

"Bonds" means City's Water Activity Enterprise Water Revenue Bonds, Series 2026, with such title as confirmed in the Sale Certificate, issued pursuant to this Ordinance.

"Book-entry form" or "book-entry system" means, with respect to the Bonds, a form or system, as applicable, under which physical Bond certificates in fully registered form are registered only in the name of The Depository Trust Company or its nominee as Owner, with the physical Bond certificates "immobilized" in the custody of The Depository Trust Company. The book-entry system maintained by and the responsibility of The Depository Trust Company and not maintained by or the responsibility of the City or the Paying Agent is the record that

identifies, and records the transfer of the interests of, the owners of book-entry interests in the Bonds.

"Business Day" means a day of the year, other than a Saturday or Sunday, other than a day on which commercial banks located in the city in which the principal corporate trust office of the Paying Agent is located are required or authorized to remain closed and other than a day on which the New York Stock Exchange is closed.

"Capital Improvements" means the acquisition of land, water or water rights, easements, facilities, and equipment, including two 3 million-gallon water storage tanks (other than ordinary repairs and replacements), and those property improvements or any combination of property improvements which will constitute enlargements, extensions or betterments to the System and will be incorporated into the System.

"Charter" means the home rule charter of the City, including all amendments thereto prior to the date hereof.

"City" means the City of and County of Broomfield, Colorado, a municipal corporation and political subdivision of the State.

"City Clerk" means the City Clerk of the City, or his or her successor in functions, if any.

"City Manager" means the City Manager of the City, or his or her successor in functions, if any.

"Closing Date" means the date of delivery of and payment for the Bonds.

"Combined Maximum Annual Principal and Interest Requirements" means the largest sum of the principal of and interest on the Bonds, any other Outstanding Parity Bonds and any additional Parity Bonds proposed to be issued, excluding any securities the principal of which is payable within less than one year from the date on which issued, to be paid during any one Fiscal Year for the period beginning with the Fiscal Year in which such computation is made and ending with the Fiscal Year in which any Bond or other such security last becomes due at maturity or on a Redemption Date, whichever time is later (but excluding any reserve requirement to secure such payments unless otherwise expressly provided), subject in all respects to the following, as applicable:

(1) The word "principal," as used in this definition, means the principal which must be paid to security Owners, whether on stated maturity dates or on mandatory Redemption Dates, or otherwise.

(2) Any computation made under this definition shall be adjusted for all purposes in the same manner as is provided in Section 703 hereof.

"Commercial Bank" means a state or national bank or trust company which is a member of the Federal Deposit Insurance Corporation (or any successors thereto) and of the Federal

Reserve System, which has a capital and surplus of $10,000,000 or more, and which is located within the United States of America.

"Continuing Disclosure Certificate" means the Continuing Disclosure Certificate for the Bonds executed by the City.

"Cost of the Project" means all costs, as designated by the City, of the Project, or any interest therein, which cost, at the option of the City (except as may be otherwise limited by law) may include all, any one or other portion of the incidental costs pertaining to the Project, including, without limitation:

(i) All preliminary expenses or other costs advanced by the City or advanced by the Federal Government, the State or by any other Person from any source, with the approval of the Council, or any combination thereof, or otherwise;

(ii) The costs of making surveys and tests, audits, preliminary plans, other plans, specifications, estimates of costs and other preliminaries;

(iii) The costs of contingencies;

(iv) The costs of premiums on any builders' risk insurance and performance bonds during the construction, installation and other acquisition of the Project, or a reasonably allocated share thereof;

(v) The costs of appraising, printing, estimates, advice, inspection, other services of engineers, architects, accountants, financial consultants, attorneys at law, clerical help and other agents and employees;

(vi) The costs of making, publishing, posting, mailing and otherwise giving any notice in connection with the Project and the issuance of the Bonds;

(vii) All costs and expenses of issuing the Bonds including, without limitation, fees of the Paying Agent, Bond Counsel, counsel to the Purchaser, counsel to the City, financial advisor, rating agencies and printers to the extent not defrayed as an Operation and Maintenance Expense;

(viii) The costs of the filing or recording of instruments and the cost of any title insurance premiums;

(ix) The costs of funding any construction loans and other temporary loans pertaining to the Project and of the incidental expenses incurred in connection with such loans;

(x) The costs of demolishing, removing, or relocating any buildings, structures, or other facilities on land acquired for the Project, and of acquiring lands to which such buildings, structures or other facilities may be moved or relocated;

(xi) The costs of machinery and equipment, including storage tanks;

(xii) The costs of any properties, rights, easements or other interests in properties, or any licenses, privileges, agreements and franchises;

(xiii) The payment of the premium for the Insurance Policy issued by the Insurer and Reserve Fund Insurance Policy issued by the Surety Provider;

(xiv) The costs of labor, material and obligations incurred to contractors, builders and materialmen in connection with the acquisition and construction of the Project;

(xv) The costs of amending any ordinance or other instrument pertaining to the Bonds or otherwise to the System; and

(xvi) All other expenses pertaining to the Project.

"Council" means the City Council of the City.

"C.R.S." means the Colorado Revised Statutes, as amended and supplemented as of the date hereof.

"Director of Finance" means the Director of Finance of the City, or his or her successor in functions, if any.

"Events of Default" means the events stated in Section 903 hereof.

"Federal Government" means the United States of America and any agency, instrumentality or corporation thereof.

"Federal Securities" means bills, certificates of indebtedness, notes, or bonds which are direct obligations of, or the principal and interest of which obligations are unconditionally guaranteed by, the United States of America.

"Fiscal Year" means the calendar year or any other 12-month period hereafter selected by the City as its fiscal year.

"Gross Pledged Revenues" all income from rates, fees, tolls and charges and tap fees, or any combination thereof, but not special assessments, for the services furnished by, or the direct or indirect connection with, or the use of, or any commodity from the System, including without limiting the generality of the foregoing, minimum charges, charges for the availability of service, disconnection fees, reconnection fees and reasonable penalties for any delinquencies, and all income or other realized gain, if any, from any investment of Gross Pledged Revenues and of the proceeds of securities payable from Net Pledged Revenues (except income or other gain from any investment of moneys held in an escrow fund or account for the defeasance of securities payable from the Net Pledged Revenues or any other similar fund) to the extent not required to be rebated to the federal government. Gross

Pledged Revenues shall also include amounts on deposit in a rate stabilization fund. Gross Pledged Revenues excludes any refund of rates, tolls and charges due to others.

"improve" or "improvement" means the extension, reconstruction, alteration, betterment or other improvement by the construction, purchase or other acquisition of facilities, including, without limitation, appurtenant machinery, apparatus, fixtures, structures and buildings.

"Independent Accountant" means any certified public accountant, or any firm of certified public accountants, duly licensed to practice and practicing as such under the laws of the State:

(i) Who is, in fact, independent and not under the control of the City;

(ii) Who does not have any substantial interest, direct or indirect, with the City, and

(iii) Who is not connected with the City as an officer or employee thereof, but who may be regularly retained to make annual or similar audits of any books or records of the City.

"Independent Engineer" means an individual, firm or corporation engaged in the engineering profession of recognized good standing and having specific experience in respect of business and properties of a character similar to those of the System, which individual, firm or corporation has no substantial interest, direct or indirect, in the City and in the case of an individual, is not a member of the Council, or an officer or employee of the City, and in the case of a firm or corporation, does not have a partner, director, officer or employee who is a member of the Council or an officer or employee of the City.

"Insurance Policy" means the municipal bond new issue insurance policy, if any, issued by the Insurer that guarantees payment of principal of and interest on the Bonds when due.

"Insurer" means the issuer of the Insurance Policy, if any, as set forth in the Sale Certificate.

"Insurance Agreement" means an agreement entered into between the City and any Insurer pursuant to Section 213 of this Ordinance.

"Investment Securities" means any securities or other obligations permitted as investments of moneys of the City under the laws of the State.

"Letter of Representations" means the Blanket Issuer Letter of Representations from the City to The Depository Trust Company in connection with the issuance of the Bonds in a book-entry system, as supplemented and amended from time to time.

"Mayor" means the Mayor of the City or his or her successor in functions, if any.

"Net Pledged Revenues" means the Gross Pledged Revenues remaining after the payment of the Operation and Maintenance Expenses of the System.

"Official Statement" means the Official Statement delivered in connection with the original issuance and sale of the Bonds.

"Operation and Maintenance Expenses" means such reasonable and necessary current expenses of the City, paid or accrued, of operating, maintaining and repairing the System as may be determined by the City, including, except as limited by contract or otherwise limited by law, without limiting the generality of the foregoing:

(a) Engineering, auditing, legal and other overhead expenses directly related and reasonably allocable to the administration, operation and maintenance of the System;

(b) Insurance, surety bond and interest rate cap agreement premiums appertaining to the System;

(c) The reasonable charges of any paying agent, registrar, transfer agent, depository or escrow bank appertaining to any securities payable from the Net Pledged Revenues;

(d) Annual payments to pension, retirement, health and hospitalization funds appertaining to the System;

(e) Any taxes, assessments, franchise fees or other charges or payments in lieu of the foregoing;

(f) Ordinary and current rentals or equipment or other property;

(g) Contractual services, professional services, salaries, administrative expenses and costs of labor appertaining to the System, the cost of water purchased for delivery through the System and the cost of materials and supplies used for current operation or routine maintenance or repair of the System;

(h) The costs incurred in the billing and collection of all or any part of the Gross Pledged Revenues;

(i) Any costs of utility services furnished to the System by the City or otherwise;

(j) Any other such expenses considered by· the· City in determining the amount of water rates, fees, tolls and charges imposed for operation and maintenance; and

(k) Expenses in connection with the issuance of bonds or other securities evidencing any loan to the City and payable from Gross Pledged Revenues.

"Operating Expenses" do not include:

(a) Any allowance for depreciation;

(b) Any costs of improvement, extension or betterment that qualify as capital items in accordance with generally accepted accounting principles;

(c) Any accumulation of reserves for capital replacements;

(d) Any reserves for operation, maintenance or repair of the System;

(e) Any allowance for the redemption of any bonds or other securities payable from the Net Pledged Revenues or the payment of any interest thereon;

(f) Any liabilities incurred in the acquisition of any facilities constituting part of the System; and

(g) Any other ground of legal liability not based on contract.

"Ordinance" means this ordinance of the City, which provides for the issuance and delivery of the Bonds.

"Outstanding" when used with reference to the Bonds, the Parity Bonds, or any other designated securities and as of any particular date means all the Bonds, the Parity Bonds, or any such other securities payable from the Net Pledged Revenues or otherwise pertaining to the System, as the case may be, in any manner theretofore and thereupon being executed and delivered:

(i) Except any Bond, Parity Bonds, or other security canceled by the City, by any paying agent, or otherwise on the City's behalf, at or before such date;

(ii) Except any Bond, Parity Bond, or other security deemed to be paid as provided in Section 1201 hereof or any similar provision of the ordinance authorizing the issuance of such other security; and

(iii) Except any Bond, Parity Bond, or other security in lieu of or in substitution for which another Bond or other security shall have been executed and delivered pursuant to Sections 306, 307 or 1108 hereof or any similar provisions of the ordinance authorizing the issuance of such other security.

"Owner" means the registered owner of any designated Bond, Parity Bond, or other designated security.

"Parity Bonds" means the 2021 Bonds and any securities hereafter issued payable from and having an irrevocable lien upon the Net Pledged Revenues on a parity with the Bonds.

"Parity Bond Ordinances" means the 2021 Ordinance and any ordinances or agreements previously or hereafter entered into by the City with respect to or authorizing the issuance of Parity Bonds.

"Paying Agent" means UMB Bank, n.a., being an agent of the City for the payment of the Bond Requirements due in connection with the Bonds, the registrar for the Bonds and for other administration of moneys pertaining to the Bonds and includes any successor Commercial Bank as paying agent.

"Paying Agent Agreement" means the agreement between the City and the Paying Agent.

"Person" means a corporation, firm, other body corporate (including, without limitation, the Federal Government, the State, or any other body corporate and politic other than the City), partnership, limited liability company, association or individual, and also includes an executor, administrator, trustee, receiver or other representative appointed according to law.

"Policy Costs" means repayment of draws under the Reserve Fund Insurance Policy, if any, plus all related reasonable expenses incurred by the Surety Provider, plus accrued interest thereon.

"Preliminary Official Statement" means the Preliminary Official Statement delivered in connection with the original issuance and sale of the Bonds.

"Project" means, the land, facilities and rights constructed, installed, purchased and otherwise acquired for the System, the cost of which is to be defrayed with a portion of the proceeds of the Bonds and which constitutes Capital Improvements.

"Project Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Project Fund" created pursuant to Section 401 hereof.

"Purchaser" means the original purchaser of the Bonds as specified in the Sale Certificate.

"Rating Agency" means each nationally recognized securities rating agency then maintaining a rating on the Bonds.

"Rebate Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Rebate Fund" created pursuant to Section 510 hereof.

"Record Date" means the close of business on the fifteenth day (whether or not a Business Day) of the calendar month next preceding an interest payment date.

"Redemption Date" means the date fixed for the redemption prior to their respective maturities of any Bonds or other designated securities payable from Net Pledged Revenues in any notice of prior redemption or otherwise fixed and designated by the City.

"Reserve Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Reserve Fund" created

pursuant to Section 506 hereof, if such an account is required as specified in the Sale Certificate. The Reserve Fund shall secure only principal of and interest on the Bonds.

"Reserve Fund Insurance Policy" means any insurance policy, surety bond, irrevocable letter of credit or similar instrument deposited in or credited to the Reserve Fund in lieu of or in partial substitution for moneys on deposit therein.

"Reserve Fund Requirement" has the meaning ascribed to such term in the Sale Certificate.

"Sale Certificate" means the sale certificate of the City relating to the Bonds issued pursuant to the Supplemental Public Securities Act and described in Section 213 hereof.

"Special Record Date" means the record date for determining ownership of the Bonds for purposes of paying accrued but unpaid interest, as such date may be determined pursuant to this Ordinance.

"State" means the State of Colorado.

"Subordinate Securities" means securities or other obligations payable from the Net Pledged Revenues subordinate and junior to the lien thereon of the Bonds and any Parity Bonds.

"Supplemental Public Securities Act" means Part 2 of Article 57 of Title 11, C.R.S., as amended.

"Supplemental Reserve Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Supplemental Reserve Fund" created pursuant to Section 507 hereof, if such an account is required as specified in the Sale Certificate. Any Supplemental Reserve Fund shall secure only the principal and interest on the Bonds.

"Supplemental Reserve Fund Requirement" means the amount set forth in the Sale Certificate, if any, for deposit into the Supplemental Reserve Fund.

"Surety Provider" means the Insurer or any other entity issuing a Reserve Fund Insurance Policy with respect to the Bonds.

"System" means the City's system for the collection, treatment and discharge of water and consisting of all properties, real, personal, mixed or otherwise, now owned or hereafter acquired by the City, whether situated within or without the City boundaries, used in connection with such system of the City, and in any way appertaining thereto, including all present or future improvements, extensions, enlargements, betterments, replacements or additions thereof or thereto and administrative facilities

"Tax Compliance Certificate" means the federal tax compliance certificate executed by the City in connection with the initial issuance and delivery of the Bonds.

"Tax Code" means the Internal Revenue Code of 1986, as amended to the date of delivery of the Bonds, and the regulations promulgated thereunder.

"Term Bonds" means Bonds that are payable on or before their specified maturing dates from sinking fund payments established for that purpose and calculated to retire such Bonds on or before their specified maturity dates.

"Trust Bank" means a Commercial Bank which is authorized to exercise and is exercising trust powers located within or without the State, and also means any branch of the Federal Reserve Bank.

"Water Enterprise Fund" means the special fund maintained by the City and designated as the "Water Enterprise Fund".

"2021 Bond Ordinance" means Ordinance No. 2157 adopted by the City Council on September 16, 2021, authorizing the issuance of the 2021 Bonds.

"2021 Bonds" means City's Water Activity Enterprise Water Revenue Bonds, Series 2021, issued pursuant to the 2021 Bond Ordinance.

B. City-Held Securities. Any securities payable from any Net Pledged Revenues held by the City shall not be deemed to be Outstanding for the purpose of redemption nor Outstanding for the purpose of consents hereunder or for any other purpose herein, except for payment.

Section 102. Parties Interested Herein. Nothing herein expressed or implied confers any right, remedy or claim upon any Person, other than the City, the Council, the Paying Agent, the Insurer, the Surety Provider, the Owners of the Bonds and the Owners of any Parity Bonds or other securities payable from the Net Pledged Revenues when reference is expressly made thereto. All the covenants, stipulations, promises and agreements herein contained by and on behalf of the City shall be for the sole and exclusive benefit of the City, the Council, the Paying Agent, the Insurer, the Surety Provider, the Owners of the Bonds and the Owners of any such other securities in the event of such a reference.

Section 103. Ratification; Approval of Documents. All action heretofore taken (not inconsistent with the provisions of this Ordinance) by the Council, the officers of the City and otherwise taken by the City directed toward the Project and the sale and delivery of the Bonds for such purposes, be, and the same hereby is, ratified, approved and confirmed.

Section 104. Repealer. All bylaws, orders, resolutions, ordinances or parts thereof, inconsistent herewith are hereby repealed to the extent only of such inconsistency. This repealer shall not be construed to revive any such bylaw, order, resolution or ordinance, or part thereof, heretofore repealed. All rules of the Council, if any, which might prevent the final passage and adoption of this Ordinance are hereby suspended.

Section 105. Severability. If any section, subsection, paragraph, clause or other provision of this Ordinance for any reason is invalid or unenforceable, the invalidity or unenforceability of such section, subsection, paragraph, clause or other provision shall not affect any of the remaining provisions of this Ordinance.

Section 106. Ordinance Irrepealable. After any of the Bonds are issued, this Ordinance shall constitute an irrevocable contract between the City and the Owner or Owners of the Bonds and this Ordinance shall be and shall remain irrepealable until the Bonds, as to all Bond Requirements, shall be fully paid, canceled, and discharged, except as herein otherwise provided.

Section 107. Conclusive Recitals. Pursuant to Section 11-57-210 of the Supplemental Public Securities Act, the Bonds shall contain a recital that they are issued pursuant to the Supplemental Public Securities Act. Such recital shall be conclusive evidence of the validity and the regularity of the issuance of the Bonds after their delivery for value.

Section 108. Limitation of Actions. Pursuant to Section 11-57-212 of the Supplemental Public Securities Act, no legal or equitable action brought with respect to any legislative acts or proceedings of the City in connection with the authorization or issuance of the Bonds, including but not limited to the adoption of this Ordinance, shall be commenced more than thirty days after the authorization of the Bonds.

ARTICLE II
DETERMINATION OF THE CITY'S AUTHORITY AND OBLIGATIONS; APPROVAL OF RELATED DOCUMENTS; AND ELECTION TO APPLY SUPPLEMENTAL PUBLIC SECURITIES ACT TO THE BONDS

Section 201. Authorization. The Bonds are issued in accordance with the Constitution and laws of the State, the Charter and the provisions of this Ordinance, specifically the Supplemental Public Securities Act; Title 37, Article 45.1, C.R.S., and all other laws of the State thereunto enabling. For the purpose of defraying the cost of the Project, the City hereby authorizes the Bonds to be issued in the aggregate principal amount provided in the Sale Certificate as approved by the City Manager or the Director of Finance, subject to the parameters and restrictions contained in this Ordinance.

Section 202. Bonds Equally Secured. The covenants and agreements herein set forth to be performed on behalf of the City shall be for the equal benefit, protection and security of the Owners of any and all of the Outstanding Bonds and any Outstanding Parity Bonds heretofore or hereafter authorized and issued, all of which, regardless of the time or times of their issue or maturity, shall be of equal rank without preference, priority or distinction of any of such securities over any other thereof, except as otherwise expressly provided in or pursuant to this Ordinance.

Section 203. Special Obligations. All of the Bond Requirements of the Bonds and the Policy Costs shall be payable and collectible solely out of the Net Pledged Revenues which revenues are so pledged; the Owner or Owners of the Bonds and the Surety Provider may not look to any general or other fund for the payment of such Bond Requirements, except the herein designated special funds pledged therefor; the Bonds and the Policy Costs shall not constitute an indebtedness or a debt within the meaning of any constitutional, or statutory provision or limitation; and the Bonds and the Policy Costs shall not be considered or held to be general obligations of the City but shall constitute its special obligations. No statutory, Charter, or constitutional provision enacted after the issuance of the Bonds shall in any manner be construed as limiting or impairing the obligation of the City to comply with the provisions of this Ordinance or to pay the Bond Requirements of the Bonds and the Policy Costs as herein provided.

Section 204. Character of Agreement. None of the covenants, agreements, representations and warranties contained herein or in the Bonds shall ever impose or shall be construed as imposing any liability, obligation or charge against the City (except the special funds pledged therefor), or against its general credit, or as payable out of its general fund or out of any funds derived from taxation or out of any other revenue source (other than those pledged therefor).

Section 205. No Pledge of Property. The payment of the Bonds and the Policy Costs is not secured by an encumbrance, mortgage or other pledge of property of the City, except for the Net Pledged Revenues and other moneys pledged for the payment of the Bond Requirements of the Bonds. No property of the City, subject to such exception, shall be liable to be forfeited or taken in payment of the Bonds or the Policy Costs.

Section 206. No Recourse Against Officers and Agents. No recourse shall be had for the payment of the Bond Requirements of the Bonds or the Policy Costs or for any claim based thereon or otherwise upon this Ordinance or any other ordinance pertaining hereto, against any individual member of the Council or any officer, employee or other agent of the City, past, present or future, either directly or indirectly through the Council, or the City, or otherwise, whether by virtue of any penalty or otherwise, all such liability, if any, being by the acceptance of the Bonds and as part of the consideration of their issuance specially waived and released.

Section 207. Authorization of the Project. The Council, on behalf of the City, does hereby determine to undertake the Project, which is hereby authorized, and the proceeds of the Bonds shall be used therefor.

Section 208. Enterprise Status. The Council, on behalf of the City, hereby confirms its determination that the System is an "enterprise" for the purposes of Article X, Section 20 of the State Constitution and Title 37 Article 45.1, C.R.S.

Section 209. Sale of Bonds. The Bonds shall be sold by negotiated sale to the Purchaser. Pursuant to the Supplemental Public Securities Act, the Council hereby delegates to the City

Manager or the Director of Finance the authority to execute the Bond Purchase Agreement and the Sale Certificate with respect to the sale of the Bonds.

Section 210. Official Statement. The preparation and use of the Preliminary Official Statement and of the final Official Statement are hereby authorized. The Director of Finance is hereby authorized to approve, on behalf of the City, the Official Statement. The execution of the Official Statement by the Director of Finance shall be conclusively deemed to evidence the approval of the form and contents thereof by the City.

Section 211. Paying Agent. The Council hereby determines to approve the Paying Agent Agreement in substantially the form as is on file with the City Clerk. The Paying Agent may resign at any time on 30 days' prior written notice to the City. The City may remove the Paying Agent upon 30 days' prior written notice to the Paying Agent. If the Paying Agent appointed thereunder shall resign, or if the City shall determine to remove the Paying Agent, then the City may appoint a successor Paying Agent, upon notice sent to each owner of any Bond at his address last shown on the registration records maintained by the Paying Agent or by electronic means to DTC or its successor. No resignation or dismissal of the Paying Agent may take effect until a successor has been appointed and has accepted the duties of the Paying Agent. Every such successor Paying Agent shall be a Commercial Bank.

Section 212. Other Related Documents. The forms, terms and provisions of, and the performance by the City of its obligations under the Preliminary Official Statement, the Paying Agent Agreement, and the Continuing Disclosure Certificate are hereby approved, and the Mayor or Mayor pro-tem and the City Clerk or Deputy City Clerk are hereby authorized and directed to execute each of such documents on behalf of and in the name of the City, and to deliver each of such documents, in substantially the form on file with the City Clerk, with such changes as are not inconsistent herewith. The Mayor, the City Manager or the Director of Finance are hereby authorized to execute and deliver any Insurance Agreement as may be required by an Insurer relating to the issuance of the Insurance Policy or a Surety Provider relating to the Reserve Fund Insurance Policy. The execution of any instrument by the appropriate officers of the City herein authorized shall be conclusive evidence of the approval by the City of such instrument in accordance with the terms hereof.

Section 213. Elections to Apply Supplemental Public Securities Act to the Bonds. Pursuant to Section 11-57-204 of the Supplemental Public Securities Act, a public entity, including the City, may elect in an act of issuance to apply all or any of the provisions of the Supplemental Public Securities Act. The Council hereby elects to apply all of the provisions of the Supplemental Public Securities Act to the Bonds. Pursuant to Section 11-57-205 of the Supplemental Public Securities Act, the Council hereby delegates to the City Manager or the Director of Finance the authority to make the following determinations with respect to the Bonds, subject to the parameters and restrictions contained in this Ordinance, without any requirement that the Council approve such determinations:

(i) Interest Rate. The net effective rate of interest to be borne by the Bonds, which shall not exceed 5.50%.

(ii) Redemption Provisions. The prior redemption provisions of the Bonds, provided that the Bonds shall be subject to optional redemption prior to maturity not later than December 1, 2036 at a redemption price not to exceed 100%.

(iii) Purchase Price. The price at which the Bonds will be sold to the Purchaser, provided that the purchase price of the Bonds shall not be less than 98% of the aggregate principal amount of the Bonds.

(iv) Principal Amount. The aggregate principal amount of the Bonds, provided that such principal amount shall not exceed $80,000,000.

(v) Maturity Schedule. The amount of principal of and interest on the Bonds maturing, or subject to mandatory sinking fund redemption in any particular year; provided that the maximum annual repayment cost shall not exceed $5,900,000 and the maximum total repayment cost shall not exceed $120,000,000.

(vi) Term of the Bonds. The Bonds shall not mature later than December 1, 2047.

(vii) Capitalized Interest. The existence and amount of any capitalized interest on the Bonds.

(viii) Reserve Fund. The amount to be deposited in the Reserve Fund, if any.

(ix) Supplemental Reserve Fund. The amount to be deposited in the Supplemental Reserve Fund, if any.

(x) Bond Insurance. Whether the Bonds will be secured by an Insurance Policy or a Reserve Fund Insurance Policy and the terms of any agreement with the provider of such Insurance Policy or Reserve Fund Insurance Policy.

Such determinations shall be evidenced by the Sale Certificate signed by the City Manager or the Director of Finance dated and delivered as of the Closing Date, which shall not be more than one year from the date of adoption of this Ordinance. If the City shall determine to not obtain an Insurance Policy to secure the payment of principal of and interest on the Bonds, or not to obtain a Reserve Fund Insurance Policy, any references to the Insurer, the Insurance Policy, the Reserve Fund Insurance Policy, the Surety Provider, Policy Costs, the Insurance Agreement, or other provisions relating to bond insurance shall be of no force or effect.

ARTICLE III
AUTHORIZATION, TERMS, EXECUTION AND ISSUANCE OF BONDS

Section 301. Bond Details.

A. Basic Provisions. The Bonds shall be issued in fully registered form (i.e. registered as to payment of both principal and interest), in denominations of $5,000 or any integral

multiple thereof. The Bonds shall be lettered "R" and shall be numbered separately from 1 upward. The Bonds shall be dated as of the date of their delivery. The Bonds shall mature on December 1, in the years and amounts and subject to prior redemption as set forth herein and in the Sale Certificate. The Bonds shall bear interest from the most recent interest payment date to which interest has been paid, or if no interest has been paid, from their date until their respective maturities (or prior redemption) at the rates set forth in the Sale Certificate. No interest shall accrue on any Bonds owned by or on behalf of the City. Interest on the Bonds shall be calculated on the basis of a 360-day year of twelve 30-day months, payable semiannually on each June 1 and December 1, commencing on the date provided in the Sale Certificate.

B. Payment of Bonds. The principal of each Bond shall be payable at the principal corporate trust office of the Paying Agent, or at such other office as the Paying Agent directs in writing to the Owners of the Bonds, or at the principal office of its successor, upon presentation and surrender of the Bond. Payment of interest on any Bond shall be made to the Owner thereof by the Paying Agent on or before each interest payment date, (or, if such interest payment date is not a Business Day, on or before the next succeeding Business Day), to such Owner at his or her address as it appears on the registration records kept by the Paying Agent on the Record Date; but any such interest not so timely paid or duly provided for shall cease to be payable to the person who is the Owner thereof at the close of business on the Record Date and shall be payable to the person who is the Owner thereof at the close of business on a Special Record Date for the payment of any such defaulted interest. Such Special Record Date and the date fixed for payment of such defaulted interest shall be fixed by the Paying Agent whenever moneys become available for payment of the defaulted interest, and notice of the Special Record Date shall be given to the Owners not less than ten days prior to the Special Record Date by first-class mail to each such Owner as shown on the Paying Agent's registration books on a date selected by the Paying Agent, stating the date of the Special Record Date and the date fixed for the payment of such defaulted interest. The Paying Agent may make payments of interest on any Bond by such alternative means as may be mutually agreed to between the Owner of such Bond and the Paying Agent. If any Bond is not paid upon its presentation and surrender at or after its maturity or prior redemption, interest shall continue at its stated rate per annum until the principal thereof is paid in full. All such payments shall be made in lawful money of the United States of America.

Section 302. Execution of Bonds. The Bonds shall be executed in the name of the City by the manual or facsimile signature of the Mayor, shall be sealed with the corporate seal of the City or a facsimile thereof thereunto affixed, imprinted, engraved or otherwise reproduced and shall be attested by the manual or facsimile signature of the City Clerk. Any Bond may be signed (manually or by facsimile), sealed or attested on behalf of the City by any person who, at the date of such act, shall hold the proper office, notwithstanding that at the date of authentication, issuance or delivery, such person may have ceased to hold such office. The Mayor and the City Clerk may adopt as and for his or her own facsimile signature the facsimile signature of his or her predecessor in office in the event that such facsimile signature appears on any of the Bonds. Before the execution of any Bond, the Mayor and the City Clerk shall

each file with the Colorado Secretary of State his or her manual signature certified by him or her under oath.

Section 303. Authentication Certificate. The authentication certificate upon the Bonds shall be substantially in the form and tenor provided in the form of the Bonds set forth in Section 309 hereof. No Bond shall be secured hereby or entitled to the benefit hereof, nor shall any Bond be valid or obligatory for any purpose, unless the certificate of authentication, substantially in such form, has been duly executed by the Paying Agent and such certificate of the Paying Agent upon any Bond shall be conclusive evidence that such Bond has been authenticated and delivered hereunder. The certificate of authentication shall be deemed to have been duly executed by the Paying Agent if manually signed by an authorized officer or employee of the Paying Agent, but it shall not be necessary that the same officer or employee sign the certificate of authentication on all of the Bonds.

Section 304. Registration and Payment. The Paying Agent shall keep or cause to be kept sufficient records for the registration and transfer of the Bonds, which shall at all times be open to inspection by the City. Upon presentation for such purpose, the Paying Agent shall, under such reasonable regulations as it may prescribe, register or transfer or cause to be registered or transferred, on said records, Bonds as herein provided. Except as provided in Section 306 hereof, the Person in whose name any Bond shall be registered on the registration records kept by the Paying Agent shall be deemed and regarded as the absolute owner thereof for the purpose of making payment of the Bond Requirements thereof and for all other purposes; and payment of or on account of the Bond Requirements of any Bond shall be made only to the Owner thereof or his or her legal representative, but such registration may be changed upon transfer of such Bond in the manner and subject to the conditions and limitations provided herein. All such payments shall be valid and effectual to discharge the liability upon such Bond to the extent of the sum or sums so paid. The foregoing provisions of this Section are subject to the provisions of Section 307 hereof.

Section 305. Transfer and Exchange. Any Bond may be transferred upon the records required to be kept pursuant to the provisions of Section 304 hereof by the Person in whose name it is registered, in person or by his or her duly authorized attorney, upon surrender of such Bond for cancellation, accompanied by delivery of a written instrument of transfer in a form approved by the Paying Agent, duly executed. Whenever any Bond or Bonds shall be surrendered for transfer, the Paying Agent shall authenticate and deliver a new Bond or Bonds for a like aggregate principal amount and of the same maturity and interest rate and of any authorized denominations. The Bonds may be exchanged by the Paying Agent for a like aggregate principal amount of Bonds of the same maturity and interest rate and of other authorized denominations. The execution by the City of any Bond of any denomination shall constitute full and due authorization of such denomination and the Paying Agent shall thereby be authorized to authenticate and deliver such Bond.

The Paying Agent shall not be required to transfer or exchange (a) any Bond subject to redemption during a period beginning at the opening of business 15 days before the day of the

mailing of a notice of redemption of Bonds and ending at the close of business on the day such notice is mailed, or (b) any Bond so selected for redemption in whole or in part after the mailing of notice calling such Bond or any portion thereof for prior redemption except the unredeemed portion of Bonds being redeemed in part.

The Paying Agent shall require the payment by any Owner requesting exchange or transfer of any tax or other governmental charge required to be paid with respect to such exchange or transfer and may charge a sum sufficient to pay the cost of preparing each new Bond upon each exchange or transfer and any other expenses of the City or the Paying Agent incurred in connection therewith.

The foregoing provisions of this Section are subject to the provisions of Section 307 hereof.

Section 306. Bond Replacement. Upon receipt by the City and the Paying Agent of evidence satisfactory to them of the ownership of and the loss, theft, destruction or mutilation of any Bond and, in the case of a lost, stolen or destroyed Bond, of indemnity satisfactory to them, and in the case of a mutilated Bond upon surrender and cancellation of the Bond, (a) the City shall execute and the Paying Agent shall authenticate and deliver a new Bond of the same date, interest rate and denomination in lieu of such lost, stolen, destroyed or mutilated Bond, or (b) if such lost, stolen, destroyed or mutilated Bond shall have matured or have been called for redemption, in lieu of executing and delivering a new Bond as aforesaid, the City may pay such Bond. Any such new Bond shall bear a number not previously assigned. The applicant for any such new Bond may be required to pay all expenses and charges of the City and of the Paying Agent in connection with the issuance of such Bond. All Bonds shall be held and owned upon the express condition that, to the extent permitted by law, the foregoing conditions are exclusive with respect to the replacement and payment of mutilated, destroyed, lost or stolen Bonds, negotiable instruments or other securities.

Section 307. Custodial Deposit.

A. Depository. Notwithstanding any contrary provision of this Ordinance, the Bonds initially shall be evidenced by one Bond of the same maturity and interest rate in denominations equal to the aggregate principal amount of the Bonds of the same maturity and interest rate. Such initially delivered Bonds shall be registered in the name of "Cede & Co." as nominee for The Depository Trust Company, the securities depository for the Bonds. The Bonds may not thereafter be transferred or exchanged except:

(1) to any successor of The Depository Trust Company or its nominee, which successor must be both a "clearing corporation" as defined in Section 4-8-102(a)(5), C.R.S. and a qualified and registered "clearing agency" under Section 17A of the Securities Exchange Act of 1934, as amended; or

(2) upon the resignation of The Depository Trust Company or a successor or new depository institution under clause (1) or this clause (2) of this paragraph A, or a determination by the Council that The Depository Trust Company or such successor or a new

depository institution is no longer able to carry out its functions, and the designation by the Council of another depository institution acceptable to the Council and to the depository then holding the Bonds, which new depository must be both a "clearing corporation" as defined in Section 4-8-102(a)(5), C.R.S. and a qualified and registered "clearing agency" under Section 17A of the Securities Exchange Act of 1934, as amended, to carry out the functions of The Depository Trust Company or such successor new depository institution; or

(3) upon the resignation of The Depository Trust Company or a successor or new depository institution under clause (1) above or designation of a new depository institution pursuant to clause (2) above, or a determination of the Council that The Depository Trust Company or such successor or depository institution is no longer able to carry out its functions, and the failure by the Council, after reasonable investigation, to locate another depository institution under clause (2) to carry out such depository institution functions.

B. Successor. In the case of a transfer to a successor of The Depository Trust Company or its nominee as referred to in clause (1) or (2) of paragraph A hereof, upon receipt of the outstanding Bonds by the Paying Agent together with written instructions for transfer satisfactory to the Paying Agent, a new Bond for each maturity and interest rate of the Bonds then outstanding shall be issued to such successor or new depository, as the case may be, or its nominee, as is specified in such written transfer instructions. In the case of a resignation or determination under clause (3) of paragraph A hereof and the failure after reasonable investigation to located another qualified depository institution for the Bonds as provided in clause (3) of paragraph A hereof, and upon receipt of the outstanding Bonds by the Paying Agent, together with written instructions for transfer satisfactory to the Paying Agent, new Bonds shall be issued in authorized denominations as provided in and subject to the limitations of Sections 301, 304, and 305 hereof, registered in the names of such Persons, as are requested in such written transfer instructions; however, the Paying Agent shall not be required to deliver such new Bonds within a period of less than 60 days from the date of receipt of such written transfer instructions.

C. Absolute Owner. The Council and the Paying Agent shall be entitled to treat the Owner of any Bond as the absolute owner thereof for all purposes hereof and any applicable laws, notwithstanding any notice to the contrary received by any or all of them and the Council and the Paying Agent shall have no responsibility for transmitting payments or notices to the beneficial owners of the Bonds held by The Depository Trust Company or any successor or new depository named pursuant to paragraph A hereof.

D. Payment. The Council and the Paying Agent shall endeavor to cooperate with The Depository Trust Company or any successor or new depository named pursuant to clause (1) or (2) of paragraph A hereof in effectuating payment of the principal amount of the Bonds upon maturity or prior redemption by arranging for payment in such a manner that funds representing such payments are available to the depository on the date they are due.

E. Redemption. Upon any partial redemption of any maturity and interest rate of the Bonds, Cede & Co. (or its successor) in its discretion may request the City to issue and

authenticate a new Bond or shall make an appropriate notation on the Bond indicating the date and amount of prepayment, except in the case of final maturity, in which case the Bond must be presented to the Paying Agent prior to payment. The records of the Paying Agent shall govern in the case of any dispute as to the amount of any partial prepayment made to Cede & Co. (or its successor).

Section 308. Bond Cancellation. Whenever any Bond shall be surrendered to the Paying Agent upon payment thereof, or to the Paying Agent for transfer, exchange or replacement as provided herein, such Bond shall be promptly canceled and destroyed by the Paying Agent in accordance with its customary practices and applicable retention laws.

Section 309. Bond Form. Subject to the provisions of this Ordinance, the Bonds shall be in substantially the following forms, with such omissions, insertions, endorsements and variations as to any recitals of fact or other provisions as may be required by the circumstances, be required or permitted by this Ordinance, be consistent with this Ordinance or be necessary or appropriate to conform to the rules and requirements of any governmental authority or any usage or requirement of law with respect thereto:

(FORM OF BOND)

Unless this Bond is presented by an authorized representative of The Depository Trust Company, a New York corporation ("DTC"), to the City or its agent for registration of transfer, exchange, or payment, and any Bond issued is registered in the name of Cede & Co. or in such other name as is requested by an authorized representative of DTC (and any payment is made to Cede & Co. or to such other entity as is requested by an authorized representative of DTC), ANY TRANSFER, PLEDGE, OR OTHER USE HEREOF FOR VALUE OR OTHERWISE BY OR TO ANY PERSON IS WRONGFUL inasmuch as the registered owner hereof, Cede & Co., has an interest herein.

UNITED STATES OF AMERICA

STATE OF COLORADO CITY AND COUNTY OF BROOMFIELD

CITY AND COUNTY OF BROOMFIELD, COLORADO
WATER ACTIVITY ENTERPRISE
WATER REVENUE BOND
SERIES 2026

No. R- $_____

INTEREST RATE	MATURITY DATE	DATED AS OF	CUSIP
_____%	December __, 20__	[Date of Delivery]	_____

REGISTERED OWNER: CEDE & CO.

PRINCIPAL AMOUNT: _____ DOLLARS

The City and County of Broomfield (the "City"), for value received, hereby promises to pay to the registered owner specified above, or registered assigns, upon the presentation and surrender of this bond, solely from the special funds provided therefor, as hereinafter set forth, the principal amount set forth above on the maturity date specified above (unless this bond shall have been called for prior redemption, in which case on the Redemption Date) and to pay solely from such special funds interest hereon at the interest rate per annum specified above, payable semiannually on June 1 and December 1 in each year, beginning on _____, until the principal amount is paid or payment has been provided for, as described in an ordinance adopted by the City Council of the City on October 28, 2025 (the "Ordinance"). This is one of an authorized series of bonds issued under the Ordinance (the "Bonds"). The Bonds are all issued under and equally and ratably secured by and entitled to the security of the Ordinance. To the extent not defined herein, terms used in this Bond shall have the same meanings as set forth in the Ordinance. This Bond bears interest, matures, is payable, is subject to redemption and is transferable as provided in the Ordinance.

Reference is made to the Ordinance and to all Ordinances supplemental thereto, with respect to the nature and extent of the security for the Bonds, the accounts, funds or revenues pledged, rights, duties and obligations of the City, the Paying Agent and the Insurer, the Surety Provider, the rights of the Owners of the Bonds, the events of defaults and remedies, the circumstances under which any Bond is no longer Outstanding, the issuance of additional bonds and the terms on which such additional bonds may be issued under and secured by the Ordinance, the ability to amend the Ordinance, and to all the provisions of which the Owner hereof by the acceptance of this Bond assents.

THE BONDS ARE ISSUED PURSUANT TO AND IN FULL COMPLIANCE WITH THE CONSTITUTION AND LAWS OF THE STATE OF COLORADO, AND PURSUANT TO THE ORDINANCE. THE BONDS ARE SPECIAL, LIMITED OBLIGATIONS OF THE CITY, SECURED BY THE NET PLEDGED REVENUES. THE BONDS DO NOT CONSTITUTE A GENERAL OBLIGATION DEBT OF THE CITY, THE STATE OR ANY POLITICAL SUBDIVISION THEREOF, AND NEITHER THE CITY, THE STATE NOR ANY OF THE POLITICAL SUBDIVISIONS THEREOF IS LIABLE THEREFOR. NEITHER THE MEMBERS OF THE CITY COUNCIL OF THE CITY NOR ANY PERSONS EXECUTING THIS BOND SHALL BE PERSONALLY LIABLE FOR THIS BOND.

It is certified, recited and warranted that all the requirements of law have been fully complied with by the proper officers of the City in the issuance of this Bond; that it is issued pursuant to and in strict conformity with the Constitution of the State, and with the Ordinance and any ordinances supplemental thereto; and that this Bond does not contravene any Constitutional or statutory limitation.

This Bond is one of a series of bonds issued pursuant to the Bond Ordinance (the "Bond Ordinance") designated as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026" (the "Bonds") in the aggregate principal amount of $[_____]. The Bonds have been duly authorized for the purpose of providing moneys to defray a portion of the cost of extending, bettering or otherwise improving and equipping the System, (the "System").

The bonds of the series of which this bond is one are issued under the authority of the City Charter; Title 37, Article 45.1, C.R.S.; and Title 11, Article 57, Part 2, C.R.S., and in full conformity therewith. Pursuant to Section 11-57-210, C.R.S., this recital shall be conclusive evidence of the validity and the regularity of the issuance of the Bonds and the Bonds shall be incontestable for any cause whatsoever after their delivery for value.

Payment of the principal of and interest of the Bonds shall be made solely from the Net Pledged Revenues. The Net Pledged Revenues are irrevocably (but not exclusively) pledged as security for such payment pursuant to the Ordinance.

This Bond shall not be valid or become obligatory for any purpose or be entitled to any security or benefit under the Ordinance until the certificate of authentication hereon shall have been duly executed by the Paying Agent.

IN WITNESS WHEREOF, the City has caused this Bond to be signed and executed in its name and upon its behalf with the facsimile signature of its Mayor, has caused the facsimile of the seal of the City to be affixed hereon and has caused this Bond to be signed, executed and attested with the facsimile signature of its City Clerk, all as of the date specified above.

By _____ (For Facsimile Signature)
MAYOR

(FACSIMILE SEAL)

Attest:

_____ (For Facsimile Signature)
OFFICE OF THE CITY CLERK

(FORM OF CERTIFICATE OF AUTHENTICATION)

CERTIFICATE OF AUTHENTICATION

This is one of the Bonds described in the within mentioned Ordinance.

UMB BANK, N.A., as Paying Agent

By _____
Authorized Signatory

Date of Authentication and Registration: _____

(END OF FORM OF CERTIFICATE OF AUTHENTICATION)

(FORM OF ASSIGNMENT)

ASSIGNMENT

FOR VALUE RECEIVED the undersigned hereby sells, assigns and transfers unto _____ the within Bond and all rights thereunder, and hereby irrevocably constitutes and appoints _____ to transfer the within Bond on the records kept for the registration thereof with full power of substitution in the premises.

Dated: _____ Signed:_____

NOTICE: The signature to this assignment must correspond with the name as it appears on the face of the within Bond in every particular, without alteration or enlargement or any change whatever. The signature must be guaranteed by an eligible guarantor institution as defined in 17 CFR § 240.17 Ad-15(a)(2).

Signature Guaranteed:

_____

Signature must be guaranteed by a member
of a Medallion Signature Program.
Address of Transferee:

_____
_____
_____

Social Security or other tax
identification number of
transferee:

_____

TRANSFER FEES MAY BE CHARGED

(END OF FORM OF ASSIGNMENT)

(FORM OF PREPAYMENT PANEL)

PREPAYMENT PANEL

The following installments of principal (or portions thereof) of this Bond have been prepaid in accordance with the terms of the Ordinance.

Date of Prepayment	Principal Prepaid	Signature of Authorized Representative of DTC

(END OF FORM OF PREPAYMENT PANEL)

(END OF FORM OF BOND)

Section 310. Optional Redemption. The Bonds will be subject to redemption, if any, at the option of the City in the time and manner, in the amounts and at the prices, and from the funds all as set forth in the Sale Certificate.

Notwithstanding the foregoing, the Bonds may not be redeemed pursuant to this Section unless all Policy Costs, if any, due and owing at the time to the Surety Provider have been paid.

Section 311. Mandatory Sinking Fund Redemption. The Term Bonds, if any, shall be subject to mandatory sinking fund redemption at the times, in the amounts and at the prices provided in the Sale Certificate.

On or before the thirtieth day prior to each such sinking fund payment date, the Paying Agent shall proceed to call the Term Bonds, if any, as provided in the Sale Certificate (or any Term Bond or Term Bonds issued to replace such Term Bonds) for redemption from the sinking fund on the next December 1, and give notice of such call without further instruction or notice from the City.

At its option, to be exercised on or before the sixtieth day next preceding each such sinking fund Redemption Date, the City may (a) deliver to the Paying Agent for cancellation Term Bonds subject to mandatory sinking fund redemption on such date in an aggregate principal amount desired or (b) receive a credit in respect of its sinking fund redemption obligation for any Term Bonds of the maturity and interest rate subject to mandatory sinking fund redemption on such date, which prior to said date have been redeemed (otherwise than through the operation of the sinking fund) and canceled by the Paying Agent and not theretofore applied as a credit against any sinking fund redemption obligation. Each Term Bond so delivered or previously redeemed will be credited by the Paying Agent at the principal amount thereof against the obligation of the City on such sinking fund date and such sinking fund obligation will be accordingly reduced. The City will on or before the sixtieth day next preceding each sinking fund Redemption Date furnish the Paying Agent with its certificate indicating whether or not and to what extent the provisions of (a) and (b) of the preceding sentence are to be availed with respect to such sinking fund payment. Failure of the City to deliver such certificate shall not affect the Paying Agent's duty to give notice of sinking fund redemption as provided in this paragraph.

Section 312. Partial Redemption. In the case of Bonds of a denomination larger than $5,000, a portion of such Bond ($5,000 or any integral multiple thereof) may be redeemed, in which case the Paying Agent shall, without charge to the owner of such Bond, authenticate and issue a replacement Bond or Bonds for the unredeemed portion thereof.

Section 313. Notice of Prior Redemption. Notice of optional or mandatory redemption shall be given by the Paying Agent in the name of the City by sending a copy of such notice by first-class, postage prepaid mail, or by electronic means to DTC or its successors, not more

than sixty nor less than thirty days prior to the Redemption Date to each Owner at his address as it last appears on the registration books kept by the Paying Agent; but neither failure to give such notice nor any defect therein shall affect the redemption of any Bond. Such notice shall identify the Bonds to be so redeemed (if less than all are to be redeemed) and the Redemption Date, and shall further state that on such Redemption Date there will become and be due and payable upon each Bond so to be redeemed, at the principal office of the Paying Agent, the principal amount thereof, accrued interest to the Redemption Date, and the stipulated premium, if any, and that from and after such date interest will cease to accrue. Notice having been given in the manner hereinabove provided, the Bond or Bonds so called for redemption shall become due and payable on the Redemption Date so designated; and upon presentation thereof at the principal office of the Paying Agent, the Paying Agent will pay the Bond or Bonds so called for redemption. No further interest shall accrue on the principal of any such Bond called for redemption from and after the Redemption Date, provided sufficient funds are deposited with the Paying Agent and available on the Redemption Date.

Notwithstanding the provisions of this Section, any notice of redemption shall either (a) contain a statement that the redemption is conditioned upon the receipt by the Paying Agent on or before the Redemption Date of funds sufficient to pay the redemption price of the Bonds so called for redemption, and that if such funds are not available, such redemption shall be canceled by written notice to the Owners of the Bonds called for redemption in the same manner as the original redemption notice was mailed, or (b) be given only if funds sufficient to pay the redemption price of the Bonds so called for redemption are on deposit with the Paying Agent in the applicable fund or account.

Section 314. Bonds Owned by the City. Bonds owned by or on behalf of the City shall not be subject to redemption. At any time the City may surrender any Bonds owned by or on behalf of the City to the Paying Agent, which shall promptly cancel such Bonds.

Section 315. No Partial Redemption After Default. Anything in this Ordinance to the contrary notwithstanding, if there shall have occurred and is continuing an Event of Default hereunder of which an officer of the Paying Agent has actual knowledge, there shall be no redemption of less than all of the Bonds at the time Outstanding (other than pursuant to Section 402 hereof).

ARTICLE IV
USE OF BOND PROCEEDS AND OTHER MONEYS

Section 401. Disposition of Bond Proceeds.

A. The proceeds of the Bonds (net of underwriting discount), upon the receipt thereof, shall be accounted for in the following manner and priority:

(i) Reserve Fund. An amount equal to the portion of the Reserve Fund Requirement as described in the Sale Certificate, if any, shall be credited to the special and separate fund

hereby created and to be known as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026 Reserve Fund."

(ii) Project Fund. The remaining proceeds derived from the sale of the Bonds shall be credited to the special and separate account hereby created and to be known as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026 Project Fund." Except as otherwise provided herein, the moneys in the Project Fund shall be used solely for the purpose of paying the Cost of the Project and for the purposes set forth in Section 502 hereof.

Section 402. Payment of Expenses. Moneys deposited in the Project Fund pursuant to Section 501 hereof may be used and paid out by the City to defray the administrative costs of the Project, including, without limitation, amounts to be paid to the Paying Agent, legal fees, accounting fees, financial advisory fees, printing costs and rating fees. The City may defray any such administrative costs from time to time as Operation and Maintenance Expenses to the extent the moneys deposited in the Project Fund pursuant to Section 501 hereof are insufficient therefor.

Section 403. Completion of Project. When the Project is completed in accordance with the relevant plans and specifications and all amounts due therefor, including all proper incidental expenses and all administrative costs of the Project referred to in Section 502 hereof, are paid, or for which full provision is made, the Director of Finance, to the extent permitted by the Tax Compliance Certificate, shall cause all surplus moneys remaining in the Project Fund, if any, except for any moneys designated in the certificate to be retained to pay any unpaid accrued costs or contingent obligations, to be transferred as follows: (a) to the Rebate Fund so as to enable the City to comply with requirements of the Tax Compliance Certificate with respect to the Bonds, (b) to the Reserve Fund to such extent as shall not cause the amount in the Reserve Fund to exceed the Reserve Fund Requirement and (c) to the Bond Fund to the extent of any remaining balance of such moneys to be applied against the next principal payment or payments coming due on the Bonds. Nothing herein prevents the transfer from the Project Fund to the Bond Fund, at any time prior to the termination of the Project Fund, of any moneys which the Director of Finance by certificate determines will not be necessary for the Project and will not be designated to be transferred to the Rebate Fund.

Section 404. Lien on Bond Proceeds. Until the proceeds of the Bonds deposited in the Project Fund are applied as herein provided, such Bond proceeds are subject to a lien thereon and pledge thereof for the benefit of the Owners of the Outstanding Bonds as provided in Section 501 hereof.

Section 405. Purchaser Not Responsible. The validity of the Bonds is not dependent upon nor affected by the validity or regularity of any proceedings relating to the application of the Bond proceeds. The Purchaser and any subsequent Owners of any of the Bonds are not responsible for the application or disposal by the City or by any of its officers, agents and employees of the moneys derived from the sale of the Bonds or of any other moneys herein designated.

ARTICLE V
ADMINISTRATION OF AND ACCOUNTING FOR PLEDGED REVENUES

Section 501. Pledge Securing Bonds. Subject only to the right of the City to cause amounts to be withdrawn and paid on account of Operation and Maintenance Expenses of the System, the Gross Pledged Revenues and, subject to the right of the City to cause amounts to be withdrawn to pay the Cost of the Project as provided herein and other than moneys and securities held in the Rebate Fund to the extent such amounts are required to be paid to the United States, all moneys and securities paid or to be paid to or held or to be held in any fund or account under this Article or under Section 501 hereof are hereby pledged, and a lien thereon is hereby created, to secure the payment of the Bond Requirements of the Outstanding Bonds and to secure the obligations of the City to pay the Policy Costs. The pledge of the Net Pledged Revenues to secure the payment of the Bond Requirements of the Outstanding Bonds and the Parity Bonds is on a parity with the pledge of the Net Pledged Revenues for, and lien thereon of the Parity Bonds heretofore issued and any other Parity Bonds hereafter issued in compliance with the provisions of Article VII hereof. The pledge of Net Pledged Revenues to secure the payment of the Policy Costs is subordinate only to the pledge to pay the Bond Requirements with respect to the Bonds and any Parity Bonds. The pledge of the Net Pledged Revenues and the funds or accounts as described in this section shall be valid and binding from and after the date of the delivery of the Bonds, and the moneys as received by the City and hereby pledged shall immediately be subject to the lien of this pledge without any physical delivery thereof, any filing, or further act. The lien of this pledge and the obligation to perform the contractual provisions hereby made shall have priority over any or all other obligations and liabilities of the City except any Outstanding Parity Bonds heretofore or hereafter authorized and any Policy Costs as provided herein. The lien of the pledge of the Net Pledged Revenues and the funds or accounts as described in this section shall be valid and binding as against all parties having claims of any kind in tort, contract or otherwise against the City (except as herein otherwise provided) irrespective of whether such parties have notice thereof.

Section 502. Water Enterprise Fund Deposits. So long as any of the Bonds or any Parity Bonds shall be Outstanding, as to any Bond Requirements and Policy Costs related to the Bonds or any Parity Bonds, the entire Gross Pledged Revenues, upon their receipt from time to time by the City, shall be set aside and credited immediately to the special and separate account previously created and known as the "City of Broomfield, Enterprise Water Revenue Bonds, Water Enterprise Fund."

Section 503. Administration of Water Enterprise Fund. So long as any of the Bonds or any Parity Bonds shall be Outstanding, as to any Bond Requirements and Policy Costs related to the Bonds or any Parity Bonds, the following payments shall be made from the Water Enterprise Fund, as provided in Sections 504 through 511 hereof.

Section 504. Operation and Maintenance Expenses. First, as a first charge on the Water Enterprise Fund, from time to time there shall continue to be held therein moneys sufficient to pay Operation and Maintenance Expenses, as they become due and payable, and thereupon they shall be promptly paid. Any surplus remaining in the Water Enterprise Fund at the end of the Fiscal Year and not needed for Operation and Maintenance Expenses shall be used for other purposes of the Water Enterprise Fund as herein provided.

Section 505. Bond Fund Payments. Second, from any remaining Net Pledged Revenues, there shall be credited, concurrently with each other and with amounts required to meet the Bond Requirements with respect to any Outstanding Parity Bonds, to the special and separate accounts hereby created and to be known as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Bond Fund," the following amounts:

A. Interest Payments. Monthly to the Bond Fund, commencing on the first day of the month immediately succeeding the delivery of any of the Bonds, or commencing on the first day of the month six months next prior to the first interest payment date of any of the Bonds, whichever commencement date is later, an amount in equal monthly installments necessary, together with any moneys therein and available therefor, to pay the interest due and payable on the Outstanding Bonds on the next succeeding interest payment date.

B. Principal Payments. Monthly to the Bond Fund, commencing on the first day of the month immediately succeeding the delivery of any of the Bonds, or commencing on the first day of the month one year next prior to the first principal payment date of any of the Bonds, whichever commencement date is later, an amount in equal monthly installments necessary, together with any moneys therein and available therefor, to pay the principal and redemption premium, if any, due and payable on the Outstanding Bonds on the next succeeding principal payment date.

If prior to any interest payment date or principal payment date, there has been accumulated in the Bond Fund the entire amount necessary to pay the next maturing installment of interest or principal, or both, the payment required in paragraph A or B (whichever is applicable) of this Section 505 may be appropriately reduced; but the required annual amounts again shall be so credited to such account commencing on such interest payment date or principal payment date.

The moneys credited to the Bond Fund shall be used to pay the Bond Requirements of the Bonds then Outstanding, as such Bond Requirements become due, except as provided in Sections 508 and 1201 hereof.

Section 506. Reserve Fund Payments. In satisfaction of the Reserve Fund Requirement, upon delivery of the Bonds, and if so provided in the Sale Certificate, either proceeds of the Bonds, cash or a Reserve Fund Insurance Policy in the amount of the Reserve Fund Requirement being provided by Surety Provider shall be deposited in the special and separate fund hereby created and to be known as the "City and County of Broomfield, Colorado, Water Activity

Enterprise Water Revenue Bonds, Series 2026, Reserve Fund". The proceeds of the Bonds, cash or a Reserve Fund Insurance Policy shall be credited to Reserve Fund as provided in the Sale Certificate. Any Reserve Fund Insurance Policy shall be held by the Paying Agent. Any Reserve Fund Insurance Policy deposited to the credit of the Reserve Fund shall be valued at the amount available to be drawn or otherwise paid pursuant to such Reserve Fund Insurance Policy at the time of calculation. The Paying Agent shall maintain adequate records as to the amount available to be drawn at any time under the Reserve Fund Insurance Policy and as to the amounts, of which it has knowledge, of Policy Costs paid and owing to the Surety Provider. Such records shall be open to inspection and verification by the Surety Provider during business hours of the Paying Agent.

Upon the execution and delivery of the Bonds, there shall be deposited to the Reserve Fund, if a Reserve Fund is required and set forth in the Sale Certificate, and in the amount set forth in the Sale Certificate, from proceeds of the Bonds or a Reserve Fund Insurance Policy. Moneys on deposit in the Reserve Fund shall only be used to pay debt service on the Bonds to the extent of any deficiency in the Bond Fund or may be applied to the defeasance of the Bonds. Moneys shall be drawn from the Reserve Fund only after amounts on deposit in the Supplemental Reserve Fund have been exhausted.

Thereafter, third, except as provided in Section 508 and 509 hereof, and concurrently with any payments required to be made pursuant to any Parity Bond Ordinances with respect to any reserve funds which may be, but are not required to be, established thereby and concurrently with any repayment or similar obligations payable to any surety provider issuing any reserve fund insurance policy with respect to any Parity Bonds, from any moneys remaining in the Water Enterprise Fund there shall be credited to the Reserve Fund monthly, commencing on the first day of the month next succeeding each date on which the moneys accounted for in the Reserve Fund for any reason are less than the Reserve Fund Requirement, such amounts in substantially equal monthly payments on the first day of each month to re-accumulate the Reserve Fund Requirement by not more than 12 such monthly payments. If a Reserve Fund Insurance Policy is on deposit in the Reserve Fund to fund all or a part of the Reserve Fund Requirement, the amounts payable into the Reserve Fund pursuant to the immediately preceding sentence shall be paid by the City first to the Surety Provider to reimburse it for Policy Costs due and owing and second to replenish cash in the Reserve Fund. If there are insufficient Net Pledged Revenues to comply with the requirements of the first sentence of this paragraph, available Net Pledged Revenues shall be credited or paid to the Reserve Fund and to reserve funds which may be established by any Parity Bond Ordinances (or to the Surety Provider or any other surety provider issuing any reserve fund insurance policy with respect to any Parity Bonds) pro rata, based upon the aggregate principal amount of the Bonds and any such Parity Bonds then Outstanding; provided, however, that compliance with the provisions of this sentence shall not cure any Event of Default caused by non-compliance with the first sentence of this paragraph. If there are insufficient Net Pledged Revenues to comply with the requirements of the first sentence of this paragraph and more than one Reserve Fund Insurance Policy is on deposit in the Reserve Fund, available Net Pledged Revenues credited to or paid to the Reserve Fund shall be applied to reimburse the

Surety Provider and any other surety provider providing a Reserve Fund Insurance Policy pro rata, based upon the original amount available to be drawn on each. The Reserve Fund Requirement shall be accumulated and, if necessary, re-accumulated from time to time, in the Reserve Fund from Net Pledged Revenues, except to the extent other moneys are credited to the Reserve Fund, and maintained as a continuing reserve to be used, except as hereinafter provided in Sections 508, 509, 604 and 1201 hereof, only to prevent deficiencies in the payment of the Bond Requirements of the Bonds Outstanding from time to time from the failure to deposit into the Bond Fund sufficient moneys to pay such Bond Requirements as the same accrue and become due. No payment need be made into the Reserve Fund at any time so long as the moneys and/or the Reserve Fund Insurance Policy therein equal not less than the Reserve Fund Requirement and there are no Policy Costs due and owing. Unless otherwise provided in the Sale Certificate, the Reserve Fund Requirement shall be re-calculated upon (i) any principal payment, whether at stated maturity or upon redemption, or (ii) the defeasance of all or a portion of the Bonds.

The City may at any time substitute (a) cash or Investment Securities for a Reserve Fund Insurance Policy or (b) a Reserve Fund Insurance Policy for cash or Investment Securities, so long as the amount on deposit in the Reserve Fund after such substitution is at least equal to the Reserve Fund Requirement. Notwithstanding the foregoing, no Reserve Fund Insurance Policy shall be deposited by the City in the Reserve Fund for such substitution unless the City has received an opinion of Bond Counsel to the effect that such substitution and the intended use by the City of the cash or Investment Securities to be released from the Reserve Fund will not adversely affect the exclusion from gross income for federal income tax purposes of interest on the Bonds.

Section 507. Supplemental Reserve Fund. Moneys in the Supplemental Reserve Fund, if such a fund is required and funded in an amount set forth in the Sale Certificate, shall held by the Paying Agent, and utilized, if necessary, only to prevent a default in the payment of the principal of, premium, if any, and interest on the Bonds when due, (including on any mandatory sinking fund redemption date or at final maturity) and the Supplemental Reserve Fund is pledged to the payment of the Bonds for such purpose.

Fourth, except as provided in Section 508 and 509 hereof, and concurrently with any payments required to be made pursuant to any Parity Bond Ordinances with respect to any supplemental reserve funds which may be, but are not required to be, established thereby, from any moneys remaining in the Water Enterprise Fund there shall be credited to the Supplemental Reserve Fund monthly, commencing on the first day of the month next succeeding each date on which the moneys accounted for in the Supplemental Reserve Fund are less than the Supplemental Reserve Fund Requirement, such amounts as is necessary to fund the Supplemental Reserve Fund to the Supplemental Reserve Fund Requirement. Any draws on the Supplemental Reserve Fund shall be replenished in the same manner as described in Section 5.06 above with respect to replenishment of the Reserve Fund and only to the extent of available revenue from the Water Enterprise Fund.

If on any date the amounts then on deposit in the Bond Fund are insufficient to pay the principal of, premium, if any, and/or interest on the Bonds on the next scheduled payment date, sinking fund installment date or at maturity, the Paying Agent shall transfer from the Supplemental Reserve Fund to the Bond Fund an amount which, when combined with moneys then on deposit therein, will be sufficient to make such payment of the Bonds when due. In the event that moneys in the Supplemental Reserve Fund, together with moneys in the Bond Fund, are insufficient to make such payment when due, the Paying Agent is to nonetheless transfer all moneys in the Supplemental Reserve Fund to the Bond Fund for the purpose of making partial payments on the Bonds. Bonds shall be selected for any such partial payments in the same manner as selected for mandatory sinking fund redemption.

Amounts in the Supplemental Reserve Fund are to be transferred to the Bond Fund prior to the transfer of moneys from the Reserve Fund to the Bond Fund.

Amounts on deposit in the Supplemental Reserve Fund may be invested or deposited at the direction of the District in Permitted Investments only and in accordance with the laws of the State and shall be valued on the basis of their current market value, as reasonably determined by the District, which value shall be determined at least annually.

Section 508. Termination of Deposits. No payment need be made into the Bond Fund or the Reserve Fund if there are no Policy Costs due and owing and if the amount in the Bond Fund and the amount in the Reserve Fund (exclusive of the amount available under a Reserve Fund Insurance Policy) total a sum at least sufficient so that all Bonds Outstanding are deemed to have been paid pursuant to Section 1201 hereof, in which case moneys therein (taking into account the known minimum gain from any investment if such moneys in Investment Securities from the time of any such investment or deposit shall be needed for such payment which will not be designated for transfer to the Rebate Fund) shall be used (together with any such gain from such investments) solely to pay the Bond Requirements of the Outstanding Bonds as the same become due; and any moneys in excess thereof in those two accounts and any other moneys derived from the Net Pledged Revenues or otherwise pertaining to the System may be used to make required payments into the Rebate Fund or in any other lawful manner determined by the Council.

Section 509. Defraying Delinquencies. If at any time the City shall for any reason fail to pay into the Bond Fund the full amount above stipulated from the Net Pledged Revenues, then an amount shall be paid into the Bond Fund at such time first from the Supplemental Reserve Fund and then from the Reserve Fund equal to the difference between that paid from the Net Pledged Revenues and the full amount so stipulated. The City shall use all cash in the Reserve Fund before drawing on a Reserve Fund Insurance Policy. If, (i) upon notice from the City requesting a draw or (ii) failure of the Paying Agent to receive the Bond Requirements by the third Business Day prior to June 1 or December 1 in each year, the Paying Agent determines that it is necessary to draw on the Reserve Fund Insurance Policy, the Paying Agent shall present a demand for payment, in the form and manner required by the Reserve Fund Insurance Policy, at least two Business Days before funds are needed. If there is more than

one Reserve Fund Insurance Policy on deposit in the Reserve Fund, the Paying Agent shall draw on them on a pro rata basis, based upon the amount available to be drawn on each.

Any money so used or drawn shall be replaced as provided in Sections 506 and 507 hereof from the first Net Pledged Revenues thereafter received and not required to be otherwise applied by this Article. Except as provided in Sections 506 and 507 hereof, the moneys in the Bond Fund, the Supplemental Reserve Fund and in the Reserve Fund (including any Reserve Fund Insurance Policy) shall be used solely and only for the purpose of paying the Bond Requirements of the Bonds from time to time.

If the amount on deposit in the Reserve Fund exceeds the Reserve Fund Requirement for any reason, the amount to be released from the Reserve Fund shall be as directed in writing by the City Manager. Any excess amount released from the Reserve Fund may be deposited in the Bond Fund, or deposited into a defeasance escrow account, or may be applied for other purposes, as directed in writing by the City Manager for such purposes authorized by law.

Section 510. Rebate Fund. Fifth, concurrently with any payments required to be made pursuant to any Parity Bond Ordinances with respect to any rebate funds established thereby, there shall be deposited into the special and separate accounts hereby created and to be known as the "City and County of Broomfield, Colorado, Water Activity Enterprise Water Revenue Bonds, Series 2026, Rebate Fund" moneys in the amounts and at the times specified in the Tax Compliance Certificate so as to enable the City to comply with Section 830 hereof. Amounts on deposit in the Rebate Fund shall not be subject to the lien and pledge of this Ordinance to the extent that such amounts are required to be paid to the United States Treasury. The City shall cause amounts on deposit in the Rebate Fund to be forwarded to the United States Treasury (at the address provided in the Tax Compliance Certificate) at the times and in the amounts set forth in the Tax Compliance Certificate.

If the moneys on deposit in the Rebate Fund are insufficient for the purposes thereof, the City shall transfer moneys in the amount of the insufficiency to the Rebate Fund from the Project Fund and, to the extent permitted by Section 509 hereof, from the Supplemental Reserve Fund, the Reserve Fund and the Bond Fund. Upon receipt by the City of an opinion of Bond Counsel to the effect that the amount in the Rebate Fund is in excess of the amount required to be contained therein, such excess may be transferred to the Water Enterprise Fund.

Section 511. Payment of Subordinate Securities. Sixth, and subject to the provisions hereinabove in this Article, but subsequent to the payments required by Sections 504, 505, 506, 507 and 510 hereof, any moneys remaining in the Water Enterprise Fund may be used by the City for the payment of Bond Requirements of Subordinate Securities, including reasonable reserves for such Subordinate Securities and for rebate of amounts to the United States Treasury with respect to such Subordinate Securities.

Section 512. Use of Remaining Revenues. After the payments hereinabove required to be made by Sections 502 through 511 hereof are made, any remaining Net Pledged Revenues in the Water Enterprise Fund shall be used, firstly, for any one or any combination of reasonably

necessary purposes and in the Council's discretion relating to the operation, improvement or debt management of the System and, secondly, to the extent of any remaining surplus, for any one or any combination of lawful purposes as the Council may from time to time conclusively determine.

ARTICLE VI
GENERAL ADMINISTRATION

Section 601. Administration of Accounts. The special funds and accounts designated in Articles IV and V hereof shall be administered as provided in this Article (but not any account under Section 1201 hereof).

Section 602. Places and Times of Deposits. Except as hereinafter provided, each of such special funds and accounts shall be maintained by the City as a book account and kept separate from all other accounts as a trust account solely for the purposes herein designated therefor. The moneys accounted for in such special book accounts may be in one or more bank accounts in one or more Commercial Banks. Each such bank account shall be continuously secured to the fullest extent required or permitted by the laws of the State for the securing of public funds and shall be irrevocable and not withdrawable by anyone for any purpose other than the respective designated purposes. Each periodic payment shall be credited to the proper book account not later than the date therefor herein designated, except that when any such date shall not be a Business Day, then such payment shall be made on or before the next preceding Business Day. Moneys shall be deposited with the Paying Agent for the Bonds not less than (a) three Business Days prior to each interest payment date and each maturity or mandatory Redemption Date, if funds are delivered by wire transfer, or (b) five Business Days prior to each payment date if funds are delivered by another method of payment, in immediately available amounts sufficient to pay the Bond Requirements then becoming due on the Outstanding Bonds.

Section 603. Investment of Moneys. Any moneys in the Project Fund, Water Enterprise Fund, Bond Fund, Supplemental Reserve Fund, Reserve Fund, and Rebate Fund and not needed for immediate use shall be invested or reinvested by the Director of Finance in Investment Securities. All such investments shall (a) either be subject to redemption at any time at a fixed value by the holder thereof at the option of such holder, or (b) mature not later than the estimated date or respective dates on which the proceeds are to be expended as estimated by the Director of Finance at the time of such investment or reinvestment; provided that (1) Investment Securities credited to the Reserve Fund shall not mature later than ten years from the date of such investment or reinvestment and (2) collateral securities of any Investment Securities may have a maturity of more than five years from the date of purchase thereof. For the purpose of any such investment or reinvestment, Investment Securities shall be deemed to mature at the earliest date on which the obligor is, on demand, obligated to pay a fixed sum in discharge of the whole of such obligations.

Section 604. Accounting for Investments. The Investment Securities so purchased as an investment or reinvestment of moneys in any such account hereunder shall be deemed at all

times to be a part of the account. Any interest or other gain from any investments and reinvestments of moneys accounted for in the Water Enterprise Fund, the Project Fund, the Bond Fund, and the Rebate Fund shall be credited to such account, and any loss resulting from any such investments or reinvestments of moneys accounted for in the Water Enterprise Fund, the Project Fund, the Bond Fund, the Supplemental Reserve Fund, the Reserve Fund, and the Rebate Fund shall be charged or debited to such Fund.

Any interest or other gain from any investment or reinvestment of moneys accounted for in the Reserve Fund (a) shall be credited to the Rebate Fund or the Bond Fund, at the discretion of the Director of Finance, if the amount credited to the Reserve Fund immediately after such credit to the Rebate Fund or the Bond Fund is not less than the Reserve Fund Requirement and (b) if the amount credited to the Reserve Fund is less than the Reserve Fund Requirement, shall be credited to the Reserve Fund (up to the amount of the deficiency).

No loss or profit in any account on any investments or reinvestments in Investment Securities shall be deemed to take place as a result of market fluctuations of the Investment Securities prior to the sale or maturity thereof. In the computation of the amount in any account for any purpose hereunder, except as herein otherwise expressly provided or for rebate purposes, as described in the Tax Compliance Certificate, Investment Securities shall be valued at the cost thereof (including any amount paid as accrued interest at the time of purchase of the obligation); provided that any time or demand deposits shall be valued at the amounts deposited, in each case exclusive of any accrued interest or any other gain to the City until such gain is realized by the presentation of matured coupons for payment or otherwise.

Section 605. Redemption or Sale of Investment Securities. The Director of Finance shall present for redemption or sale on the prevailing market at the best price obtainable any Investment Securities so purchased as an investment or reinvestment of moneys in the account whenever it shall be necessary in order to provide moneys to meet any withdrawal, payment or transfer from such account. Neither the Director of Finance nor any other officer or employee of the City shall be liable or responsible for any loss resulting from any such investment or reinvestment made in accordance with this Ordinance.

Section 606. Character of Funds. The moneys in any account designated in Articles IV and V hereof shall consist either of lawful money of the United States or Investment Securities, or both such money and such Investment Securities. Moneys deposited in a demand or time deposit account in a bank or savings and loan association, appropriately secured according to the laws of the State, shall be deemed lawful money of the United States.

Section 607. Payment of Bond Requirements. The moneys credited to any fund or account designated in Article V hereof for the payment of the Bond Requirements of any Bonds shall be used without requisition, voucher, warrant, further order or authority (other than is contained herein), or any other preliminaries, to pay promptly the Bond Requirements of any Bonds payable from such fund or account as such amounts are due, except to the extent any other moneys are available therefor.

ARTICLE VII
SECURITIES LIENS AND ADDITIONAL SECURITIES

Section 701. Lien of Bonds. The Bonds constitute an irrevocable lien (but not necessarily an exclusive lien) upon the Net Pledged Revenues on a parity with the lien of the Net Pledged Revenues of the Parity Bonds. The Policy Costs constitute an irrevocable and subordinate lien (but not necessarily an exclusive subordinate lien) upon the Net Pledged Revenues.

Section 702. Equality of Bonds. The Bonds and any Parity Bonds heretofore issued or hereafter authorized to be issued and from time to time Outstanding are equitably and ratably secured by a lien on the Net Pledged Revenues and shall not be entitled to any priority one over the other in the application of the Net Pledged Revenues regardless of the time or times of the issuance of the Bonds and any other such Parity Bonds, it being the intention of the Council that there shall be no priority among the Bonds and any such Parity Bonds regardless of the fact that they may be actually issued and delivered at different times, except that (a) moneys in the Project Fund, Bond Fund, the Supplemental Reserve Fund, and Reserve Fund shall secure only the Bonds and the moneys in any acquisition, bond, reserve or similar funds established for other Parity Bonds shall secure only such Parity Bonds; and (b) other Parity Bonds may have a lien on Net Pledged Revenues on a parity with the lien thereon of the Bonds even if no supplemental reserve fund or reserve fund is established for such Parity Bonds or a supplemental reserve fund or reserve fund is established but with a different requirement as to the amount of moneys (or the value of a supplemental reserve fund or reserve fund insurance policy with respect to such Parity Bonds) required to be on deposit therein or the manner in which such supplemental reserve fund or reserve fund is funded or the period of time over which such supplemental reserve fund or reserve fund is funded.

Section 703. Issuance of Parity Bonds. Nothing herein prevents the issuance by the City of additional securities payable from the Net Pledged Revenues and constituting a lien thereon on a parity with, but not prior nor superior to, the lien thereon of the Bonds; but before any such additional Parity Bonds, except as provided in Section 708, are authorized or actually issued all of the following conditions are satisfied:

A. Absence of Default. At the time of the adoption of the ordinance authorizing the issuance of the additional securities, the City shall not be in default in making any payments required by Article V hereof or other Parity Bond Ordinances, including any payments of Policy Costs.

B. Historic Earnings Test. The Net Pledged Revenues for any 12 consecutive months out of the 24 months preceding the month in which such securities are to be issued are at least equal to the sum of 110% of the Combined Maximum Annual Principal and Interest

Requirements of all Outstanding Bonds, Outstanding Parity Bonds and such additional Parity Bonds proposed to be issued.

C. Adjustment of Gross Pledged Revenues. In any computation under paragraph B of this Section, the amount of the Gross Pledged Revenues for the applicable period shall be decreased and may be increased by the amount of loss or gain conservatively estimated by an Independent Accountant, Independent Engineer or the Director of Finance, as the case may be, which results from any changes in any schedule of fees, rates and other charges constituting Gross Pledged Revenues based on the number of users during the applicable period as if such modified schedule of fees, rates and other charges shall have been in effect during such entire time period. However, the Gross Pledged Revenues need not be decreased by the amount of any such estimated loss to the extent the Independent Accountant, the Independent Engineer or the Director of Finance estimates the loss is temporary in nature or will be offset within a reasonable temporary period by an increase in revenues or a reduction in Operation and Maintenance Expenses not otherwise included in the calculations under this Section, and estimates any loss under this sentence will not at any time materially and adversely affect the City's apparent ability to comply with the rate maintenance covenant stated in Section 821 hereof without modification because of any restrictive legislation, regulation or other action under the police power exercised by any governmental body.

D. Reduction of Annual Requirements. The respective annual Bond Requirements (including as such a requirement the amount of any prior redemption premiums due on any Redemption Date) shall be reduced to the extent such Bond Requirements are scheduled to be paid in each of the respective Fiscal Years with moneys held in trust or in escrow for that purpose by any Trust Bank, including the known minimum yield from any investment in Federal Securities and any bank deposits, including any certificate of deposit.

E. Consideration of Additional Expenses. In determining whether or not additional Parity Bonds may be issued as aforesaid, consideration shall be given to any probable increase (but not reduction) in the Operation and Maintenance Expenses of the System as estimated by the Director of Finance that will result from the expenditure of the funds proposed to be derived from the issuance and sale of the additional securities; but the Director of Finance may reduce any such increase in Operation and Maintenance Expenses by the amount of any increase in revenues or any reduction in Operation and Maintenance Expenses resulting from the Capital Improvements to which such expenditure relates and not otherwise included in the calculations under this Section, if the Director of Finance also opines that any such increase in revenues or reduction in any increase in Operation and Maintenance Expenses will not materially and adversely affect the City's apparent ability to comply with the rate maintenance covenant stated in Section 821 hereof without modification because of any restrictive legislation, regulation or other action under the police power exercised by any governmental body.

Section 704. Certification of Revenues. A written certificate or written opinion by the Director of Finance that the annual revenues required under paragraph B of Section 703

hereof, when adjusted as hereinabove provided in paragraphs C, D, and E of Section 703 hereof, are sufficient to pay such amounts, as provided in paragraph B of Section 703 hereof, shall be conclusively presumed to be accurate in determining the right of the City to authorize, issue, sell and deliver additional securities on a parity with the Bonds.

Section 705. Subordinate Securities Permitted. Nothing herein prevents the City from issuing additional securities payable from the Net Pledged Revenues and having a lien thereon subordinate, inferior and junior to the lien thereon of the Bonds.

Section 706. Superior Securities Prohibited. Nothing herein permits the City to issue additional securities payable from the Net Pledged Revenues and having a lien thereon prior and superior to the lien thereon of the Bonds.

Section 707. Use of Proceeds. The proceeds of any Parity Bonds or other securities payable from any Net Pledged Revenues shall be used only to finance Capital Improvements or to refund all or any portion of the Bonds, Parity Bonds, or other securities payable from Net Pledged Revenues, regardless of the priority or the lien of such securities on Net Pledged Revenues.

Section 708. Issuance of Refunding Securities. The City may issue any refunding securities payable from Net Pledged Revenues to refund any Outstanding Bonds or Parity Bonds, with such details as the Council may by ordinance provide so long as there is no material impairment of any contractual obligation imposed upon the City by any proceedings authorizing the issuance of any unrefunded portion of such Outstanding securities of any one or more issues; but so long as the Bonds, or any part thereof, are Outstanding, refunding securities payable from Net Pledged Revenues may be issued on a parity with the unrefunded Bonds only if:

A. Prior Consent. The City first receives the consent of the Owner or Owners of the unrefunded portion of the Bonds; or

B. Requirements Not Increased. The Combined Maximum Annual Principal and Interest Requirements for the Bonds and Parity Bonds Outstanding immediately after the issuance of the refunding securities is not greater than the Combined Maximum Annual Principal and Interest Requirements for all Bonds and Parity Bonds Outstanding immediately prior to the issuance of the refunding securities and the lien of any refunding Parity Bonds on the Net Pledged Revenues is not raised to a higher priority than the lien thereon of any securities thereby refunded; or

C. Earnings Test. The refunding securities are issued in compliance with Section 703 hereof.

ARTICLE VIII
PROTECTIVE COVENANTS

Section 801. General. The City hereby covenants and agrees with the Owners of the Bonds and makes provisions which shall be a part of its contract with such Owners to the effect and with the purpose set forth in the following Sections of this Article.

Section 802. Performance of Duties. The City, acting by and through the Council or otherwise, shall faithfully and punctually perform, or cause to be performed, all duties with respect to the Gross Pledged Revenues and the System required by the Constitution and laws of the State and the various ordinances of the City, including, without limitation, the making and collection of reasonable and sufficient fees, rates and other charges for services rendered or furnished by or the use of the System, as herein provided, and the proper segregation of the proceeds of the Bonds and of any securities hereafter authorized and the Gross Pledged Revenues and their application from time to time to the respective accounts provided therefor.

Section 803. Contractual Obligations. The City shall perform all contractual obligations undertaken by it under any agreements relating to the Bonds, the Gross Pledged Revenues, the Project, or the System, or any combination thereof, with any other Persons.

Section 804. Further Assurances. At any and all times the City shall, so far as it may be authorized by law, pass, make, do, execute, acknowledge, deliver and file or record all and every such further instruments, acts, deeds, conveyances, assignments, transfers, other documents and assurances as may be reasonably necessary or desirable for the better assuring, conveying, granting, assigning and confirming all and singular the rights, the Gross Pledged Revenues and other moneys and accounts hereby pledged or assigned, or intended so to be, or which the City may hereafter become bound to pledge or to assign, or as may be reasonable and required to carry out the purposes of this Ordinance and to comply with any instrument of the City amendatory thereof, or supplemental thereto. The City, acting by and through the Council, or otherwise, shall at all times, to the extent permitted by law, defend, preserve and protect the pledge of the Gross Pledged Revenues and other moneys and accounts pledged hereunder and all the rights of every Owner of any Bond hereunder against all claims and demands of all Persons whomsoever.

Section 805. Conditions Precedent. Upon the date of issuance of the Bonds, all conditions, acts and things required by the Federal or State Constitution, Title 37, Article 45.1, C.R.S., Title 11, Article 57, Part 2, C.R.S., this Ordinance, or any other applicable law to exist, to have happened and to have been performed precedent to or in the issuance of the Bonds shall exist, have happened, and have been performed; and the Bonds, together with all other obligations of the City, shall not contravene any debt or other limitation prescribed by the State Constitution.

Section 806. Efficient Operation and Maintenance. The City shall at all times operate the System properly and in a sound and economical manner; and the City shall maintain, preserve

and keep the same properly or cause the same so to be maintained, preserved and kept, with the appurtenances and every part and parcel thereof in good repair, working order and condition, and shall from time to time make or cause to be made all necessary and proper repairs, replacements and renewals so that at all times the operation of the System may be properly and advantageously conducted. All salaries, fees, wages and other compensation paid by the City in connection with the maintenance, repair and operation of the System shall be reasonable and proper.

Section 807. Rules, Regulations and Other Details. The City, acting by and through the Council, shall establish and enforce reasonable rules and regulations governing the operation, use and services of the System. The City shall observe and perform all of the terms and conditions contained in this Ordinance, and shall comply with all valid acts, rules, regulations, orders and directions of any legislative, executive, administrative or judicial body applicable to the System or to the City, except for any period during which the same are being contested in good faith by proper legal proceedings.

Section 808. Payment of Governmental Charges. The City shall pay or cause to be paid all taxes and assessments or other governmental charges, if any, lawfully levied or assessed upon or in respect of the System, or upon any part thereof, or upon any portion of the Gross Pledged Revenues, when the same shall become due, and shall duly observe and comply with all valid requirements of any governmental authority relative to the System or any part thereof, except for any period during which the same are being contested in good faith by proper legal proceedings. The City shall not create or suffer to be created any lien upon the System, or any part thereof, or upon the Gross Pledged Revenues, except the pledge and lien created by this Ordinance for the payment of the Bond Requirements of the Bonds and except as herein otherwise permitted. The City shall pay or cause to be discharged or shall make adequate provision to satisfy and to discharge, within 60 days after the same shall become payable, all lawful claims and demands for labor, materials, supplies or other objects which, if unpaid, might by law become a lien upon the System, or any part thereof, or the Gross Pledged Revenues; but nothing herein requires the City to pay or cause to be discharged or to make provision for any such tax, assessment, lien or charge, so long as the validity thereof is contested in good faith and by appropriate legal proceedings.

Section 809. Protection of Security. The City, the officers, agents and employees of the City, and the Council shall not take any action in such manner or to such extent as might prejudice the security for the payment of the Bond Requirements of the Bonds, the Parity Bonds, and any other securities payable from the Net Pledged Revenues or any Policy Costs relating thereto according to the terms thereof. No contract shall be entered into nor any other action taken by which the rights of any Owner of any Bond or other security payable from Net Pledged Revenues or any Policy Costs relating thereto might be prejudicially and materially impaired or diminished.

Section 810. Prompt Payment of Bonds. The City shall promptly pay the Bond Requirements of the Bonds at the places, on the dates and in the manner specified herein and in the Bonds according to the true intent and meaning hereof.

Section 811. Use of Bond Fund, Supplemental Reserve and Reserve Funds. The Bond Fund, the Supplemental Reserve Fund and the Reserve Fund shall be used solely for and the moneys credited to such funds and accounts therein are hereby pledged, and a lien thereon is hereby created, for the purpose of paying the Bond Requirements of the Bonds to their respective maturities or any Redemption Date or Dates, subject to the provisions of Sections 506, 507, 508, 509, 604 and 1201 hereof.

Section 812. Other Liens. Other than as provided herein, there are no liens or encumbrances of any nature whatsoever on or against the System, or any part thereof, or on or against the Gross Pledged Revenues on a parity with or superior to the lien thereon of the Bonds.

Section 813. Corporate Existence. The City shall maintain its corporate identity and existence so long as any of the Bonds remain Outstanding, unless another body corporate and politic by operation of law succeeds to the powers, privileges, rights, liabilities, disabilities, duties and immunities of the City and is obligated by law to operate and maintain the System and to fix and collect the Gross Pledged Revenues as herein provided without adversely and materially affecting at any time the privileges and rights of any Owner of any Outstanding Bond.

Section 814. Disposal of System Prohibited. Except for the use of the System and services pertaining thereto in the normal course of business, or as provided in Section 815 hereof, neither all nor a substantial part of the System shall be sold, leased, mortgaged, pledged, encumbered, alienated or otherwise disposed of, until all the Bonds have been paid in full, as to all Bond Requirements, or unless provision has been made therefor, or until the Bonds have otherwise been redeemed, including, without limitation, the termination of the pledge as herein authorized; and the City shall not dispose of its title to the System or to any useful part thereof, including any property necessary to the operation and use of the System and the lands and interests in lands comprising the sites of the System.

Section 815. Disposal of Unnecessary Property. The City at any time and from time to time may sell, exchange, lease or otherwise dispose of any property constituting a part of the System and not useful in the construction, reconstruction or operation thereof, or which shall cease to be necessary for the efficient operation of the System, or which shall have been replaced by other property of at least equal value. Any proceeds of any such sale, exchange, lease or other disposition received and not used to replace such property so sold or so exchanged or otherwise so disposed of, shall be deposited by the City in the Water Enterprise Fund or into a special book account for the betterment, enlargement, extension, other improvement and equipment of the System, or any combination thereof, as the Council may determine, provided that any proceeds of any such lease received shall be deposited by the City as Gross Pledged Revenues in the Water Enterprise Fund.

Section 816. Competing System. So long as any of the Bonds are Outstanding, the City shall not grant any franchise or license to any competing facilities so that the Gross Pledged Revenues shall not be sufficient to satisfy the covenant in Section 821 hereof.

Section 817. Loss From Condemnation. If any part of the System is taken by the exercise of the power of eminent domain, the amount of any award received by the City as a result of such taking shall be paid into the Water Enterprise Fund or into a capital improvement account pertaining to the System for the purposes thereof, or, applied to the redemption of the Outstanding Bonds and any Outstanding Parity Bonds relating thereto, all as the City may determine.

Section 818. Employment of Management Engineers. If the City defaults in paying the Bond Requirements of the Bonds or any Parity Bonds, and any other securities or Policy Costs relating thereto payable from the Gross Pledged Revenues promptly as the same fall due, or an Event of Default has occurred and is continuing, or if the Net Pledged Revenues in any Fiscal Year fail to equal at least the amount of the Bond Requirements of the Outstanding Bonds, Parity Bonds, and any other securities (including all reserves therefor specified in the authorizing proceedings, including, without limitation, this Ordinance) or Policy Costs relating thereto payable from the Net Pledged Revenues in that Fiscal Year, the City shall retain a firm of competent management engineers skilled in the operation of such facilities to assist the management of the System so long as such default continues or so long as the Net Pledged Revenues are less than the amount hereinabove designated in this Section.

Section 819. Budgets. The Council and officials of the City shall annually and at such other times as may be provided by law prepare and adopt a budget pertaining to the System.

Section 820. Reasonable and Adequate Charges. While the Bonds remain Outstanding and unpaid, the fees, rates and other charges due to the City for the use of or otherwise pertaining to and services rendered by the System to the City, to its inhabitants and to all other users within and without the boundaries of the City shall be reasonable and just, taking into account and consideration public interests and needs, the cost and value of the System, the Operation and Maintenance Expenses thereof, and the amounts necessary to meet the Bond Requirements of all Bonds, the Parity Bonds, and any other securities payable from the Net Pledged Revenues, including, without limitation, reserves and any replacement accounts therefor.

Section 821. Adequacy and Applicability of Charges. There shall be charged against users of service pertaining to and users of the System, such fees, rates and other charges so that the Gross Pledged Revenues shall be adequate to meet the requirements of this and the preceding Sections hereof. Such charges pertaining to the System shall be at least sufficient so that the Gross Pledged Revenues annually are sufficient to pay in each Fiscal Year:

A. Operation and Maintenance Expenses. An amount equal to the annual Operation and Maintenance Expenses for such Fiscal Year,

B. Principal and Interest. An amount equal to 110% of both the principal and interest on the Bonds and any Parity Bonds then Outstanding in that Fiscal Year (excluding the reserves therefor), and

C. Deficiencies. Any amounts required to pay all Policy Costs, if any, due and owing and all sums, if any, due and owing to meet then existing deficiencies pertaining to any fund or account relating to the Gross Pledged Revenues or any securities payable therefrom.

Section 822. Limitations Upon Free Service. No free service or facilities shall be furnished by the System, except that if the City elects to use for City purposes any water facilities, or other services and facilities provided by the System or otherwise to use the System or any part thereof, the City is not required to pay for such use.

Section 823. Levy of Charges. The City shall forthwith and in any event prior to the delivery of any of the Bonds, fix, establish and levy the fees, rates and other charges which are required by Section 821 of this Ordinance, if such action is necessary therefor. No reduction in any initial or existing rate schedule for the System may be made:

A. Proper Application. Unless the City has fully complied with the provisions of Article V of this Ordinance for at least the full Fiscal Year immediately preceding such reduction of the initial or any other existing rate schedule; and

B. Sufficient Revenues. Unless the audit required by the Independent Accountant by Section 827 hereof for the full Fiscal Year immediately preceding such reduction discloses that the estimated revenues resulting from the proposed rate schedule for the System, after the schedule's proposed reduction, shall be at least sufficient to produce the amounts required by Section 821 hereof.

Section 824. Collection of Charges. The City shall cause all fees, rates and other charges pertaining to the System to be collected as soon as is reasonable, shall reasonably prescribe and enforce rules and regulations or impose contractual obligations for the payment of such charges, and for the use of the System, and shall provide methods of collection and penalties, to the end that the Gross Pledged Revenues shall be adequate to meet the requirements of this Ordinance and any other ordinance supplemental thereto.

Section 825. Procedure for Collecting Charges. All bills for water services and all other services or facilities furnished or served by or through the System shall be rendered to customers on a regularly established basis. The fees, rates and other charges due shall be collected in a lawful manner, including, without limitation, discontinuance of service.

Section 826. Maintenance of Records. So long as any of the Bonds and any Parity Bonds payable from the Gross Pledged Revenues remain Outstanding, proper books of record and account pertaining to the Gross Pledged Revenues and the System shall be kept by the City, separate and apart from all other records and accounts.

Section 827. Audits Required. The City shall cause an audit for the Fiscal Year of the books and accounts pertaining to the Gross Pledged Revenues and the System to be completed by an Independent Accountant within 210 days following the close of each Fiscal Year.

Section 828. Accounting Principles. System records and accounts, and audits thereof, shall be currently kept and made, as nearly as practicable, in accordance with the then generally accepted accounting principles, methods and terminology followed and construed for utility operations comparable to the System, except as may be otherwise provided herein or required by applicable law or regulation or by contractual obligation existing on the effective date of this Ordinance.

Section 829. Insurance and Reconstruction. Except to the extent of any self-insurance, the City shall at all times maintain with responsible insurers fire and extended coverage insurance, worker's compensation insurance, public liability insurance and all such other insurance as is customarily maintained with respect to utilities of like character against loss of or damage to the System and against loss of revenues and against public and other liability to the extent reasonably necessary to protect the interests of the City and of each Owner of a Bond. If any useful part of the System shall be damaged or destroyed, the City shall, as expeditiously as may be possible, commence and diligently proceed with the repair or replacement of the damaged property so as to restore the same to use. The proceeds of any such insurance shall be payable to the City and (except for proceeds of any use and occupancy insurance) shall be applied to the necessary costs involved in such repair and replacement and to the extent not so applied shall (together with the proceeds of any such use and occupancy insurance) be deposited in the Water Enterprise Fund by the City as revenues derived from the operation of the System. If the costs of such repair and replacement of the damaged property exceed the proceeds of such insurance available for the payment of the same, moneys in the Water Enterprise Fund shall be used to the extent necessary for such purposes, as permitted by Section 512 hereof.

Section 830. Federal Income Tax Exemption. The City covenants for the benefit of the Owners of the Bonds that it will not take any action or omit to take any action with respect to the Bonds, the proceeds thereof, any other funds of the City or any facilities financed with the proceeds of the Bonds if such action or omission (i) would cause the interest on the Bonds to lose its exclusion from gross income for federal income tax purposes under Section 103 of the Tax Code, (ii) would cause interest on the Bonds to lose its exclusion from alternative minimum taxable income as defined in Section 55(b)(2) of the Tax Code, except to the extent that such interest is taken into account in determining the annual adjusted financial statement income of applicable corporations (as defined in Section 59(k) of the Tax Code) for the purpose of computing the alternative minimum tax imposed on corporations; or (iii) would cause interest on the Bonds to lose its exclusion from State taxable income or State alternative minimum taxable income under present State law. In furtherance of this covenant, the City agrees to comply with the procedures set forth in the Tax Compliance Certificate with respect to the Bonds. The foregoing covenant shall remain in full force and effect notwithstanding the payment in full or defeasance of the Bonds until the date on which

all obligations of the City in fulfilling the above covenant under the Tax Code and State law have been met.

Section 831. Continuing Disclosure. The City shall comply with the provisions of the Continuing Disclosure Certificate. Any failure by the City to perform in accordance with this Section shall not constitute an Event of Default under this Ordinance, and the rights and remedies provided by this Ordinance upon the occurrence of an Event of Default shall not apply to any such failure. The Paying Agent shall not have any power or duty to enforce this Section. No Owner of a Bond shall be entitled to damages for the City's non-compliance with its obligations under this Section; however, the Owners of the Bonds may enforce specific performance of the obligations contained in this Section by any judicial proceeding available.

ARTICLE IX
PRIVILEGES, RIGHTS AND REMEDIES

Section 901. Owners' Remedies. Each Owner of any Bond shall be entitled to all of the privileges, rights and remedies provided or permitted in this Ordinance, and as otherwise provided or permitted by law or in equity or by any statutes, except as provided in Sections 202 through 206 and 1201 hereof, but subject to the provisions herein concerning the pledge of and the covenants and the other contractual provisions concerning the Gross Pledged Revenues and the proceeds of the Bonds.

Section 902. Right to Enforce Payment. Nothing in this Article affects or impairs the right of any Owner of any Bond to enforce the payment of the Bond Requirements due in connection with his or her Bond or the obligation of the City to pay the Bond Requirements of each Bond to the Owner thereof at the time and the place expressed in the Bond.

Section 903. Events of Default. Each of the following events is hereby declared an "Event of Default," provided however, that in determining whether a payment default has occurred pursuant to paragraphs A or B of this Section, no effect shall be given to payments made under the Insurance Policy:

A. Nonpayment of Principal. Payment of the principal of any of the Bonds is not made when the same becomes due and payable, either at maturity or by proceedings for prior redemption, or otherwise;

B. Nonpayment of Interest. Payment of any installment of interest on any of the Bonds is not made when the same becomes due and payable;

C. Cross Defaults. The occurrence and continuance of an "event of default," as defined in any Parity Bond Ordinance;

D. Failure to Reconstruct. The City unreasonably delays or fails to carry out with reasonable dispatch the reconstruction of any part of the System which is destroyed or damaged and is not promptly repaired or replaced (whether such failure promptly to repair

the same is due to impracticability of such repair or replacement or is due to a lack of moneys therefor or for any other reason), but it shall not be an Event of Default if such reconstruction is not essential to the efficient operation of the System;

E. Appointment of Receiver. An order or decree is entered by a court of competent jurisdiction with the consent or acquiescence of the City appointing a receiver or receivers for the System or for the Gross Pledged Revenues and any other moneys subject to the lien to secure the payment of the Bonds, or if an order or decree having been entered without the consent or acquiescence of the City is not vacated or discharged or stayed on appeal within 60 days after entry;

F. Default Under Insurance Agreement. If an event of default shall have occurred and be continuing under the provisions of the Insurance Agreement; and

G. Default of Any Provision. The City defaults in the due and punctual performance of any other of the representations, covenants, conditions, agreements and other provisions contained in the Bonds or in this Ordinance on its part to be performed (other than Section 831 hereof), and such default continues for 60 days after written notice specifying such default and requiring the same to be remedied is given to the City and the Insurer specifying the failure and requiring that it be remedied, which notice may be given by the Paying Agent in its discretion and, except as provided in Section 1101 hereof, shall be given by the Paying Agent at the written request of the Owners of not less than 25 percent in aggregate principal amount of Bonds then Outstanding.

Section 904. Remedies for Defaults. Except as provided in Section 1101 hereof, upon the happening and continuance of any Event of Default, the Owner or Owners of not less than 25% in aggregate principal amount of the Bonds then Outstanding, including, without limitation, a trustee or trustees therefor, may proceed against the City and its agents, officers and employees to protect and to enforce the rights of any Owner of Bonds under this Ordinance by mandamus or by other suit, action or special proceedings in equity or at law, in any court of competent jurisdiction, either for the appointment of a receiver or for the specific performance of any covenant or agreement contained herein or in an award of execution of any power herein granted for the enforcement of any proper legal or equitable remedy as such Owner or Owners may deem most effectual to protect and to enforce the rights aforesaid, or thereby to enjoin any act or thing which may be unlawful or in violation of any right of any Owner of any Bond, or to require the City to act as if it were the trustee of an expressed trust, or any combination of such remedies. All such proceedings at law or in equity shall be instituted, had and maintained for the equal benefit of all Owners of the Bonds.

Section 905. Receiver's Rights and Privileges. Any receiver appointed in any proceedings to protect the rights of such Owners hereunder, the consent to any such appointment being hereby expressly granted by the City, may enter and may take possession of the System, may operate and maintain the same, may prescribe fees, rates and other charges, and may

collect, receive and apply all Gross Pledged Revenues arising after the appointment of such receiver in the same manner as the City itself might do.

Section 906. Rights and Privileges Cumulative. The failure of any Owner of any Outstanding Bond to proceed in any manner herein provided shall not relieve the City, or any of its officers, agents or employees of any liability for failure to perform or carry out any duty, obligation or other commitment. Each right or privilege of any such Owner (or trustee thereof) is in addition and is cumulative to any other right or privilege, and the exercise of any right or privilege by or on behalf of any Owner shall not be deemed a waiver of any other right or privilege thereof.

Section 907. Duties upon Defaults. Upon the happening of any Event of Default, the City shall do and perform all proper acts on behalf of and for the Owners of Bonds to protect and to preserve the security created for the payment of the Bonds and to insure the payment of the Bond Requirements promptly as the same become due. While any Event of Default exists, except to the extent it may be unlawful to do so, all Gross Pledged Revenues shall be paid into the Bond Fund and into bond or similar funds established for any Parity Bonds then Outstanding, pro rata based upon the aggregate principal amount of the Bonds and Parity Bonds then Outstanding. Except as provided in Section 1101 hereof, if the City fails or refuses to proceed as in this Section provided, the Owner or Owners of not less than 25% in aggregate principal amount of the Bonds then Outstanding, after demand in writing, may proceed to protect and to enforce the rights of the Owners of the Bonds as hereinabove provided, and to that end any such Owners of the Outstanding Bonds shall be subrogated to all rights of the City under any agreement, lease or other contract involving the System or the Gross Pledged Revenues entered into prior to the effective date of this Ordinance or thereafter while any of the Bonds are Outstanding.

ARTICLE X
AMENDMENT OF ORDINANCE

Section 1001. Privilege of Amendments.

A. Except as hereafter provided, this Ordinance may be amended or supplemented by ordinances adopted by the Council in accordance with law, without receipt by the City of any additional consideration, but with the written consent of the Insurer and, subject to Section 1101 hereof, the Owners of not less than a majority in aggregate principal amount of the Bonds Outstanding at the time of the adoption of such amendatory or supplemental ordinance excluding, pursuant to Section 101 B hereof, any Bonds which may then be held or owned for the account of the City. Notwithstanding the foregoing, no such ordinance shall permit:

(1) Changing Payment. A change in the maturity, terms of redemption or interest payment of any Outstanding Bond; or

(2) Reducing Return. A reduction in the principal amount of any Bond or the rate of interest thereon, without the consent of the Owner of the Bond; or

(3) Prior Lien. The creation of a lien upon or a pledge of revenues ranking prior to the lien or to the pledge created by this Ordinance; or

(4) Modifying Any Bond. A reduction of the principal amount or percentages or otherwise affecting the description of Bonds the consent of the Owners of which is required for any such modification or amendment; or

(5) Priorities Between Bonds. The establishment of priorities as between Bonds issued and Outstanding; or

(6) Modification of Less Than All the Bonds. The modification of or otherwise affecting the rights of the Owners of less than all of the Outstanding Bonds.

B. Notwithstanding the foregoing provisions of this Section, this Ordinance and the rights and obligations of the City and of the Owners of the Bonds may also be modified or amended at any time, with the written consent of the Insurer but without the consent of any Owners of the Bonds, but only to the extent permitted by law and only for any or all of the following purposes:

(1) to add to the covenants and agreements of the City in this Ordinance contained other covenants and agreements thereafter to be observed;

(2) to subject to the covenants and agreements of the City in this Ordinance additional System revenues, to be defined and treated as Gross Pledged Revenues, for the purpose of providing additional security for the Bonds and any Parity Bonds;

(3) in connection with the provision of a Reserve Fund Insurance Policy subsequent to the issuance of the Bonds;

(4) to provide for the appointment of a new Paying Agent;

(5) to make such provisions for the purpose of curing any ambiguity or of curing or correcting any formal defect or omission in this Ordinance, or in regard to questions arising under this Ordinance, as the City may deem necessary or desirable, and which shall not adversely affect the interests of the Owners of the Bonds; or

(6) in order to preserve or protect the excludability from gross income for federal income tax purposes of the interest allocable to the Bonds.

Section 1002. Notice of Amendment. Whenever the Council proposes to amend or modify this Ordinance under the provisions of this Article, it shall cause notice of the proposed amendment to be sent to Owners of all Outstanding Bonds at their addresses as the same last appear on the registration records maintained by the Paying Agent or by electronic means to DTC or its successors, and to the Insurer. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy of the proposed amendatory ordinance is on file with the City Manager for public inspection. Notice of the proposed amendment,

together with a copy of the proposed amendatory ordinance, shall be delivered to the Rating Agencies then maintaining a rating on the Bonds at least 15 days in advance of the adoption of the amendment. A full transcript of all proceedings relating to the execution of such amendatory ordinance shall be provided to the Insurer.

Section 1003. Time for Amendment. If the ordinance is required to be consented to by the Owners of the Bonds, whenever at any time within one year from the date of the giving of such notice there shall be filed with the City Manager an instrument or instruments executed by the Owners of not less than a majority in aggregate principal amount of the Bonds then Outstanding, which instrument or instruments shall refer to the proposed amendatory ordinance described in such notice and shall specifically consent to and approve the adoption of such ordinance, the Council may adopt such amendatory ordinance and such ordinance shall become effective. If the ordinance is not required to be consented to by the Owners of the Bonds, the amendatory ordinance may be adopted by the Council at any time.

Section 1004. Binding Consent to Amendment. If the Owners of not less than a majority in aggregate principal amount of the Bonds Outstanding at the time of the adoption of such amendatory ordinance requiring consent of the Owners of the Bonds, or the predecessors in title of such Owners, shall have consented to and approved the adoption thereof as herein provided, no Owner of any Bond, whether or not such Owner shall have consented to or shall have revoked any consent as in this Article provided, shall have any right or interest to object to the adoption of such amendatory ordinance or to object to any of the terms or provisions therein contained or to the operation thereof or to enjoin or restrain the City from taking any action pursuant to the provisions thereof.

Section 1005. Time Consent Binding. Any consent given by the Owner of a Bond pursuant to the provisions of this Article shall be irrevocable for a period of 6 months from the date of the giving of the notice above provided for and shall be conclusive and binding upon all future Owners of the same Bond during such period. Such consent may be revoked at any time after 6 months from the date of such giving of such notice by the Owner who gave such consent or by a successor in title by filing notice of such revocation with the City Manager, but such revocation shall not be effective if the Owners of not less than a majority in aggregate principal amount of the Bonds Outstanding as in this Article provided, prior to the attempted revocation, consented to and approved the amendatory ordinance referred to in such revocation.

Section 1006. Unanimous Consent. Notwithstanding anything in the foregoing provisions of this Article, the terms and provisions of this Ordinance or of any ordinance amendatory thereof or supplemental thereto and the rights and the obligations of the City and of the Owners of the Bonds thereunder may be modified or amended in any respect upon the adoption by the City and upon the filing with the City Manager of an ordinance to that effect and with the consent of the Insurer and the Owners of all the then Outstanding Bonds, such consent to be given as provided in Section 1003 hereof; and no notice to Owners of Bonds

shall be required as provided in Section 1002 hereof, nor shall the time of consent be limited except as may be provided in such consent.

Section 1007. Exclusion of City's Bonds. At the time of any consent or of other action taken under this Article, the City shall furnish to the City Manager a certificate of the Director of Finance, upon which the City may rely, describing all Bonds to be excluded for the purpose of consent or of other action or of any calculation of Outstanding Bonds provided for in this Article, and the City shall not be entitled with respect to such Bonds to give any consent or to take any other action provided for in this Article, as provided in Section 101 B hereof.

Section 1008. Notation on Bonds. Bonds authenticated and delivered after the effective date of any action taken as in this Article provided may bear a notation by endorsement or otherwise in form approved by the Council as to such action; and after the approval of such notation, then upon demand of the Owner of any Bond Outstanding and upon presentation of his or her Bond for that purpose at the principal office of the Paying Agent, suitable notation shall be made on such Bond by the Paying Agent as to any such action. If the Council so determines, new Bonds, so modified as in the opinion of the Council conform to such action, shall be prepared, executed, authenticated and delivered; and upon demand of the Owner of any Bond then Outstanding, shall be exchanged without cost to such Owner for Bonds then Outstanding upon surrender of such Bonds.

Section 1009. Proof of Instruments and Bonds. The fact and date of execution of any instrument under the provisions of this Article, the amount and number of the Bonds held by any Person executing such instrument, and the date of his or her holding the same may be proved as provided by Section 1203 hereof.

Section 1010. Copies of Supplemental Ordinances to Rating Agencies. Copies of any supplemental or amendatory ordinance shall be sent by the City to the Rating Agencies at least 10 days prior to the effective date thereof.

ARTICLE XI
INSURANCE POLICY AND RESERVE POLICY PROVISIONS

Section 1101. Insurer To Be Deemed Owner, Rights of the Insurer, Payments by the Insurer: Notices.

A. Notwithstanding any provision of this Ordinance to the contrary, so long as the Insurer is not in default in its payment obligations under the Insurance Policy, the Insurer shall at all times be deemed the sole and exclusive Owner of the Outstanding Bonds for the purposes of all approvals, consents, waivers, institution of any action, and the direction of all remedies pursuant to this Ordinance, including but not limited to approval of or consent to any amendment of or supplement to this Ordinance which requires the consent or approval of the Owners of not less than a majority of the aggregate principal amount of the Bonds then Outstanding pursuant to this Ordinance; provided, however, that the Insurer shall not be deemed to be the sole and exclusive Owner of the Outstanding Bonds with respect to any

amendment or supplement to this Ordinance which seeks to amend or supplement this Ordinance for the purposes set forth in clauses A (1) through A (6) of Section 1001 hereof, and provided, further, that the Insurer shall not have the right to direct or consent to City, Paying Agent or Owner action as provided herein, if:

(1) the Insurer shall be in default under the Insurance Policy;

(2) any material provision of the Insurance Policy shall be held to be invalid by a final, non-appealable order of a court of competent jurisdiction, or the validity or enforceability thereof shall be contested by the Insurer; or

(3) a proceeding shall have been instituted in a court having jurisdiction in the premises seeking an order for relief, rehabilitation, reorganization, conservation, liquidation or dissolution in respect of the Insurer and such proceeding is not terminated for a period of 90 consecutive days or such court enters an order granting the relief sought in such proceeding.

B. To the extent that the Insurer makes payment of any principal of or interest on a Bond, it shall be fully subrogated to all of the Owner's rights thereunder in accordance with the terms of the Insurance Policy to the extent of such payment, including the Owner's rights to payment thereof.

C. In the event that the principal of or interest on a Bond shall be paid by the Insurer pursuant to the terms of the Insurance Policy: (1) such Bond shall continue to be "Outstanding" under this Ordinance, and (2) the Insurer shall be fully subrogated to all of the rights of the Owner thereof in accordance with the terms and conditions of paragraph B of this Section and the Insurance Policy.

D. This Ordinance shall not be discharged unless and until all amounts due to the Insurer have been paid in full or duly provided for.

E. The rights granted under this Ordinance to the Insurer to request, consent to or direct any action are rights granted to the Insurer in consideration of its issuance of the Insurance Policy. Any exercise by the Insurer of such rights is merely an exercise of the Insurer's contractual rights and shall not be construed or deemed to be taken for the benefit of or on behalf of the Owners, nor does such action evidence any position of the Insurer, positive or negative, as to whether Owner consent is required in addition to consent of the Insurer.

F. No modification, amendment or supplement to this Ordinance shall become effective except upon obtaining the prior written consent of the Insurer.

G. No contract shall be entered into nor any action taken by the City or the Paying Agent pursuant to which the rights of the Insurer or security for or sources of payment of the Bonds under this Ordinance may be impaired or prejudiced except upon obtaining the prior written consent of the Insurer.

H. The provisions of this Article shall be of no force or effect if the Bonds are not insured by an Insurer.

ARTICLE XII
MISCELLANEOUS

Section 1201. Defeasance. If, when the Bonds shall be paid in accordance with their terms (or payment of the Bonds has been provided for in the manner set forth in the following paragraph), then this Ordinance and all rights granted hereunder shall thereupon cease, terminate and become void and be discharged and satisfied.

Payment of any Outstanding Bond shall prior to the maturity or Redemption Date thereof be deemed to have been provided for within the meaning and with the effect expressed in this Section if (a) in case said Bond is to be redeemed on any date prior to its maturity, the City shall have given to the Paying Agent in form satisfactory to it irrevocable instructions to give on a date in accordance with the provisions of Section 405 hereof, notice of redemption of such Bond on said Redemption Date, such notice to be given in accordance with the provisions of Section 405 hereof, (b) there shall have been deposited with the Paying Agent or a Trust Bank either moneys in an amount which shall be sufficient, and/or Federal Securities which shall not contain provisions permitting the redemption thereof at the option of the issuer, the principal of and the interest on which when due, and without any reinvestment thereof, will provide moneys which, together with the moneys, if any, deposited with or held by the Paying Agent or Trust Bank at the same time, shall be sufficient to pay when due the Bond Requirements due and to become due on said Bond on and prior to the Redemption Date or maturity date thereof, as the case may be, and (c) in the event said Bond is not by its terms subject to redemption within the next sixty days, the City shall have given the Paying Agent in form satisfactory to it irrevocable instructions to give, as soon as practicable in the same manner as the notice of redemption is given pursuant to Section 405 hereof, a notice to the Owner of such Bond that the deposit required by (b) above has been made with the Paying Agent or Trust Bank and that payment of said Bond has been provided for in accordance with this Section and stating such maturity or Redemption Date upon which moneys are to be available for the payment of the Bond Requirements of said Bond. Neither such securities nor moneys deposited with the Paying Agent or Trust Bank pursuant to this Section or principal or interest payments on any such Federal Securities shall be withdrawn or used for any purpose other than, and shall be held in trust for, the payment of the Bond Requirements of said Bond; provided any cash received from such principal or interest payments on such Federal Securities deposited with the Paying Agent or other Trust Bank, if not then needed for such purpose, shall, to the extent practicable, be reinvested in securities of the type described in (b) of this paragraph maturing at times and in amounts sufficient to pay when due the Bond Requirements to become due on said Bond on or prior to such Redemption Date or maturity date thereof, as the case may be. At such time as payment of a Bond has been provided for as aforesaid, such Bond shall no longer be secured by or entitled to the benefits of this Ordinance, except for the purpose of any payment from such moneys or securities deposited with the Paying Agent or other Trust Bank.

The release of the obligations of the City under this Section shall be without prejudice to the right of the Paying Agent to be paid reasonable compensation for all services rendered by it hereunder and all its reasonable expenses, charges and other disbursements incurred on or about the administration of and performance of its powers and duties hereunder.

Upon compliance with the foregoing provisions of this Section with respect to all Bonds then Outstanding, this Ordinance may be discharged in accordance with the provisions of this Section but the liability of the City in respect of the Bonds shall continue; provided that the Owners thereof shall thereafter be entitled to payment only out of the moneys or Federal Securities deposited with the Paying Agent or other Trust Bank as provided in this Section.

Section 1202. Delegated Powers. The officers, employees and agents of the City be, and they hereby are, authorized and directed to take all action necessary or appropriate to effectuate the provisions of this Ordinance, including, without limitation:

A. Final Certificates. the execution of such certificates as may be reasonably required by the Purchaser, including the Continuing Disclosure Certificate and Insurance Agreement, if any;

B. Paying Agent Agreement. the execution and delivery of an agreement with the Paying Agent necessary or desirable to evidence the acceptance by the Paying Agent of its duties hereunder;

C. Official Statement. the execution and delivery of the final Official Statement; and

D. Bond Purchase Agreement. the execution and delivery of the Bond Purchase Agreement from the Purchaser.

E. Electronic Signatures. The use of electronic signatures to execute any of the documents described in this Section 1202 or elsewhere in this Ordinance, as authorized by Article 71.3 of Title 24, C.R.S., also known as the Uniform Electronic Transactions Act.

Section 1203. Evidence of Bond Owners. Any request, consent or other instrument which this Ordinance may require or may permit to be signed and to be executed by the Owners of any Bonds may be in one or more instruments of similar tenor and shall be signed or shall be executed by each such Owner in person or by his or her attorney appointed in writing. Proof of the execution of any such instrument or of an instrument appointing any such attorney, or the holding by any Person of the Bonds shall be sufficient for any purpose of this Ordinance (except as otherwise herein expressly provided) if made in the following manner:

A. Proof of Execution. The fact and the date of the execution by any Owner of any Bonds or his or her attorney of such instrument may be established by a certificate, which need not be acknowledged or verified, of an officer of a bank or trust company satisfactory to the City Manager or Director of Finance of any notary public or other officer authorized to take acknowledgments of deeds to be recorded in the state in which he or she purports to act, that

the individual signing such request or other instrument acknowledged to him or her the execution thereof, or by an affidavit of a witness of such execution, duly sworn to before such notary public or other officer; the authority of the individual or individuals executing any such instrument on behalf of a corporate Owner of any securities may be established without further proof if such instrument is signed by an individual purporting to be the president or vice-president of such corporation with a corporate seal affixed and attested by an individual purporting to be its secretary or an assistant secretary; and the authority of any Person or Persons executing any such instrument in any fiduciary or representative capacity may be established without further proof if such instrument is signed by a Person or Persons purporting to act in such fiduciary or representative capacity; and

B. Proof of Holdings. The amount of Bonds held by any Person and the numbers, date and other identification thereof, together with the date of his or her holding the Bonds, shall be proved by the registration records maintained by the Paying Agent.

Section 1204. Parties Interested Herein. Nothing in this Ordinance expressed or implied is intended or shall be construed to confer upon, or to give to, any Person, other than the City, the Paying Agent, the Insurer and the Owners of the Bonds, any right, remedy or claim under or by reason of this Ordinance or any covenant, condition or stipulation hereof; and all the covenants, stipulations, promises and agreements in this Ordinance contained by and on behalf of the City shall be for the sole and exclusive benefit of the City, the Paying Agent, the Insurer, the Surety Provider and the Owners of the Bonds.

Section 1205. Notices. Except as otherwise may be provided in this Ordinance, all notices, certificates, requests or other communications pursuant to this Ordinance shall be in writing and shall be sufficiently given and shall be deemed given by personal delivery, electronic means, or when mailed by first class mail, and either delivered or addressed as follows:

If to the City at:

City and County of Broomfield
One DesCombes Drive
Broomfield, Colorado 80020
Attention: Director of Finance

If to the Paying Agent at:

UMB Bank, n.a.
1670 Broadway
Denver, Colorado 80202
Attention: Corporate Trust Services

Any of the foregoing Persons may, by notice given hereunder to each of the other Persons, designate any further or different addresses to which subsequent notices, certificates, requests or other communications shall be sent.

Section 1206. Additional Notices to Rating Agencies. The Paying Agent hereby agrees that if at any time (a) the City shall redeem any portion of the Bonds Outstanding prior to maturity, but excluding redemptions pursuant to Section 402 hereof, (b) the City shall provide for the payment of any portion of the Bonds pursuant to Section 1201 hereof, (c) a successor Paying Agent is appointed hereunder, or (d) any supplement to this Ordinance shall become effective or any Person shall waive any provision of this Ordinance, then, in each case, the Paying Agent shall give notice to each Rating Agency.

Section 1207. Business Days. If the date for making any payment or the last date for performance of any act or the exercising of any rights, as provided in this Ordinance, shall not be a Business Day, such payment may be made or act performed or right exercised on the next succeeding Business Day, with the same force and effect as if done on the nominal date provided in this Ordinance, and no interest shall accrue for the period after such nominal date.

Section 1208. Effective Date. This Ordinance shall be in full force and effect seven days after final publication.

Section 1209. Disposition of Ordinance. This Ordinance, as adopted by the Council, shall be numbered and recorded by the City Clerk in the official records of the City. The adoption and publication shall be authenticated by the signatures of the Mayor and City Clerk, and by the certificate of publication.

Introduced and approved after first reading on October 14, 2025, and ordered published in full.

Introduced a second time and approved on October 28, 2025, and ordered published.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

_____

City and County Attorney

ORDINANCE NO. 2289

An ordinance authorizing the issuance of the City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026

Recitals.

Whereas, the City and County of Broomfield (the "City") is a political subdivision of the State of Colorado (the "State") a body corporate and politic, a home-rule city and county pursuant to Article XX of the constitution and a city and county pursuant to Sections 10, 11, 12 and 13 of Article XX of the constitution;

Whereas, the members of the City Council of the City (the "Council") have been duly elected or appointed and qualified;

Whereas, pursuant to Chapter XVII of the Charter and Chapter 3-32 of the City Municipal Code (the "Code"), the Council has established the City of Broomfield, Colorado, Sewer Activity Enterprise (the "Enterprise"), governed by the Council and having all lawful powers consistent with the Charter and ordinances of the City, including, without limitation, the power to issue and reissue bonds, notes, and other obligations, in the name of the City, payable solely from lawful revenues available to the enterprise for the purpose of operating the sewer system (the "System");

Whereas, the Council has determined and hereby determines that the System constitutes an enterprise pursuant to Article X, Section 20 of the Colorado Constitution ("TABOR") and Title 37, Article 45.1, C.R.S. (the "Enterprise Act");

Whereas, pursuant to Section 14.4 of the Charter, the City is authorized, pursuant to ordinance, and without an election, to borrow money, issue bonds, or otherwise extend its credit for purchasing, constructing, condemning, otherwise acquiring, extending or improving a water, electric, gas or sewer system, or other public facility or income-producing project or for any other capital improvement; provided that the bonds or other obligations shall be made payable from the net revenues derived from the operation of such system, utility or other such project or capital improvement, and provided, further, that any two or more of such systems, utilities, projects or capital improvements may be combined, operated and maintained as joint municipal systems, utilities, projects or capital improvements, in which case such bonds or other obligations shall be made payable out of the net revenue derived from the operation of such joint systems, utilities or capital improvements;

Whereas, the Council proposes to extend, better, otherwise improve and equip the System, including the financing a portion of the costs of constructing and/or acquiring wastewater improvements for City purposes (the "Improvement Project");

Whereas, the City has previously issued its Sewer and Wastewater Reclamation Activity Enterprise Sewer Revenue Refunding Bonds, Series 2012 (the "2012 Bonds"), which 2012 Bonds are currently outstanding in the aggregate principal amount of $15,315,000, and mature on December 1, 2031;

Whereas, the 2012 Bonds maturing on and after December 1, 2023 are subject to redemption prior to their respective maturities, at the option of the City, in whole or in part, in integral multiples of $5,000, selected as to maturity by the City, and if less than an entire maturity is to be redeemed, then by lot within such maturity, on December 1, 2022 and thereafter at par plus accrued interest to the redemption date;

Whereas, the City intends to issue certain Sewer Activity enterprise revenue bonds (the "Bonds") to defray in part the costs of the Improvement Project, refund the 2012 Bonds (the "Refunding Project" and together with the Improvement Project, the "Project") and the payment of the costs of issuance of the Bonds;

Whereas, except for the 2012 Bonds, which are expected to be fully redeemed, paid and discharged contemporaneously with the issuance of the Bonds, the City has not previously pledged nor hypothecated the revenues derived or to be derived from the operation of the System, or any part thereof, to the payment of any bonds or other financial obligations or for any other purpose with the result that the Net Pledged Revenues (defined below) may now be pledged lawfully and irrevocably for the payment of the Bonds on a parity with the 2012 Bonds, and the Bonds may be made payable from the Net Pledged Revenues;

Whereas, in connection with the discharge and defeasance of the 2012 Bonds, the City will enter into an escrow agreement (the "Escrow Agreement") with UMB Bank, n.a., acting as Escrow Agent, if required, pursuant to which UMB Bank, n.a., will pay the principal of and interest on the 2012 Bonds on the Redemption date (defined below);

Whereas, there are on file with the City Clerk: (i) the form of the Preliminary Official Statement for the Bonds; (ii) the form of the Paying Agent Agreement; (iii) the form of the Disclosure Certificate; (iv) the form of Bond Purchase Agreement; and (v) a form of Escrow Agreement;

Whereas, pursuant to Section 11-57-203, C.R.S., the City desires to delegate to the City Manager and the Director of Finance the independent authority to accept the proposal to purchase the Bonds by execution of the Bond Purchase Agreement and to make final determinations relating to the Bonds, subject to the parameters contained in Section 213 of this Ordinance;

Whereas, it is necessary to provide for the form of the Bonds, Bond details, the payment of the Bonds, and other provisions relating to the authorization, issuance and sale of the Bonds.

Now, therefore, be it ordained by the City Council of the City and County of Broomfield, Colorado:

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ARTICLE I
DEFINITIONS, INTERPRETATION, RATIFICATION AND EFFECTIVE DATE

Section 101. Meanings and Construction.

A. Definitions. The terms in this Section for all purposes of this Ordinance and of any ordinance amendatory hereof or supplemental hereto, or relating hereto, and of any other ordinance or any other document pertaining hereto, except where the context by clear implication otherwise requires, shall have the meanings herein specified:

"acquire" or "acquisition" means the opening, laying out, establishment, purchase, construction, securing, installation, reconstruction, lease, gift, grant from the Federal Government, the State, any body corporate and politic therein, or any other Person, the endowment, bequest, devise, transfer, assignment, option to purchase, other contract, or other acquisition, or any combination thereof, of any properties pertaining to the System, or an interest therein, or any other properties herein designated.

"Bond Counsel" means an attorney or a firm of attorneys, designated by the City of nationally recognized standing in matters pertaining to the tax status of interest on bonds issued by states and their political subdivisions, duly admitted to the practice of law before the highest court of any state of the United States of America or the District of Columbia.

"Bond Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Bond Fund" created pursuant to Section 505 hereof.

"Bond Purchase Agreement" means the Bond Purchase Agreement concerning the purchase of the Bonds, between the City and the Purchaser.

"Bond Requirements" means the principal of, any prior redemption premiums due in connection with, and the interest on the Bonds, any Parity Bonds, or other securities payable from the Net Pledged Revenues and heretofore or hereafter issued, if any, or such part of such securities as may be designated.

"Bonds" means City's Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, with such title as confirmed in the Sale Certificate, issued pursuant to this Ordinance.

"Book-entry form" or "book-entry system" means, with respect to the Bonds, a form or system, as applicable, under which physical Bond certificates in fully registered form are registered only in the name of The Depository Trust Company or its nominee as Owner, with the physical Bond certificates "immobilized" in the custody of The Depository Trust Company. The book-entry system maintained by and the responsibility of The Depository Trust Company and not maintained by or the responsibility of the City or the Paying Agent is the record that identifies, and records the transfer of the interests of, the owners of book-entry interests in the Bonds.

"Business Day" means a day of the year, other than a Saturday or Sunday, other than a day on which commercial banks located in the city in which the principal corporate trust office of the Paying Agent is located are required or authorized to remain closed and other than a day on which the New York Stock Exchange is closed.

"Capital Improvements" means the acquisition of land, easements, facilities, and equipment (other than ordinary repairs and replacements), and those property improvements or any combination of property improvements which will constitute enlargements, extensions or betterments to the System and will be incorporated into the System.
"Charter" means the home rule charter of the City, including all amendments thereto prior to the date hereof.
"City" means the City of and County of Broomfield, Colorado, a municipal corporation and political subdivision of the State.
"City Clerk" means the City Clerk of the City, or his or her successor in functions, if any.
"City Manager" means the City Manager of the City, or his or her successor in functions, if any.
"Closing Date" means the date of delivery of and payment for the Bonds.
"Combined Maximum Annual Principal and Interest Requirements" means the largest sum of the principal of and interest on the Bonds, any other Outstanding Parity Bonds and any additional Parity Bonds proposed to be issued, excluding any securities the principal of which is payable within less than one year from the date on which issued, to be paid during any one Fiscal Year for the period beginning with the Fiscal Year in which such computation is made and ending with the Fiscal Year in which any Bond or other such security last becomes due at maturity or on a Redemption Date, whichever time is later (but excluding any reserve requirement to secure such payments unless otherwise expressly provided), subject in all respects to the following, as applicable:
(1) The word "principal," as used in this definition, means the principal which must be paid to security Owners, whether on stated maturity dates or on mandatory Redemption Dates, or otherwise.
(2) Any computation made under this definition shall be adjusted for all purposes in the same manner as is provided in Section 703 hereof.
"Commercial Bank" means a state or national bank or trust company which is a member of the Federal Deposit Insurance Corporation (or any successors thereto) and of the Federal Reserve System, which has a capital and surplus of $10,000,000 or more, and which is located within the United States of America.
"Continuing Disclosure Certificate" means the Continuing Disclosure Certificate for the Bonds executed by the City.
"Cost of the Project" means all costs, as designated by the City, of the Project, or any interest therein, which cost, at the option of the City (except as may be otherwise limited by law) may include all, any one or other portion of the incidental costs pertaining to the Project, including, without limitation:
(i) All preliminary expenses or other costs advanced by the City or advanced by the Federal Government, the State or by any other Person from any source, with the approval of the Council, or any combination thereof, or otherwise;
(ii) The costs of making surveys and tests, audits, preliminary plans, other plans, specifications, estimates of costs and other preliminaries;
(iii) The costs of contingencies;
(iv) The costs of premiums on any builders' risk insurance and performance bonds during the construction, installation and other acquisition of the Project, or a reasonably allocated share thereof;

(v) The costs of appraising, printing, estimates, advice, inspection, other services of engineers, architects, accountants, financial consultants, attorneys at law, clerical help and other agents and employees;
(vi) The costs of making, publishing, posting, mailing and otherwise giving any notice in connection with the Project and the issuance of the Bonds;
(vii) All costs and expenses of issuing the Bonds including, without limitation, fees of the Paying Agent, Bond Counsel, counsel to the Purchaser, counsel to the City, financial advisor, rating agencies and printers to the extent not defrayed as an Operation and Maintenance Expense;
(viii) The costs of the filing or recording of instruments and the cost of any title insurance premiums;
(ix) The costs of funding any construction loans and other temporary loans pertaining to the Project and of the incidental expenses incurred in connection with such loans;
(x) The costs of demolishing, removing, or relocating any buildings, structures, or other facilities on land acquired for the Project, and of acquiring lands to which such buildings, structures or other facilities may be moved or relocated;
(xi) The costs of machinery and equipment;
(xii) The costs of any properties, rights, easements or other interests in properties, or any licenses, privileges, agreements and franchises;
(xiii) The payment of the premium for the Insurance Policy issued by the Insurer and Reserve Fund Insurance Policy issued by the Surety Provider;
(xiv) The costs of labor, material and obligations incurred to contractors, builders and materialmen in connection with the acquisition and construction of the Project;
(xv) The costs of amending any ordinance or other instrument pertaining to the Bonds or otherwise to the System; and
(xvi) All other expenses pertaining to the Project.
"Council" means the City Council of the City.
"C.R.S." means the Colorado Revised Statutes, as amended and supplemented as of the date hereof.
"Director of Finance" means the Director of Finance of the City, or his or her successor in functions, if any.
"Escrow Account" means the account maintained by the Escrow Bank pursuant to the Escrow Agreement with respect to the defeasance of the 2012 Bonds, if required.
"Escrow Agreement" means the Escrow Agreement dated as of its date, between the Enterprise and the Escrow Bank relating to the defeasance of the 2012 Bonds, if required.
"Escrow Bank" means UMB Bank, n.a., or its successors and assigns, acting as Escrow Bank under the Escrow Agreement.
"Events of Default" means the events stated in Section 903 hereof.
"Federal Government" means the United States of America and any agency, instrumentality or corporation thereof.
"Federal Securities" means bills, certificates of indebtedness, notes, or bonds which are direct obligations of, or the principal and interest of which obligations are unconditionally guaranteed by, the United States of America.

"Fiscal Year" means the calendar year or any other 12-month period hereafter selected by the City as its fiscal year.

"Gross Pledged Revenues" all income from rates, fees, tolls and charges and tap fees, or any combination thereof, but not special assessments, for the services furnished by, or the direct or indirect connection with, or the use of, or any commodity from the System, including without limiting the generality of the foregoing, minimum charges, charges for the availability of service, disconnection fees, reconnection fees and reasonable penalties for any delinquencies, and all income or other realized gain, if any, from any investment of Gross Pledged Revenues and of the proceeds of securities payable from Net Pledged Revenues (except income or other gain from any investment of moneys held in an escrow fund or account for the defeasance of securities payable from the Net Pledged Revenues or any other similar fund) to the extent not required to be rebated to the federal government. Gross Pledged Revenues shall also include amounts on deposit in a rate stabilization fund. Gross Pledged Revenues excludes any refund of rates, tolls and charges due to others.

"improve" or "improvement" means the extension, reconstruction, alteration, betterment or other improvement by the construction, purchase or other acquisition of facilities, including, without limitation, appurtenant machinery, apparatus, fixtures, structures and buildings.

"Independent Accountant" means any certified public accountant, or any firm of certified public accountants, duly licensed to practice and practicing as such under the laws of the State:

(i) Who is, in fact, independent and not under the control of the City;

(ii) Who does not have any substantial interest, direct or indirect, with the City, and

(iii) Who is not connected with the City as an officer or employee thereof, but who may be regularly retained to make annual or similar audits of any books or records of the City.

"Independent Engineer" means an individual, firm or corporation engaged in the engineering profession of recognized good standing and having specific experience in respect of business and properties of a character similar to those of the System, which individual, firm or corporation has no substantial interest, direct or indirect, in the City and in the case of an individual, is not a member of the Council, or an officer or employee of the City, and in the case of a firm or corporation, does not have a partner, director, officer or employee who is a member of the Council or an officer or employee of the City.

"Insurance Policy" means the municipal bond new issue insurance policy, if any, issued by the Insurer that guarantees payment of principal of and interest on the Bonds when due.

"Insurer" means the issuer of the Insurance Policy, if any, as set forth in the Sale Certificate.

"Insurance Agreement" means an agreement entered into between the City and any Insurer pursuant to Section 213 of this Ordinance.

"Investment Securities" means any securities or other obligations permitted as investments of moneys of the City under the laws of the State.

"Letter of Representations" means the Blanket Issuer Letter of Representations from the City to The Depository Trust Company in connection with the issuance of the Bonds in a book-entry system, as supplemented and amended from time to time.

"Mayor" means the Mayor of the City or his or her successor in functions, if any.

"Net Pledged Revenues" means the Gross Pledged Revenues remaining after the payment of the Operation and Maintenance Expenses of the System.

"Official Statement" means the Official Statement delivered in connection with the original issuance and sale of the Bonds.

"Operation and Maintenance Expenses" means such reasonable and necessary current expenses of the City, paid or accrued, of operating, maintaining and repairing the System as may be determined by the City, including, except as limited by contract or otherwise limited by law, without limiting the generality of the foregoing:

(a) Engineering, auditing, legal and other overhead expenses directly related and reasonably allocable to the administration, operation and maintenance of the System;

(b) Insurance, surety bond and interest rate cap agreement premiums appertaining to the System;

(c) The reasonable charges of any paying agent, registrar, transfer agent, depository or escrow bank appertaining to any securities payable from the Net Pledged Revenues;

(d) Annual payments to pension, retirement, health and hospitalization funds appertaining to the System;

(e) Any taxes, assessments, franchise fees or other charges or payments in lieu of the foregoing;

(f) Ordinary and current rentals or equipment or other property;

(g) Contractual services, professional services, salaries, administrative expenses and costs of labor appertaining to the System, the cost of water purchased for delivery through the System and the cost of materials and supplies used for current operation or routine maintenance or repair of the System;

(h) The costs incurred in the billing and collection of all or any part of the Gross Pledged Revenues;

(i) Any costs of utility services furnished to the System by the City or otherwise;

(j) Any other such expenses considered by· the· City in determining the amount of water rates, fees, tolls and charges imposed for operation and maintenance; and

(k) Expenses in connection with the issuance of bonds or other securities evidencing any loan to the City and payable from Gross Pledged Revenues.

"Operating Expenses" do not include:

(a) Any allowance for depreciation;

(b) Any costs of improvement, extension or betterment that qualify as capital items in accordance with generally accepted accounting principles;

(c) Any accumulation of reserves for capital replacements;

(d) Any reserves for operation, maintenance or repair of the System;

(e) Any allowance for the redemption of any bonds or other securities payable from the Net Pledged Revenues or the payment of any interest thereon;

(f) Any liabilities incurred in the acquisition of any facilities constituting part of the System; and

(g) Any other ground of legal liability not based on contract.

"Ordinance" means this ordinance of the City, which provides for the issuance and delivery of the Bonds.

"Outstanding" when used with reference to the Bonds, the Parity Bonds, or any other designated securities and as of any particular date means all the Bonds, the Parity Bonds, or any such other securities payable from the Net Pledged Revenues or otherwise pertaining to

the System, as the case may be, in any manner theretofore and thereupon being executed and delivered:

(i) Except any Bond, Parity Bonds, or other security canceled by the City, by any paying agent, or otherwise on the City's behalf, at or before such date;

(ii) Except any Bond, Parity Bond, or other security deemed to be paid as provided in Section 1201 hereof or any similar provision of the ordinance authorizing the issuance of such other security; and

(iii) Except any Bond, Parity Bond, or other security in lieu of or in substitution for which another Bond or other security shall have been executed and delivered pursuant to Sections 306, 307 or 1108 hereof or any similar provisions of the ordinance authorizing the issuance of such other security.

"Owner" means the registered owner of any designated Bond, Parity Bond, or other designated security.

"Parity Bonds" means any securities hereafter issued payable from and having an irrevocable lien upon the Net Pledged Revenues on a parity with the Bonds.

"Parity Bond Ordinances" means any ordinances or agreements previously or hereafter entered into by the City with respect to or authorizing the issuance of Parity Bonds.

"Paying Agent" means UMB Bank, n.a., being an agent of the City for the payment of the Bond Requirements due in connection with the Bonds, the registrar for the Bonds and for other administration of moneys pertaining to the Bonds and includes any successor Commercial Bank as paying agent.

"Paying Agent Agreement" means the agreement between the City and the Paying Agent.

"Person" means a corporation, firm, other body corporate (including, without limitation, the Federal Government, the State, or any other body corporate and politic other than the City), partnership, limited liability company, association or individual, and also includes an executor, administrator, trustee, receiver or other representative appointed according to law.

"Policy Costs" means repayment of draws under the Reserve Fund Insurance Policy, if any, plus all related reasonable expenses incurred by the Surety Provider, plus accrued interest thereon.

"Preliminary Official Statement" means the Preliminary Official Statement delivered in connection with the original issuance and sale of the Bonds.

"Project" means, the land, facilities and rights constructed, installed, purchased and otherwise acquired for the System, the cost of which is to be defrayed with a portion of the proceeds of the Bonds and which constitutes Capital Improvements.

"Project Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Project Fund" created pursuant to Section 501 hereof.

"Purchaser" means the original purchaser of the Bonds as specified in the Sale Certificate.

"Rating Agency" means each nationally recognized securities rating agency then maintaining a rating on the Bonds.

"Rebate Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Rebate Fund" created pursuant to Section 510 hereof.

"Record Date" means the close of business on the fifteenth day (whether or not a Business Day) of the calendar month next preceding an interest payment date.
"Redemption Date" means, with respect to the 2012 Bonds, the earliest date on which such 2012 Bonds can be called for prior redemption; and with respect to the Bonds, the date fixed for the redemption prior to their respective maturities of any Bonds or other designated securities payable from Net Pledged Revenues in any notice of prior redemption or otherwise fixed and designated by the City.
"Refunded Bond Requirements" means: (i) the payment of the interest due on the Refunded Bonds, both accrued and not accrued, as the same become due on and after the date of delivery of the Bonds and on and before the Redemption Date; (ii) the payment of principal of the Refunded Bonds as the same becomes due upon prior redemption on the Redemption Date; and (iii) the payment of any required redemption premium.
"Refunded Bonds" means any or all of the 2012 Bonds as designated in the Sale Certificate.
"Refunding Project" means the issuance of a portion of the Bonds for the purposes of defraying the costs of refunding the Refunded Bonds.
"Reserve Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Reserve Fund" created pursuant to Section 506 hereof, if such an account is required as specified in the Sale Certificate. The Reserve Fund shall secure only principal of and interest on the Bonds.
"Reserve Fund Insurance Policy" means any insurance policy, surety bond, irrevocable letter of credit or similar instrument deposited in or credited to the Reserve Fund in lieu of or in partial substitution for moneys on deposit therein.
"Reserve Fund Requirement" has the meaning ascribed to such term in the Sale Certificate.
"Sale Certificate" means the sale certificate of the City relating to the Bonds issued pursuant to the Supplemental Public Securities Act and described in Section 213 hereof.
"Sewer Enterprise Fund" means the special fund maintained by the City and designated as the "Sewer Enterprise Fund".
"Special Record Date" means the record date for determining ownership of the Bonds for purposes of paying accrued but unpaid interest, as such date may be determined pursuant to this Ordinance.
"State" means the State of Colorado.
"Subordinate Securities" means securities or other obligations payable from the Net Pledged Revenues subordinate and junior to the lien thereon of the Bonds and any Parity Bonds.
"Supplemental Public Securities Act" means Part 2 of Article 57 of Title 11, C.R.S., as amended.
"Supplemental Reserve Fund" means the special fund designated as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Supplemental Reserve Fund" created pursuant to Section 507 hereof, if such an account is required as specified in the Sale Certificate. Any Supplemental Reserve Fund shall secure only the principal and interest on the Bonds.
"Supplemental Reserve Fund Requirement" means the amount set forth in the Sale Certificate, if any, for deposit into the Supplemental Reserve Fund.

"Surety Provider" means the Insurer or any other entity issuing a Reserve Fund Insurance Policy with respect to the Bonds.
"System" means the City's system for the collection, treatment and discharge of water and consisting of all properties, real, personal, mixed or otherwise, now owned or hereafter acquired by the City, whether situated within or without the City boundaries, used in connection with such system of the City, and in any way appertaining thereto, including all present or future improvements, extensions, enlargements, betterments, replacements or additions thereof or thereto and administrative facilities
"Tax Compliance Certificate" means the federal tax compliance certificate executed by the City in connection with the initial issuance and delivery of the Bonds.
"Tax Code" means the Internal Revenue Code of 1986, as amended to the date of delivery of the Bonds, and the regulations promulgated thereunder.
"Term Bonds" means Bonds that are payable on or before their specified maturing dates from sinking fund payments established for that purpose and calculated to retire such Bonds on or before their specified maturity dates.
"Trust Bank" means a Commercial Bank which is authorized to exercise and is exercising trust powers located within or without the State, and also means any branch of the Federal Reserve Bank.
"2012 Bonds" means the City and County of Broomfield, Colorado, Sewer and Wastewater Reclamation Revenue Refunding Bonds, Series 2012, which 2012 Bonds shall be fully discharged and defeased contemporaneously with the issuance of the Bonds and no longer outstanding.
B. City-Held Securities. Any securities payable from any Net Pledged Revenues held by the City shall not be deemed to be Outstanding for the purpose of redemption nor Outstanding for the purpose of consents hereunder or for any other purpose herein, except for payment.

Section 102. Parties Interested Herein. Nothing herein expressed or implied confers any right, remedy or claim upon any Person, other than the City, the Council, the Paying Agent, the Insurer, the Surety Provider, the Owners of the Bonds and the Owners of any Parity Bonds or other securities payable from the Net Pledged Revenues when reference is expressly made thereto. All the covenants, stipulations, promises and agreements herein contained by and on behalf of the City shall be for the sole and exclusive benefit of the City, the Council, the Paying Agent, the Insurer, the Surety Provider, the Owners of the Bonds and the Owners of any such other securities in the event of such a reference.

Section 103. Ratification; Approval of Documents. All action heretofore taken (not inconsistent with the provisions of this Ordinance) by the Council, the officers of the City and otherwise taken by the City directed toward the Project and the sale and delivery of the Bonds for such purposes, be, and the same hereby is, ratified, approved and confirmed.

Section 104. Repealer. All bylaws, orders, resolutions, ordinances or parts thereof, inconsistent herewith are hereby repealed to the extent only of such inconsistency. This repealer shall not be construed to revive any such bylaw, order, resolution or ordinance, or

part thereof, heretofore repealed. All rules of the Council, if any, which might prevent the final passage and adoption of this Ordinance are hereby suspended.

Section 105. Severability. If any section, subsection, paragraph, clause or other provision of this Ordinance for any reason is invalid or unenforceable, the invalidity or unenforceability of such section, subsection, paragraph, clause or other provision shall not affect any of the remaining provisions of this Ordinance.

Section 106. Ordinance Irrepealable. After any of the Bonds are issued, this Ordinance shall constitute an irrevocable contract between the City and the Owner or Owners of the Bonds and this Ordinance shall be and shall remain irrepealable until the Bonds, as to all Bond Requirements, shall be fully paid, canceled, and discharged, except as herein otherwise provided.

Section 107. Conclusive Recitals. Pursuant to Section 11-57-210 of the Supplemental Public Securities Act, the Bonds shall contain a recital that they are issued pursuant to the Supplemental Public Securities Act. Such recital shall be conclusive evidence of the validity and the regularity of the issuance of the Bonds after their delivery for value.

Section 108. Limitation of Actions. Pursuant to Section 11-57-212 of the Supplemental Public Securities Act, no legal or equitable action brought with respect to any legislative acts or proceedings of the City in connection with the authorization or issuance of the Bonds, including but not limited to the adoption of this Ordinance, shall be commenced more than thirty days after the authorization of the Bonds.

ARTICLE II
DETERMINATION OF THE CITY'S AUTHORITY AND OBLIGATIONS; APPROVAL OF RELATED DOCUMENTS; AND ELECTION TO APPLY SUPPLEMENTAL PUBLIC SECURITIES ACT TO THE BONDS

Section 201. Authorization. The Bonds are issued in accordance with the Constitution and laws of the State, the Charter and the provisions of this Ordinance, specifically the Supplemental Public Securities Act; Title 37, Article 45.1, C.R.S., and all other laws of the State thereunto enabling. For the purpose of defraying the cost of the Project, the City hereby authorizes the Bonds to be issued in the aggregate principal amount provided in the Sale Certificate as approved by the City Manager or the Director of Finance, subject to the parameters and restrictions contained in this Ordinance.

Section 202. Bonds Equally Secured. The covenants and agreements herein set forth to be performed on behalf of the City shall be for the equal benefit, protection and security of the Owners of any and all of the Outstanding Bonds and any Outstanding Parity Bonds heretofore or hereafter authorized and issued, all of which, regardless of the time or times of their issue or maturity, shall be of equal rank without preference, priority or distinction of any of such

securities over any other thereof, except as otherwise expressly provided in or pursuant to this Ordinance.

Section 203. Special Obligations. All of the Bond Requirements of the Bonds and the Policy Costs shall be payable and collectible solely out of the Net Pledged Revenues which revenues are so pledged; the Owner or Owners of the Bonds and the Surety Provider may not look to any general or other fund for the payment of such Bond Requirements, except the herein designated special funds pledged therefor; the Bonds and the Policy Costs shall not constitute an indebtedness or a debt within the meaning of any constitutional, or statutory provision or limitation; and the Bonds and the Policy Costs shall not be considered or held to be general obligations of the City but shall constitute its special obligations. No statutory, Charter, or constitutional provision enacted after the issuance of the Bonds shall in any manner be construed as limiting or impairing the obligation of the City to comply with the provisions of this Ordinance or to pay the Bond Requirements of the Bonds and the Policy Costs as herein provided.

Section 204. Character of Agreement. None of the covenants, agreements, representations and warranties contained herein or in the Bonds shall ever impose or shall be construed as imposing any liability, obligation or charge against the City (except the special funds pledged therefor), or against its general credit, or as payable out of its general fund or out of any funds derived from taxation or out of any other revenue source (other than those pledged therefor).

Section 205. No Pledge of Property. The payment of the Bonds and the Policy Costs is not secured by an encumbrance, mortgage or other pledge of property of the City, except for the Net Pledged Revenues and other moneys pledged for the payment of the Bond Requirements of the Bonds. No property of the City, subject to such exception, shall be liable to be forfeited or taken in payment of the Bonds or the Policy Costs.

Section 206. No Recourse Against Officers and Agents. No recourse shall be had for the payment of the Bond Requirements of the Bonds or the Policy Costs or for any claim based thereon or otherwise upon this Ordinance or any other ordinance pertaining hereto, against any individual member of the Council or any officer, employee or other agent of the City, past, present or future, either directly or indirectly through the Council, or the City, or otherwise, whether by virtue of any penalty or otherwise, all such liability, if any, being by the acceptance of the Bonds and as part of the consideration of their issuance specially waived and released.

Section 207. Authorization of the Project. The Council, on behalf of the City, does hereby determine to undertake the Project, which is hereby authorized, and the proceeds of the Bonds shall be used therefor.

Section 208. Enterprise Status. The Council, on behalf of the City, hereby confirms its determination that the System is an "enterprise" for the purposes of Article X, Section 20 of the State Constitution and Title 37 Article 45.1, C.R.S.

Section 209. Sale of Bonds. The Bonds shall be sold by negotiated sale to the Purchaser. Pursuant to the Supplemental Public Securities Act, the Council hereby delegates to the City Manager or the Director of Finance the authority to execute the Bond Purchase Agreement and the Sale Certificate with respect to the sale of the Bonds.

Section 210. Official Statement. The preparation and use of the Preliminary Official Statement and of the final Official Statement are hereby authorized. The Director of Finance is hereby authorized to approve, on behalf of the City, the Official Statement. The execution of the Official Statement by the Director of Finance shall be conclusively deemed to evidence the approval of the form and contents thereof by the City.

Section 211. Paying Agent and Allotment Contract. The Council hereby determines to approve the Paying Agent Agreement. The Paying Agent may resign at any time on 30 days' prior written notice to the City. The City may remove the Paying Agent upon 30 days' prior written notice to the Paying Agent. If the Paying Agent appointed thereunder shall resign, or if the City shall determine to remove the Paying Agent, then the City may appoint a successor Paying Agent, upon notice sent to each owner of any Bond at his address last shown on the registration records maintained by the Paying Agent or by electronic means to DTC or its successor. No resignation or dismissal of the Paying Agent may take effect until a successor has been appointed and has accepted the duties of the Paying Agent. Every such successor Paying Agent shall be a Commercial Bank.

Section 212. Other Related Documents. The forms, terms and provisions of, and the performance by the City of its obligations under the Preliminary Official Statement, the Paying Agent Agreement, the Escrow Agreement and the Continuing Disclosure Certificate are hereby approved, and the Mayor or Mayor pro-tem and the City Clerk or Deputy City Clerk are hereby authorized and directed to execute each of such documents on behalf of and in the name of the City, and to deliver each of such documents, in substantially the form on file with the City Clerk, with such changes as are not inconsistent herewith. The Mayor, the City Manager or the Director of Finance are hereby authorized to execute and deliver any Insurance Agreement as may be required by an Insurer relating to the issuance of the Insurance Policy or a Surety Provider relating to the Reserve Fund Insurance Policy. The execution of any instrument by the appropriate officers of the City herein authorized shall be conclusive evidence of the approval by the City of such instrument in accordance with the terms hereof.

Section 213. Elections to Apply Supplemental Public Securities Act to the Bonds. Pursuant to Section 11-57-204 of the Supplemental Public Securities Act, a public entity, including the City, may elect in an act of issuance to apply all or any of the provisions of the Supplemental Public Securities Act. The Council hereby elects to apply all of the provisions of the

Supplemental Public Securities Act to the Bonds. Pursuant to Section 11-57-205 of the Supplemental Public Securities Act, the Council hereby delegates to the City Manager or the Director of Finance the authority to make the following determinations with respect to the Bonds, subject to the parameters and restrictions contained in this Ordinance, without any requirement that the Council approve such determinations:

(i) Interest Rate. The net effective rate of interest to be borne by the Bonds, which shall not exceed 5.50%

(ii) Redemption Provisions. The prior redemption provisions of the Bonds, provided that the Bonds shall be subject to optional redemption prior to maturity not later than December 1, 2036 at a redemption price not to exceed 100%.

(iii) Purchase Price. The price at which the Bonds will be sold to the Purchaser, provided that the purchase price of the Bonds shall not be less than 98% of the aggregate principal amount of the Bonds.

(iv) Principal Amount. The aggregate principal amount of the Bonds, provided that such principal amount shall not exceed $125,000,000.

(v) Maturity Schedule. The amount of principal of and interest on the Bonds maturing, or subject to mandatory sinking fund redemption in any particular year; provided that the maximum annual repayment cost shall not exceed $11,000,000 and the maximum total repayment cost shall not exceed $220,000,000.

(vi) Term of the Bonds. The Bonds shall not mature later than December 1, 2047.

(vii) Capitalized Interest. The existence and amount of any capitalized interest on the Bonds.

(viii) Reserve Fund. The amount to be deposited in the Reserve Fund, if any.

(ix) Supplemental Reserve Fund. The amount to be deposited in the Supplemental Reserve Fund, if any.

(x) Bond Insurance. Whether the Bonds will be secured by an Insurance Policy or a Reserve Fund Insurance Policy and the terms of any agreement with the provider of such Insurance Policy or Reserve Fund Insurance Policy.

Such determinations shall be evidenced by the Sale Certificate signed by the City Manager, or the Director of Finance dated and delivered as of the Closing Date, which shall not be more than one year from the date of adoption of this Ordinance. If the City shall determine to not obtain an Insurance Policy to secure the payment of principal of and interest on the Bonds, or not to obtain a Reserve Fund Insurance Policy, any references to the Insurer, the Insurance Policy, the Reserve Fund Insurance Policy, the Surety Provider, Policy Costs, the Insurance Agreement, or other provisions relating to bond insurance shall be of no force or effect.

ARTICLE III
AUTHORIZATION, TERMS, EXECUTION AND ISSUANCE OF BONDS

Section 301. Bond Details.

A. Basic Provisions. The Bonds shall be issued in fully registered form (i.e., registered as to payment of both principal and interest), in denominations of $5,000 or any integral multiple thereof. The Bonds shall be lettered "R" and shall be numbered separately from 1

upward. The Bonds shall be dated as of the date of their delivery. The Bonds shall mature on December 1, in the years and amounts and subject to prior redemption as set forth herein and in the Sale Certificate. The Bonds shall bear interest from the most recent interest payment date to which interest has been paid, or if no interest has been paid, from their date until their respective maturities (or prior redemption) at the rates set forth in the Sale Certificate. No interest shall accrue on any Bonds owned by or on behalf of the City. Interest on the Bonds shall be calculated on the basis of a 360-day year of twelve 30-day months, payable semiannually on each June 1 and December 1, commencing on the date provided in the Sale Certificate.

B. Payment of Bonds. The principal of each Bond shall be payable at the principal corporate trust office of the Paying Agent, or at such other office as the Paying Agent directs in writing to the Owners of the Bonds, or at the principal office of its successor, upon presentation and surrender of the Bond. Payment of interest on any Bond shall be made to the Owner thereof by the Paying Agent on or before each interest payment date, (or, if such interest payment date is not a Business Day, on or before the next succeeding Business Day), to such Owner at his or her address as it appears on the registration records kept by the Paying Agent on the Record Date; but any such interest not so timely paid or duly provided for shall cease to be payable to the person who is the Owner thereof at the close of business on the Record Date and shall be payable to the person who is the Owner thereof at the close of business on a Special Record Date for the payment of any such defaulted interest. Such Special Record Date and the date fixed for payment of such defaulted interest shall be fixed by the Paying Agent whenever moneys become available for payment of the defaulted interest, and notice of the Special Record Date shall be given to the Owners not less than ten days prior to the Special Record Date by first-class mail to each such Owner as shown on the Paying Agent's registration books on a date selected by the Paying Agent, stating the date of the Special Record Date and the date fixed for the payment of such defaulted interest. The Paying Agent may make payments of interest on any Bond by such alternative means as may be mutually agreed to between the Owner of such Bond and the Paying Agent. If any Bond is not paid upon its presentation and surrender at or after its maturity or prior redemption, interest shall continue at its stated rate per annum until the principal thereof is paid in full. All such payments shall be made in lawful money of the United States of America.

Section 302. Execution of Bonds. The Bonds shall be executed in the name of the City by the manual or facsimile signature of the Mayor, shall be sealed with the corporate seal of the City or a facsimile thereof thereunto affixed, imprinted, engraved or otherwise reproduced and shall be attested by the manual or facsimile signature of the City Clerk. Any Bond may be signed (manually or by facsimile), sealed or attested on behalf of the City by any person who, at the date of such act, shall hold the proper office, notwithstanding that at the date of authentication, issuance or delivery, such person may have ceased to hold such office. The Mayor and the City Clerk may adopt as and for his or her own facsimile signature the facsimile signature of his or her predecessor in office in the event that such facsimile signature appears on any of the Bonds. Before the execution of any Bond, the Mayor and the City Clerk shall each file with the Colorado Secretary of State his or her manual signature certified by him or her under oath.

Section 303. Authentication Certificate. The authentication certificate upon the Bonds shall be substantially in the form and tenor provided in the form of the Bonds set forth in Section 309 hereof. No Bond shall be secured hereby or entitled to the benefit hereof, nor shall any Bond be valid or obligatory for any purpose, unless the certificate of authentication, substantially in such form, has been duly executed by the Paying Agent and such certificate of the Paying Agent upon any Bond shall be conclusive evidence that such Bond has been authenticated and delivered hereunder. The certificate of authentication shall be deemed to have been duly executed by the Paying Agent if manually signed by an authorized officer or employee of the Paying Agent, but it shall not be necessary that the same officer or employee sign the certificate of authentication on all of the Bonds.

Section 304. Registration and Payment. The Paying Agent shall keep or cause to be kept sufficient records for the registration and transfer of the Bonds, which shall at all times be open to inspection by the City. Upon presentation for such purpose, the Paying Agent shall, under such reasonable regulations as it may prescribe, register or transfer or cause to be registered or transferred, on said records, Bonds as herein provided. Except as provided in Section 306 hereof, the Person in whose name any Bond shall be registered on the registration records kept by the Paying Agent shall be deemed and regarded as the absolute owner thereof for the purpose of making payment of the Bond Requirements thereof and for all other purposes; and payment of or on account of the Bond Requirements of any Bond shall be made only to the Owner thereof or his or her legal representative, but such registration may be changed upon transfer of such Bond in the manner and subject to the conditions and limitations provided herein. All such payments shall be valid and effectual to discharge the liability upon such Bond to the extent of the sum or sums so paid. The foregoing provisions of this Section are subject to the provisions of Section 307 hereof.

Section 305. Transfer and Exchange. Any Bond may be transferred upon the records required to be kept pursuant to the provisions of Section 304 hereof by the Person in whose name it is registered, in person or by his or her duly authorized attorney, upon surrender of such Bond for cancellation, accompanied by delivery of a written instrument of transfer in a form approved by the Paying Agent, duly executed. Whenever any Bond or Bonds shall be surrendered for transfer, the Paying Agent shall authenticate and deliver a new Bond or Bonds for a like aggregate principal amount and of the same maturity and interest rate and of any authorized denominations. The Bonds may be exchanged by the Paying Agent for a like aggregate principal amount of Bonds of the same maturity and interest rate and of other authorized denominations. The execution by the City of any Bond of any denomination shall constitute full and due authorization of such denomination and the Paying Agent shall thereby be authorized to authenticate and deliver such Bond.

The Paying Agent shall not be required to transfer or exchange (a) any Bond subject to redemption during a period beginning at the opening of business 15 days before the day of the mailing of a notice of redemption of Bonds and ending at the close of business on the day such notice is mailed, or (b) any Bond so selected for redemption in whole or in part after the

mailing of notice calling such Bond or any portion thereof for prior redemption except the unredeemed portion of Bonds being redeemed in part.

The Paying Agent shall require the payment by any Owner requesting exchange or transfer of any tax or other governmental charge required to be paid with respect to such exchange or transfer and may charge a sum sufficient to pay the cost of preparing each new Bond upon each exchange or transfer and any other expenses of the City or the Paying Agent incurred in connection therewith.

The foregoing provisions of this Section are subject to the provisions of Section 307 hereof.

Section 306. Bond Replacement. Upon receipt by the City and the Paying Agent of evidence satisfactory to them of the ownership of and the loss, theft, destruction or mutilation of any Bond and, in the case of a lost, stolen or destroyed Bond, of indemnity satisfactory to them, and in the case of a mutilated Bond upon surrender and cancellation of the Bond, (a) the City shall execute and the Paying Agent shall authenticate and deliver a new Bond of the same date, interest rate and denomination in lieu of such lost, stolen, destroyed or mutilated Bond, or (b) if such lost, stolen, destroyed or mutilated Bond shall have matured or have been called for redemption, in lieu of executing and delivering a new Bond as aforesaid, the City may pay such Bond. Any such new Bond shall bear a number not previously assigned. The applicant for any such new Bond may be required to pay all expenses and charges of the City and of the Paying Agent in connection with the issuance of such Bond. All Bonds shall be held and owned upon the express condition that, to the extent permitted by law, the foregoing conditions are exclusive with respect to the replacement and payment of mutilated, destroyed, lost or stolen Bonds, negotiable instruments or other securities.

Section 307. Custodial Deposit.

A. Depository. Notwithstanding any contrary provision of this Ordinance, the Bonds initially shall be evidenced by one Bond of the same maturity and interest rate in denominations equal to the aggregate principal amount of the Bonds of the same maturity and interest rate. Such initially delivered Bonds shall be registered in the name of "Cede & Co." as nominee for The Depository Trust Company, the securities depository for the Bonds. The Bonds may not thereafter be transferred or exchanged except:

(1) to any successor of The Depository Trust Company or its nominee, which successor must be both a "clearing corporation" as defined in Section 4-8-102(a)(5), C.R.S. and a qualified and registered "clearing agency" under Section 17A of the Securities Exchange Act of 1934, as amended; or

(2) upon the resignation of The Depository Trust Company or a successor or new depository institution under clause (1) or this clause (2) of this paragraph A, or a determination by the Council that The Depository Trust Company or such successor or a new depository institution is no longer able to carry out its functions, and the designation by the Council of another depository institution acceptable to the Council and to the depository then holding the Bonds, which new depository must be both a "clearing corporation" as defined in Section 4-8-102(a)(5), C.R.S. and a qualified and registered "clearing agency" under Section

17A of the Securities Exchange Act of 1934, as amended, to carry out the functions of The Depository Trust Company or such successor new depository institution; or

(3) upon the resignation of The Depository Trust Company or a successor or new depository institution under clause (1) above or designation of a new depository institution pursuant to clause (2) above, or a determination of the Council that The Depository Trust Company or such successor or depository institution is no longer able to carry out its functions, and the failure by the Council, after reasonable investigation, to locate another depository institution under clause (2) to carry out such depository institution functions.

B. Successor. In the case of a transfer to a successor of The Depository Trust Company or its nominee as referred to in clause (1) or (2) of paragraph A hereof, upon receipt of the outstanding Bonds by the Paying Agent together with written instructions for transfer satisfactory to the Paying Agent, a new Bond for each maturity and interest rate of the Bonds then outstanding shall be issued to such successor or new depository, as the case may be, or its nominee, as is specified in such written transfer instructions. In the case of a resignation or determination under clause (3) of paragraph A hereof and the failure after reasonable investigation to located another qualified depository institution for the Bonds as provided in clause (3) of paragraph A hereof, and upon receipt of the outstanding Bonds by the Paying Agent, together with written instructions for transfer satisfactory to the Paying Agent, new Bonds shall be issued in authorized denominations as provided in and subject to the limitations of Sections 301, 304, and 305 hereof, registered in the names of such Persons, as are requested in such written transfer instructions; however, the Paying Agent shall not be required to deliver such new Bonds within a period of less than 60 days from the date of receipt of such written transfer instructions.

C. Absolute Owner. The Council and the Paying Agent shall be entitled to treat the Owner of any Bond as the absolute owner thereof for all purposes hereof and any applicable laws, notwithstanding any notice to the contrary received by any or all of them and the Council and the Paying Agent shall have no responsibility for transmitting payments or notices to the beneficial owners of the Bonds held by The Depository Trust Company or any successor or new depository named pursuant to paragraph A hereof.

D. Payment. The Council and the Paying Agent shall endeavor to cooperate with The Depository Trust Company or any successor or new depository named pursuant to clause (1) or (2) of paragraph A hereof in effectuating payment of the principal amount of the Bonds upon maturity or prior redemption by arranging for payment in such a manner that funds representing such payments are available to the depository on the date they are due.

E. Redemption. Upon any partial redemption of any maturity and interest rate of the Bonds, Cede & Co. (or its successor) in its discretion may request the City to issue and authenticate a new Bond or shall make an appropriate notation on the Bond indicating the date and amount of prepayment, except in the case of final maturity, in which case the Bond must be presented to the Paying Agent prior to payment. The records of the Paying Agent shall govern in the case of any dispute as to the amount of any partial prepayment made to Cede & Co. (or its successor).

Section 308. Bond Cancellation. Whenever any Bond shall be surrendered to the Paying Agent upon payment thereof, or to the Paying Agent for transfer, exchange or replacement as

provided herein, such Bond shall be promptly canceled and destroyed by the Paying Agent in accordance with its customary practices and applicable retention laws.

Section 309. Bond Form. Subject to the provisions of this Ordinance, the Bonds shall be in substantially the following forms, with such omissions, insertions, endorsements and variations as to any recitals of fact or other provisions as may be required by the circumstances, be required or permitted by this Ordinance, be consistent with this Ordinance or be necessary or appropriate to conform to the rules and requirements of any governmental authority or any usage or requirement of law with respect thereto:

(FORM OF BOND)

Unless this Bond is presented by an authorized representative of The Depository Trust Company, a New York corporation ("DTC"), to the City or its agent for registration of transfer, exchange, or payment, and any Bond issued is registered in the name of Cede & Co. or in such other name as is requested by an authorized representative of DTC (and any payment is made to Cede & Co. or to such other entity as is requested by an authorized representative of DTC), ANY TRANSFER, PLEDGE, OR OTHER USE HEREOF FOR VALUE OR OTHERWISE BY OR TO ANY PERSON IS WRONGFUL inasmuch as the registered owner hereof, Cede & Co., has an interest herein.

UNITED STATES OF AMERICA

STATE OF COLORADO CITY AND COUNTY OF BROOMFIELD

CITY AND COUNTY OF BROOMFIELD, COLORADO
SEWER ACTIVITY ENTERPRISE
SEWER REVENUE BOND
SERIES 2026

No. R- $_____

INTEREST RATE	MATURITY DATE	DATED AS OF	CUSIP
_____%	December __, 20__	[Date of Delivery]	_____

REGISTERED OWNER: CEDE & CO.

PRINCIPAL AMOUNT: _____ DOLLARS

The City and County of Broomfield (the "City"), for value received, hereby promises to pay to the registered owner specified above, or registered assigns, upon the presentation and surrender of this bond, solely from the special funds provided therefor, as hereinafter set forth, the principal amount set forth above on the maturity date specified above (unless this bond shall have been called for prior redemption, in which case on the Redemption Date) and to pay solely from such special funds interest hereon at the interest rate per annum specified above, payable semiannually on June 1 and December 1 in each year, beginning on _____, until the principal amount is paid or payment has been provided for, as described in an ordinance adopted by the City Council of the City on October __, 2025 (the "Ordinance"). This is one of an authorized series of bonds issued under the Ordinance (the "Bonds"). The Bonds are all issued under and equally and ratably secured by and entitled to the security of the Ordinance. To the extent not defined herein, terms used in this Bond shall

have the same meanings as set forth in the Ordinance. This Bond bears interest, matures, is payable, is subject to redemption and is transferable as provided in the Ordinance.

Reference is made to the Ordinance and to all Ordinances supplemental thereto, with respect to the nature and extent of the security for the Bonds, the accounts, funds or revenues pledged, rights, duties and obligations of the City, the Paying Agent and the Insurer, the Surety Provider, the rights of the Owners of the Bonds, the events of defaults and remedies, the circumstances under which any Bond is no longer Outstanding, the issuance of additional bonds and the terms on which such additional bonds may be issued under and secured by the Ordinance, the ability to amend the Ordinance, and to all the provisions of which the Owner hereof by the acceptance of this Bond assents.

THE BONDS ARE ISSUED PURSUANT TO AND IN FULL COMPLIANCE WITH THE CONSTITUTION AND LAWS OF THE STATE, AND PURSUANT TO THE ORDINANCE. THE BONDS ARE SPECIAL, LIMITED OBLIGATIONS OF THE CITY, SECURED BY THE NET PLEDGED REVENUES. THE BONDS DO NOT CONSTITUTE A GENERAL OBLIGATION DEBT OF THE CITY, THE STATE OR ANY POLITICAL SUBDIVISION THEREOF, AND NEITHER THE CITY, THE STATE NOR ANY OF THE POLITICAL SUBDIVISIONS THEREOF IS LIABLE THEREFOR. NEITHER THE MEMBERS OF THE CITY COUNCIL OF THE CITY NOR ANY PERSONS EXECUTING THIS BOND SHALL BE PERSONALLY LIABLE FOR THIS BOND.

It is certified, recited and warranted that all the requirements of law have been fully complied with by the proper officers of the City in the issuance of this Bond; that it is issued pursuant to and in strict conformity with the Constitution of the State, and with the Ordinance and any ordinances supplemental thereto; and that this Bond does not contravene any Constitutional or statutory limitation.

This Bond is one of a series of bonds issued pursuant to the Bond Ordinance (the "Bond Ordinance") designated as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026" (the "Bonds") in the aggregate principal amount of $[_____]. The Bonds have been duly authorized for the purpose of providing moneys to defray a portion of the cost of extending, bettering or otherwise improving and equipping the System, refund the City's previously issued Sewer and Wastewater Reclamation Activity Enterprise Sewer Revenue Refunding Bonds, Series 2012 (the "2012 Bonds"), and to pay the costs of issuing the Bonds.

The bonds of the series of which this bond is one are issued under the authority of the City Charter; Title 37, Article 45.1, C.R.S.; and Title 11, Article 57, Part 2, C.R.S., and in full conformity therewith. Pursuant to Section 11-57-210, C.R.S., this recital shall be conclusive evidence of the validity and the regularity of the issuance of the Bonds and the Bonds shall be incontestable for any cause whatsoever after their delivery for value.

Payment of the principal of and interest of the Bonds shall be made solely from the Net Pledged Revenues. The Net Pledged Revenues are irrevocably (but not exclusively) pledged as security for such payment pursuant to the Ordinance.

This Bond shall not be valid or become obligatory for any purpose or be entitled to any security or benefit under the Ordinance until the certificate of authentication hereon shall have been duly executed by the Paying Agent.

IN WITNESS WHEREOF, the City has caused this Bond to be signed and executed in its name and upon its behalf with the facsimile signature of its Mayor, has caused the facsimile of the seal of the City to be affixed hereon and has caused this Bond to be signed, executed and attested with the facsimile signature of its City Clerk, all as of the date specified above.

By_____ (For Facsimile Signature)
MAYOR

(FACSIMILE SEAL)

Attest:

_____(For Facsimile Signature)
OFFICE OF THE CITY CLERK

(FORM OF CERTIFICATE OF AUTHENTICATION)

CERTIFICATE OF AUTHENTICATION

This is one of the Bonds described in the within mentioned Ordinance.

UMB BANK, N.A., as Paying Agent

By_____
Authorized Signatory

Date of Authentication and Registration: _____

(END OF FORM OF CERTIFICATE OF AUTHENTICATION)

(FORM OF ASSIGNMENT)

ASSIGNMENT

FOR VALUE RECEIVED the undersigned hereby sells, assigns and transfers unto _____ the within Bond and all rights thereunder, and hereby irrevocably constitutes and appoints _____ to transfer the within Bond on the records kept for the registration thereof with full power of substitution in the premises.

Dated: _____ Signed:_____

NOTICE: The signature to this assignment must correspond with the name as it appears on the face of the within Bond in every particular, without alteration or enlargement or any change whatever. The signature must be guaranteed by an eligible guarantor institution as defined in 17 CFR § 240.17 Ad-15(a)(2).

Signature Guaranteed:

_____

Signature must be guaranteed by a member
of a Medallion Signature Program.

Address of Transferee:

_____
_____
_____

Social Security or other tax
identification number of
Transferee:

_____

TRANSFER FEES MAY BE CHARGED

(END OF FORM OF ASSIGNMENT)

(FORM OF PREPAYMENT PANEL)

PREPAYMENT PANEL

The following installments of principal (or portions thereof) of this Bond have been prepaid in accordance with the terms of the Ordinance.

Date of Prepayment	Principal Prepaid	Signature of Authorized Representative of DTC
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

(END OF FORM OF PREPAYMENT PANEL)

(END OF FORM OF BOND)

Section 310. Optional Redemption. The Bonds will be subject to redemption, if any, at the option of the City in the time and manner, in the amounts and at the prices, and from the funds all as set forth in the Sale Certificate.

Notwithstanding the foregoing, the Bonds may not be redeemed pursuant to this Section unless all Policy Costs, if any, due and owing at the time to the Surety Provider have been paid.

Section 311. Mandatory Sinking Fund Redemption. The Term Bonds, if any, shall be subject to mandatory sinking fund redemption at the times, in the amounts and at the prices provided in the Sale Certificate.

On or before the thirtieth day prior to each such sinking fund payment date, the Paying Agent shall proceed to call the Term Bonds, if any, as provided in the Sale Certificate (or any Term Bond or Term Bonds issued to replace such Term Bonds) for redemption from the sinking fund on the next December 1, and give notice of such call without further instruction or notice from the City.

At its option, to be exercised on or before the sixtieth day next preceding each such sinking fund Redemption Date, the City may (a) deliver to the Paying Agent for cancellation Term Bonds subject to mandatory sinking fund redemption on such date in an aggregate principal amount desired or (b) receive a credit in respect of its sinking fund redemption obligation for any Term Bonds of the maturity and interest rate subject to mandatory sinking fund redemption on such date, which prior to said date have been redeemed (otherwise than through the operation of the sinking fund) and canceled by the Paying Agent and not theretofore applied as a credit against any sinking fund redemption obligation. Each Term Bond so delivered or previously redeemed will be credited by the Paying Agent at the principal amount thereof against the obligation of the City on such sinking fund date and such sinking fund obligation will be accordingly reduced. The City will on or before the sixtieth day next preceding each sinking fund Redemption Date furnish the Paying Agent with its certificate indicating whether or not and to what extent the provisions of (a) and (b) of the preceding sentence are to be availed with respect to such sinking fund payment. Failure of the City to deliver such certificate shall not affect the Paying Agent's duty to give notice of sinking fund redemption as provided in this paragraph.

Section 312. Partial Redemption. In the case of Bonds of a denomination larger than $5,000, a portion of such Bond ($5,000 or any integral multiple thereof) may be redeemed, in which case the Paying Agent shall, without charge to the owner of such Bond, authenticate and issue a replacement Bond or Bonds for the unredeemed portion thereof.

Section 313. Notice of Prior Redemption. Notice of optional or mandatory redemption shall be given by the Paying Agent in the name of the City by sending a copy of such notice by first-class, postage prepaid mail, or by electronic means to DTC or its successors, not more

than sixty nor less than thirty days prior to the Redemption Date to each Owner at his address as it last appears on the registration books kept by the Paying Agent; but neither failure to give such notice nor any defect therein shall affect the redemption of any Bond. Such notice shall identify the Bonds to be so redeemed (if less than all are to be redeemed) and the Redemption Date, and shall further state that on such Redemption Date there will become and be due and payable upon each Bond so to be redeemed, at the principal office of the Paying Agent, the principal amount thereof, accrued interest to the Redemption Date, and the stipulated premium, if any, and that from and after such date interest will cease to accrue. Notice having been given in the manner hereinabove provided, the Bond or Bonds so called for redemption shall become due and payable on the Redemption Date so designated; and upon presentation thereof at the principal office of the Paying Agent, the Paying Agent will pay the Bond or Bonds so called for redemption. No further interest shall accrue on the principal of any such Bond called for redemption from and after the Redemption Date, provided sufficient funds are deposited with the Paying Agent and available on the Redemption Date.

Notwithstanding the provisions of this Section, any notice of redemption shall either (a) contain a statement that the redemption is conditioned upon the receipt by the Paying Agent on or before the Redemption Date of funds sufficient to pay the redemption price of the Bonds so called for redemption, and that if such funds are not available, such redemption shall be canceled by written notice to the Owners of the Bonds called for redemption in the same manner as the original redemption notice was mailed, or (b) be given only if funds sufficient to pay the redemption price of the Bonds so called for redemption are on deposit with the Paying Agent in the applicable fund or account.

Section 314. Bonds Owned by the City. Bonds owned by or on behalf of the City shall not be subject to redemption. At any time, the City may surrender any Bonds owned by or on behalf of the City to the Paying Agent, which shall promptly cancel such Bonds.

Section 315. No Partial Redemption After Default. Anything in this Ordinance to the contrary notwithstanding, if there shall have occurred and is continuing an Event of Default hereunder of which an officer of the Paying Agent has actual knowledge, there shall be no redemption of less than all of the Bonds at the time Outstanding (other than pursuant to Section 402 hereof).

ARTICLE IV
USE OF BOND PROCEEDS AND OTHER MONEYS

Section 401. Disposition of Bond Proceeds.

A. The proceeds of the Bonds (net of underwriting discount), upon the receipt thereof, shall be accounted for in the following manner and priority:

(i) Reserve Fund. An amount equal to the portion of the Reserve Fund Requirement as described in the Sale Certificate, if any, shall be credited to the special and separate fund

hereby created and to be known as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026 Reserve Fund."

(ii) Escrow Account. If required, an amount of the proceeds derived from the sale of the Bonds shall be credited to the special and separate account hereby and created and held by the Escrow Bank to be known as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026 Escrow Account." Such deposit shall be sufficient to pay the Refunded Bond Requirements on the Redemption Date. Except as otherwise provided herein, the moneys in the Escrow Account shall be used solely for the purpose of paying the costs of the Refunding Project. If the City does not deposit proceeds of the Bonds to pay the Refunded Bond Requirements in such Escrow Account, then all references to the Escrow Account, the Escrow Agreement and the Escrow Bank are of no force or effect.

(iii) Project Fund. The remaining proceeds derived from the sale of the Bonds shall be credited to the special and separate account hereby created and to be known as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026 Project Fund." Except as otherwise provided herein, the moneys in the Project Fund shall be used solely for the purpose of paying the Cost of the Project and for the purposes set forth in Section 502 hereof.

Section 402. Payment of Expenses. Moneys deposited in the Project Fund pursuant to Section 501 hereof may be used and paid out by the City to defray the administrative costs of the Project, including, without limitation, amounts to be paid to the Paying Agent, legal fees, accounting fees, financial advisory fees, printing costs and rating fees. The City may defray any such administrative costs from time to time as Operation and Maintenance Expenses to the extent the moneys deposited in the Project Fund pursuant to Section 501 hereof are insufficient therefor.

Section 403. Completion of Project. When the Project is completed in accordance with the relevant plans and specifications and all amounts due therefor, including all proper incidental expenses and all administrative costs of the Project referred to in Section 502 hereof, are paid, or for which full provision is made, the Director of Finance, to the extent permitted by the Tax Compliance Certificate, shall cause all surplus moneys remaining in the Project Fund, if any, except for any moneys designated in the certificate to be retained to pay any unpaid accrued costs or contingent obligations, to be transferred as follows: (a) to the Rebate Fund so as to enable the City to comply with requirements of the Tax Compliance Certificate with respect to the Bonds, (b) to the Reserve Fund to such extent as shall not cause the amount in the Reserve Fund to exceed the Reserve Fund Requirement and (c) to the Bond Fund to the extent of any remaining balance of such moneys to be applied against the next principal payment or payments coming due on the Bonds. Nothing herein prevents the transfer from the Project Fund to the Bond Fund, at any time prior to the termination of the Project Fund, of any moneys which the Director of Finance by certificate determines will not be necessary for the Project and will not be designated to be transferred to the Rebate Fund.

Section 404. Lien on Bond Proceeds. Until the proceeds of the Bonds deposited in the Project Fund are applied as herein provided, such Bond proceeds are subject to a lien thereon and pledge thereof for the benefit of the Owners of the Outstanding Bonds as provided in Section 501 hereof.

Section 405. Purchaser Not Responsible. The validity of the Bonds is not dependent upon nor affected by the validity or regularity of any proceedings relating to the application of the Bond proceeds. The Purchaser and any subsequent Owners of any of the Bonds are not responsible for the application or disposal by the City or by any of its officers, agents and employees of the moneys derived from the sale of the Bonds or of any other moneys herein designated.

ARTICLE V
ADMINISTRATION OF AND ACCOUNTING FOR PLEDGED REVENUES

Section 501. Pledge Securing Bonds. Subject only to the right of the City to cause amounts to be withdrawn and paid on account of Operation and Maintenance Expenses of the System, the Gross Pledged Revenues and, subject to the right of the City to cause amounts to be withdrawn to pay the Cost of the Project as provided herein and other than moneys and securities held in the Rebate Fund to the extent such amounts are required to be paid to the United States, all moneys and securities paid or to be paid to or held or to be held in any fund or account under this Article or under Section 501 hereof are hereby pledged, and a lien thereon is hereby created, to secure the payment of the Bond Requirements of the Outstanding Bonds and to secure the obligations of the City to pay the Policy Costs. The pledge of the Net Pledged Revenues to secure the payment of the Bond Requirements of the Outstanding Bonds and the Parity Bonds is on a parity with the pledge of the Net Pledged Revenues for, and lien thereon of the Parity Bonds heretofore issued and any other Parity Bonds hereafter issued in compliance with the provisions of Article VII hereof. The pledge of Net Pledged Revenues to secure the payment of the Policy Costs is subordinate only to the pledge to pay the Bond Requirements with respect to the Bonds and any Parity Bonds. The pledge of the Net Pledged Revenues and the funds or accounts as described in this section shall be valid and binding from and after the date of the delivery of the Bonds, and the moneys as received by the City and hereby pledged shall immediately be subject to the lien of this pledge without any physical delivery thereof, any filing, or further act. The lien of this pledge and the obligation to perform the contractual provisions hereby made shall have priority over any or all other obligations and liabilities of the City except any Outstanding Parity Bonds heretofore or hereafter authorized and any Policy Costs as provided herein. The lien of the pledge of the Net Pledged Revenues and the funds or accounts as described in this section shall be valid and binding as against all parties having claims of any kind in tort, contract or otherwise against the City (except as herein otherwise provided) irrespective of whether such parties have notice thereof.

Section 502. Sewer Enterprise Fund Deposits. So long as any of the Bonds or any Parity Bonds shall be Outstanding, as to any Bond Requirements and Policy Costs related to the Bonds or any Parity Bonds, the entire Gross Pledged Revenues, upon their receipt from time to time by the City, shall be set aside and credited immediately to the special and separate account previously created and known as the "City of Broomfield, Enterprise Sewer Revenue and Refunding Bonds, Sewer Enterprise Fund."

Section 503. Administration of Sewer Enterprise Fund. So long as any of the Bonds or any Parity Bonds shall be Outstanding, as to any Bond Requirements and Policy Costs related to the Bonds or any Parity Bonds, the following payments shall be made from the Sewer Enterprise Fund, as provided in Sections 504 through 511 hereof.

Section 504. Operation and Maintenance Expenses. First, as a first charge on the Sewer Enterprise Fund, from time to time there shall continue to be held therein moneys sufficient to pay Operation and Maintenance Expenses, as they become due and payable, and thereupon they shall be promptly paid. Any surplus remaining in the Sewer Enterprise Fund at the end of the Fiscal Year and not needed for Operation and Maintenance Expenses shall be used for other purposes of the Sewer Enterprise Fund as herein provided.

Section 505. Bond Fund Payments. Second, from any remaining Net Pledged Revenues, there shall be credited, concurrently with each other and with amounts required to meet the Bond Requirements with respect to any Outstanding Parity Bonds, to the special and separate accounts hereby created and to be known as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Bond Fund," the following amounts:

A. Interest Payments. Monthly to the Bond Fund, commencing on the first day of the month immediately succeeding the delivery of any of the Bonds, or commencing on the first day of the month six months next prior to the first interest payment date of any of the Bonds, whichever commencement date is later, an amount in equal monthly installments necessary, together with any moneys therein and available therefor, to pay the interest due and payable on the Outstanding Bonds on the next succeeding interest payment date.

B. Principal Payments. Monthly to the Bond Fund, commencing on the first day of the month immediately succeeding the delivery of any of the Bonds, or commencing on the first day of the month one year next prior to the first principal payment date of any of the Bonds, whichever commencement date is later, an amount in equal monthly installments necessary, together with any moneys therein and available therefor, to pay the principal and redemption premium, if any, due and payable on the Outstanding Bonds on the next succeeding principal payment date.

If prior to any interest payment date or principal payment date, there has been accumulated in the Bond Fund the entire amount necessary to pay the next maturing installment of interest or principal, or both, the payment required in paragraph A or B (whichever is applicable) of this Section 505 may be appropriately reduced; but the required annual

amounts again shall be so credited to such account commencing on such interest payment date or principal payment date.

The moneys credited to the Bond Fund shall be used to pay the Bond Requirements of the Bonds then Outstanding, as such Bond Requirements become due, except as provided in Sections 508 and 1201 hereof.

Section 506. Reserve Fund Payments. In satisfaction of the Reserve Fund Requirement, upon delivery of the Bonds, and if so provided in the Sale Certificate, either proceeds of the Bonds, cash or a Reserve Fund Insurance Policy in the amount of the Reserve Fund Requirement being provided by Surety Provider shall be deposited in the special and separate fund hereby created and to be known as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Reserve Fund". The proceeds of the Bonds, cash or a Reserve Fund Insurance Policy shall be credited to Reserve Fund as provided in the Sale Certificate. Any Reserve Fund Insurance Policy shall be held by the Paying Agent. Any Reserve Fund Insurance Policy deposited to the credit of the Reserve Fund shall be valued at the amount available to be drawn or otherwise paid pursuant to such Reserve Fund Insurance Policy at the time of calculation. The Paying Agent shall maintain adequate records as to the amount available to be drawn at any time under the Reserve Fund Insurance Policy and as to the amounts, of which it has knowledge, of Policy Costs paid and owing to the Surety Provider. Such records shall be open to inspection and verification by the Surety Provider during business hours of the Paying Agent.

Upon the execution and delivery of the Bonds, there shall be deposited to the Reserve Fund, if a Reserve Fund is required and set forth in the Sale Certificate, and in the amount set forth in the Sale Certificate, from proceeds of the Bonds or a Reserve Fund Insurance Policy. Moneys on deposit in the Reserve Fund shall only be used to pay debt service on the Bonds to the extent of any deficiency in the Bond Fund or may be applied to the defeasance of the Bonds. Moneys shall be drawn from the Reserve Fund only after amounts on deposit in the Supplemental Reserve Fund have been exhausted.

Thereafter, third, except as provided in Section 508 and 509 hereof, and concurrently with any payments required to be made pursuant to any Parity Bond Ordinances with respect to any reserve funds which may be, but are not required to be, established thereby and concurrently with any repayment or similar obligations payable to any surety provider issuing any reserve fund insurance policy with respect to any Parity Bonds, from any moneys remaining in the Sewer Enterprise Fund there shall be credited to the Reserve Fund monthly, commencing on the first day of the month next succeeding each date on which the moneys accounted for in the Reserve Fund for any reason are less than the Reserve Fund Requirement, such amounts in substantially equal monthly payments on the first day of each month to re-accumulate the Reserve Fund Requirement by not more than 12 such monthly payments. If a Reserve Fund Insurance Policy is on deposit in the Reserve Fund to fund all or a part of the Reserve Fund Requirement, the amounts payable into the Reserve Fund pursuant to the immediately preceding sentence shall be paid by the City first to the Surety Provider to

reimburse it for Policy Costs due and owing and second to replenish cash in the Reserve Fund. If there are insufficient Net Pledged Revenues to comply with the requirements of the first sentence of this paragraph, available Net Pledged Revenues shall be credited or paid to the Reserve Fund and to reserve funds which may be established by any Parity Bond Ordinances (or to the Surety Provider or any other surety provider issuing any reserve fund insurance policy with respect to any Parity Bonds) pro rata, based upon the aggregate principal amount of the Bonds and any such Parity Bonds then Outstanding; provided, however, that compliance with the provisions of this sentence shall not cure any Event of Default caused by non-compliance with the first sentence of this paragraph. If there are insufficient Net Pledged Revenues to comply with the requirements of the first sentence of this paragraph and more than one Reserve Fund Insurance Policy is on deposit in the Reserve Fund, available Net Pledged Revenues credited to or paid to the Reserve Fund shall be applied to reimburse the Surety Provider and any other surety provider providing a Reserve Fund Insurance Policy pro rata, based upon the original amount available to be drawn on each. The Reserve Fund Requirement shall be accumulated and, if necessary, re-accumulated from time to time, in the Reserve Fund from Net Pledged Revenues, except to the extent other moneys are credited to the Reserve Fund, and maintained as a continuing reserve to be used, except as hereinafter provided in Sections 508, 509, 604 and 1201 hereof, only to prevent deficiencies in the payment of the Bond Requirements of the Bonds Outstanding from time to time from the failure to deposit into the Bond Fund sufficient moneys to pay such Bond Requirements as the same accrue and become due. No payment need be made into the Reserve Fund at any time so long as the moneys and/or the Reserve Fund Insurance Policy therein equal not less than the Reserve Fund Requirement and there are no Policy Costs due and owing. Unless otherwise provided in the Sale Certificate, the Reserve Fund Requirement shall be re-calculated upon (i) any principal payment, whether at stated maturity or upon redemption, or (ii) the defeasance of all or a portion of the Bonds.

The City may at any time substitute (a) cash or Investment Securities for a Reserve Fund Insurance Policy or (b) a Reserve Fund Insurance Policy for cash or Investment Securities, so long as the amount on deposit in the Reserve Fund after such substitution is at least equal to the Reserve Fund Requirement. Notwithstanding the foregoing, no Reserve Fund Insurance Policy shall be deposited by the City in the Reserve Fund for such substitution unless the City has received an opinion of Bond Counsel to the effect that such substitution and the intended use by the City of the cash or Investment Securities to be released from the Reserve Fund will not adversely affect the exclusion from gross income for federal income tax purposes of interest on the Bonds.

Section 507. Supplemental Reserve Fund. Moneys in the Supplemental Reserve Fund, if such a fund is required and funded in an amount set forth in the Sale Certificate, shall held by the Paying Agent, and utilized, if necessary, only to prevent a default in the payment of the principal of, premium, if any, and interest on the Bonds when due, (including on any mandatory sinking fund redemption date or at final maturity) and the Supplemental Reserve Fund is pledged to the payment of the Bonds for such purpose.

Fourth, except as provided in Section 508 and 509 hereof, and concurrently with any payments required to be made pursuant to any Parity Bond Ordinances with respect to any supplemental reserve funds which may be, but are not required to be, established thereby, from any moneys remaining in the Sewer Enterprise Fund there shall be credited to the Supplemental Reserve Fund monthly, commencing on the first day of the month next succeeding each date on which the moneys accounted for in the Supplemental Reserve Fund are less than the Supplemental Reserve Fund Requirement, such amounts as is necessary to fund the Supplemental Reserve Fund to the Supplemental Reserve Fund Requirement. Any draws on the Supplemental Reserve Fund shall be replenished in the same manner as described in Section 5.06 above with respect to replenishment of the Reserve Fund and only to the extent of available revenue from the Sewer Enterprise Fund.

If on any date the amounts then on deposit in the Bond Fund are insufficient to pay the principal of, premium, if any, and/or interest on the Bonds on the next scheduled payment date, sinking fund installment date or at maturity, the Paying Agent shall transfer from the Supplemental Reserve Fund to the Bond Fund an amount which, when combined with moneys then on deposit therein, will be sufficient to make such payment of the Bonds when due. In the event that moneys in the Supplemental Reserve Fund, together with moneys in the Bond Fund, are insufficient to make such payment when due, the Paying Agent is to nonetheless transfer all moneys in the Supplemental Reserve Fund to the Bond Fund for the purpose of making partial payments on the Bonds. Bonds shall be selected for any such partial payments in the same manner as selected for mandatory sinking fund redemption.

Amounts in the Supplemental Reserve Fund are to be transferred to the Bond Fund prior to the transfer of moneys from the Reserve Fund to the Bond Fund.

Amounts on deposit in the Supplemental Reserve Fund may be invested or deposited at the direction of the District in Permitted Investments only and in accordance with the laws of the State and shall be valued on the basis of their current market value, as reasonably determined by the District, which value shall be determined at least annually.

Section 508. Termination of Deposits. No payment need be made into the Bond Fund or the Reserve Fund if there are no Policy Costs due and owing and if the amount in the Bond Fund and the amount in the Reserve Fund (exclusive of the amount available under a Reserve Fund Insurance Policy) total a sum at least sufficient so that all Bonds Outstanding are deemed to have been paid pursuant to Section 1201 hereof, in which case moneys therein (taking into account the known minimum gain from any investment if such moneys in Investment Securities from the time of any such investment or deposit shall be needed for such payment which will not be designated for transfer to the Rebate Fund) shall be used (together with any such gain from such investments) solely to pay the Bond Requirements of the Outstanding Bonds as the same become due; and any moneys in excess thereof in those two accounts and any other moneys derived from the Net Pledged Revenues or otherwise pertaining to the System may be used to make required payments into the Rebate Fund or in any other lawful manner determined by the Council.

Section 509. Defraying Delinquencies. If at any time the City shall for any reason fail to pay into the Bond Fund the full amount above stipulated from the Net Pledged Revenues, then an amount shall be paid into the Bond Fund at such time first from the Supplemental Reserve Fund and then from the Reserve Fund equal to the difference between that paid from the Net Pledged Revenues and the full amount so stipulated. The City shall use all cash in the Reserve Fund before drawing on a Reserve Fund Insurance Policy. If, (i) upon notice from the City requesting a draw or (ii) failure of the Paying Agent to receive the Bond Requirements by the third Business Day prior to June 1 or December 1 in each year, the Paying Agent determines that it is necessary to draw on the Reserve Fund Insurance Policy, the Paying Agent shall present a demand for payment, in the form and manner required by the Reserve Fund Insurance Policy, at least two Business Days before funds are needed. If there is more than one Reserve Fund Insurance Policy on deposit in the Reserve Fund, the Paying Agent shall draw on them on a pro rata basis, based upon the amount available to be drawn on each.

Any money so used or drawn shall be replaced as provided in Sections 506 and 507 hereof from the first Net Pledged Revenues thereafter received and not required to be otherwise applied by this Article. Except as provided in Sections 506 and 507 hereof, the moneys in the Bond Fund, the Supplemental Reserve Fund and in the Reserve Fund (including any Reserve Fund Insurance Policy) shall be used solely and only for the purpose of paying the Bond Requirements of the Bonds from time to time.

If the amount on deposit in the Reserve Fund exceeds the Reserve Fund Requirement for any reason, the amount to be released from the Reserve Fund shall be as directed in writing by the City Manager. Any excess amount released from the Reserve Fund may be deposited in the Bond Fund, or deposited into a defeasance escrow account, or may be applied for other purposes, as directed in writing by the City Manager for such purposes authorized by law.

Section 510. Rebate Fund. Fifth, concurrently with any payments required to be made pursuant to any Parity Bond Ordinances with respect to any rebate funds established thereby, there shall be deposited into the special and separate accounts hereby created and to be known as the "City and County of Broomfield, Colorado, Sewer Activity Enterprise Sewer Revenue and Refunding Bonds, Series 2026, Rebate Fund" moneys in the amounts and at the times specified in the Tax Compliance Certificate so as to enable the City to comply with Section 830 hereof. Amounts on deposit in the Rebate Fund shall not be subject to the lien and pledge of this Ordinance to the extent that such amounts are required to be paid to the United States Treasury. The City shall cause amounts on deposit in the Rebate Fund to be forwarded to the United States Treasury (at the address provided in the Tax Compliance Certificate) at the times and in the amounts set forth in the Tax Compliance Certificate.

If the moneys on deposit in the Rebate Fund are insufficient for the purposes thereof, the City shall transfer moneys in the amount of the insufficiency to the Rebate Fund from the Project Fund and, to the extent permitted by Section 509 hereof, from the Supplemental Reserve Fund, the Reserve Fund and the Bond Fund. Upon receipt by the City of an opinion of Bond

Counsel to the effect that the amount in the Rebate Fund is in excess of the amount required to be contained therein, such excess may be transferred to the Sewer Enterprise Fund.

Section 511. Payment of Subordinate Securities. Sixth, and subject to the provisions hereinabove in this Article, but subsequent to the payments required by Sections 504, 505, 506, 507 and 510 hereof, any moneys remaining in the Sewer Enterprise Fund may be used by the City for the payment of Bond Requirements of Subordinate Securities, including reasonable reserves for such Subordinate Securities and for rebate of amounts to the United States Treasury with respect to such Subordinate Securities.

Section 512. Use of Remaining Revenues. After the payments hereinabove required to be made by Sections 502 through 511 hereof are made, any remaining Net Pledged Revenues in the Sewer Enterprise Fund shall be used, firstly, for any one or any combination of reasonably necessary purposes and in the Council's discretion relating to the operation, improvement or debt management of the System and, secondly, to the extent of any remaining surplus, for any one or any combination of lawful purposes as the Council may from time to time conclusively determine.

Section 513. Maintenance of the Escrow Account. The Escrow Account shall be maintained in an amount at the time of the initial deposits therein and at all times subsequently at least sufficient, together with the known minimum yield to be derived from the initial investment and any temporary reinvestment of the deposits therein or any part thereof in Federal Securities to pay the principal of and interest on the Refunded Bonds on and after the delivery of the Bonds to and including the first available Redemption Date for the Refunded Bonds. The form, terms and provisions of the Escrow Agreement are hereby approved in substantially the form as on file with the Clerk, and the Mayor and City Clerk are hereby authorized to execute and deliver the Escrow Agreement.

Section 514. Use of the Escrow Account. Moneys shall be withdrawn by the Escrow Bank from the Escrow Account in sufficient amounts and at such times to permit the payment without default of the principal of and interest on the Refunded Bonds and after the delivery of the Bonds to and including the first available Redemption Date for the Refunded Bonds. Any moneys remaining in the Escrow Account after provision shall have been made for the payment in full of the Refunded Bonds shall be applied to any lawful purpose of the City as the Council may hereafter determine.

ARTICLE VI
GENERAL ADMINISTRATION

Section 601. Administration of Accounts. The special funds and accounts designated in Articles IV and V hereof, except for the Escrow Account, shall be administered as provided in this Article (but not any account under Section 1201 hereof).

Section 602. Places and Times of Deposits. Except as hereinafter provided, each of such special funds and accounts shall be maintained by the City as a book account and kept separate from all other accounts as a trust account solely for the purposes herein designated therefor. The moneys accounted for in such special book accounts may be in one or more bank accounts in one or more Commercial Banks. Each such bank account shall be continuously secured to the fullest extent required or permitted by the laws of the State for the securing of public funds and shall be irrevocable and not withdrawable by anyone for any purpose other than the respective designated purposes. Each periodic payment shall be credited to the proper book account not later than the date therefor herein designated, except that when any such date shall not be a Business Day, then such payment shall be made on or before the next preceding Business Day. Moneys shall be deposited with the Paying Agent for the Bonds not less than (a) three Business Days prior to each interest payment date and each maturity or mandatory Redemption Date, if funds are delivered by wire transfer, or (b) five Business Days prior to each payment date if funds are delivered by another method of payment, in immediately available amounts sufficient to pay the Bond Requirements then becoming due on the Outstanding Bonds.

Section 603. Investment of Moneys. Any moneys in the Project Fund, Sewer Enterprise Fund, Bond Fund, Supplemental Reserve Fund, Reserve Fund, and Rebate Fund and not needed for immediate use shall be invested or reinvested by the Director of Finance in Investment Securities. All such investments shall (a) either be subject to redemption at any time at a fixed value by the holder thereof at the option of such holder, or (b) mature not later than the estimated date or respective dates on which the proceeds are to be expended as estimated by the Director of Finance at the time of such investment or reinvestment; provided that (1) Investment Securities credited to the Reserve Fund shall not mature later than ten years from the date of such investment or reinvestment and (2) collateral securities of any Investment Securities may have a maturity of more than five years from the date of purchase thereof. For the purpose of any such investment or reinvestment, Investment Securities shall be deemed to mature at the earliest date on which the obligor is, on demand, obligated to pay a fixed sum in discharge of the whole of such obligations.

Section 604. Accounting for Investments. The Investment Securities so purchased as an investment or reinvestment of moneys in any such account hereunder shall be deemed at all times to be a part of the account. Any interest or other gain from any investments and reinvestments of moneys accounted for in the Sewer Enterprise Fund, the Project Fund, the Bond Fund, and the Rebate Fund shall be credited to such account, and any loss resulting from any such investments or reinvestments of moneys accounted for in the Sewer Enterprise Fund, the Project Fund, the Bond Fund, the Supplemental Reserve Fund, the Reserve Fund, and the Rebate Fund shall be charged or debited to such Fund.

Any interest or other gain from any investment or reinvestment of moneys accounted for in the Reserve Fund (a) shall be credited to the Rebate Fund or the Bond Fund, at the discretion of the Director of Finance, if the amount credited to the Reserve Fund immediately after such credit to the Rebate Fund or the Bond Fund is not less than the Reserve Fund Requirement

and (b) if the amount credited to the Reserve Fund is less than the Reserve Fund Requirement, shall be credited to the Reserve Fund (up to the amount of the deficiency).

No loss or profit in any account on any investments or reinvestments in Investment Securities shall be deemed to take place as a result of market fluctuations of the Investment Securities prior to the sale or maturity thereof. In the computation of the amount in any account for any purpose hereunder, except as herein otherwise expressly provided or for rebate purposes, as described in the Tax Compliance Certificate, Investment Securities shall be valued at the cost thereof (including any amount paid as accrued interest at the time of purchase of the obligation); provided that any time or demand deposits shall be valued at the amounts deposited, in each case exclusive of any accrued interest or any other gain to the City until such gain is realized by the presentation of matured coupons for payment or otherwise.

Section 605. Redemption or Sale of Investment Securities. The Director of Finance shall present for redemption or sale on the prevailing market at the best price obtainable any Investment Securities so purchased as an investment or reinvestment of moneys in the account whenever it shall be necessary in order to provide moneys to meet any withdrawal, payment or transfer from such account. Neither the Director of Finance nor any other officer or employee of the City shall be liable or responsible for any loss resulting from any such investment or reinvestment made in accordance with this Ordinance.

Section 606. Character of Funds. The moneys in any account designated in Articles IV and V hereof shall consist either of lawful money of the United States or Investment Securities, or both such money and such Investment Securities. Moneys deposited in a demand or time deposit account in a bank or savings and loan association, appropriately secured according to the laws of the State, shall be deemed lawful money of the United States.

Section 607. Payment of Bond Requirements. The moneys credited to any fund or account designated in Article V hereof for the payment of the Bond Requirements of any Bonds shall be used without requisition, voucher, warrant, further order or authority (other than is contained herein), or any other preliminaries, to pay promptly the Bond Requirements of any Bonds payable from such fund or account as such amounts are due, except to the extent any other moneys are available therefor.

ARTICLE VII
SECURITIES LIENS AND ADDITIONAL SECURITIES

Section 701. Lien of Bonds. The Bonds constitute an irrevocable lien (but not necessarily an exclusive lien) upon the Net Pledged Revenues on a parity with the lien of the Net Pledged Revenues of the Parity Bonds. The Policy Costs constitute an irrevocable and subordinate lien (but not necessarily an exclusive subordinate lien) upon the Net Pledged Revenues.

Section 702. Equality of Bonds. The Bonds and any Parity Bonds heretofore issued or hereafter authorized to be issued and from time to time Outstanding are equitably and

ratably secured by a lien on the Net Pledged Revenues and shall not be entitled to any priority one over the other in the application of the Net Pledged Revenues regardless of the time or times of the issuance of the Bonds and any other such Parity Bonds, it being the intention of the Council that there shall be no priority among the Bonds and any such Parity Bonds regardless of the fact that they may be actually issued and delivered at different times, except that (a) moneys in the Project Fund, Bond Fund, the Supplemental Reserve Fund, and Reserve Fund shall secure only the Bonds and the moneys in any acquisition, bond, reserve or similar funds established for other Parity Bonds shall secure only such Parity Bonds; and (b) other Parity Bonds may have a lien on Net Pledged Revenues on a parity with the lien thereon of the Bonds even if no supplemental reserve fund or reserve fund is established for such Parity Bonds or a supplemental reserve fund or reserve fund is established but with a different requirement as to the amount of moneys (or the value of a supplemental reserve fund or reserve fund insurance policy with respect to such Parity Bonds) required to be on deposit therein or the manner in which such supplemental reserve fund or reserve fund is funded or the period of time over which such supplemental reserve fund or reserve fund is funded.

Section 703. Issuance of Parity Bonds. Nothing herein prevents the issuance by the City of additional securities payable from the Net Pledged Revenues and constituting a lien thereon on a parity with, but not prior nor superior to, the lien thereon of the Bonds; but before any such additional Parity Bonds, except as provided in Section 708, are authorized or actually issued all of the following conditions are satisfied:

A. Absence of Default. At the time of the adoption of the ordinance authorizing the issuance of the additional securities, the City shall not be in default in making any payments required by Article V hereof or other Parity Bond Ordinances, including any payments of Policy Costs.

B. Historic Earnings Test. The Net Pledged Revenues for any 12 consecutive months out of the 24 months preceding the month in which such securities are to be issued are at least equal to the sum of 110% of the Combined Maximum Annual Principal and Interest Requirements of all Outstanding Bonds, Outstanding Parity Bonds and such additional Parity Bonds proposed to be issued.

C. Adjustment of Gross Pledged Revenues. In any computation under paragraph B of this Section, the amount of the Gross Pledged Revenues for the applicable period shall be decreased and may be increased by the amount of loss or gain conservatively estimated by an Independent Accountant, Independent Engineer or the Director of Finance, as the case may be, which results from any changes in any schedule of fees, rates and other charges constituting Gross Pledged Revenues based on the number of users during the applicable period as if such modified schedule of fees, rates and other charges shall have been in effect during such entire time period. However, the Gross Pledged Revenues need not be decreased by the amount of any such estimated loss to the extent the Independent Accountant, the Independent Engineer or the Director of Finance estimates the loss is temporary in nature or will be offset within a reasonable temporary period by an increase in revenues or a reduction in Operation and Maintenance Expenses not otherwise included in the calculations under this Section, and estimates any loss under this sentence will not at any time materially and adversely affect the City's apparent ability to comply with the rate maintenance covenant

stated in Section 821 hereof without modification because of any restrictive legislation, regulation or other action under the police power exercised by any governmental body.

D. Reduction of Annual Requirements. The respective annual Bond Requirements (including as such a requirement the amount of any prior redemption premiums due on any Redemption Date) shall be reduced to the extent such Bond Requirements are scheduled to be paid in each of the respective Fiscal Years with moneys held in trust or in escrow for that purpose by any Trust Bank, including the known minimum yield from any investment in Federal Securities and any bank deposits, including any certificate of deposit.

E. Consideration of Additional Expenses. In determining whether or not additional Parity Bonds may be issued as aforesaid, consideration shall be given to any probable increase (but not reduction) in the Operation and Maintenance Expenses of the System as estimated by the Director of Finance that will result from the expenditure of the funds proposed to be derived from the issuance and sale of the additional securities; but the Director of Finance may reduce any such increase in Operation and Maintenance Expenses by the amount of any increase in revenues or any reduction in Operation and Maintenance Expenses resulting from the Capital Improvements to which such expenditure relates and not otherwise included in the calculations under this Section, if the Director of Finance also opines that any such increase in revenues or reduction in any increase in Operation and Maintenance Expenses will not materially and adversely affect the City's apparent ability to comply with the rate maintenance covenant stated in Section 821 hereof without modification because of any restrictive legislation, regulation or other action under the police power exercised by any governmental body.

Section 704. Certification of Revenues. A written certificate or written opinion by the Director of Finance that the annual revenues required under paragraph B of Section 703 hereof, when adjusted as hereinabove provided in paragraphs C, D, and E of Section 703 hereof, are sufficient to pay such amounts, as provided in paragraph B of Section 703 hereof, shall be conclusively presumed to be accurate in determining the right of the City to authorize, issue, sell and deliver additional securities on a parity with the Bonds.

Section 705. Subordinate Securities Permitted. Nothing herein prevents the City from issuing additional securities payable from the Net Pledged Revenues and having a lien thereon subordinate, inferior and junior to the lien thereon of the Bonds.

Section 706. Superior Securities Prohibited. Nothing herein permits the City to issue additional securities payable from the Net Pledged Revenues and having a lien thereon prior and superior to the lien thereon of the Bonds.

Section 707. Use of Proceeds. The proceeds of any Parity Bonds or other securities payable from any Net Pledged Revenues shall be used only to finance Capital Improvements or to refund all or any portion of the Bonds, Parity Bonds, or other securities payable from Net Pledged Revenues, regardless of the priority or the lien of such securities on Net Pledged Revenues.

Section 708. Issuance of Refunding Securities. The City may issue any refunding securities payable from Net Pledged Revenues to refund any Outstanding Bonds or Parity Bonds, with such details as the Council may by ordinance provide so long as there is no material impairment of any contractual obligation imposed upon the City by any proceedings authorizing the issuance of any unrefunded portion of such Outstanding securities of any one or more issues; but so long as the Bonds, or any part thereof, are Outstanding, refunding securities payable from Net Pledged Revenues may be issued on a parity with the unrefunded Bonds only if:

A. Prior Consent. The City first receives the consent of the Owner or Owners of the unrefunded portion of the Bonds; or

B. Requirements Not Increased. The Combined Maximum Annual Principal and Interest Requirements for the Bonds and Parity Bonds Outstanding immediately after the issuance of the refunding securities is not greater than the Combined Maximum Annual Principal and Interest Requirements for all Bonds and Parity Bonds Outstanding immediately prior to the issuance of the refunding securities and the lien of any refunding Parity Bonds on the Net Pledged Revenues is not raised to a higher priority than the lien thereon of any securities thereby refunded; or

C. Earnings Test. The refunding securities are issued in compliance with Section 703 hereof.

ARTICLE VIII
PROTECTIVE COVENANTS

Section 801. General. The City hereby covenants and agrees with the Owners of the Bonds and makes provisions which shall be a part of its contract with such Owners to the effect and with the purpose set forth in the following Sections of this Article.

Section 802. Performance of Duties. The City, acting by and through the Council or otherwise, shall faithfully and punctually perform, or cause to be performed, all duties with respect to the Gross Pledged Revenues and the System required by the Constitution and laws of the State and the various ordinances of the City, including, without limitation, the making and collection of reasonable and sufficient fees, rates and other charges for services rendered or furnished by or the use of the System, as herein provided, and the proper segregation of the proceeds of the Bonds and of any securities hereafter authorized and the Gross Pledged Revenues and their application from time to time to the respective accounts provided therefor.

Section 803. Contractual Obligations. The City shall perform all contractual obligations undertaken by it under any agreements relating to the Bonds, the Gross Pledged Revenues, the Project, or the System, or any combination thereof, with any other Persons.

Section 804. Further Assurances. At any and all times the City shall, so far as it may be authorized by law, pass, make, do, execute, acknowledge, deliver and file or record all and every such further instruments, acts, deeds, conveyances, assignments, transfers, other

documents and assurances as may be reasonably necessary or desirable for the better assuring, conveying, granting, assigning and confirming all and singular the rights, the Gross Pledged Revenues and other moneys and accounts hereby pledged or assigned, or intended so to be, or which the City may hereafter become bound to pledge or to assign, or as may be reasonable and required to carry out the purposes of this Ordinance and to comply with any instrument of the City amendatory thereof, or supplemental thereto. The City, acting by and through the Council, or otherwise, shall at all times, to the extent permitted by law, defend, preserve and protect the pledge of the Gross Pledged Revenues and other moneys and accounts pledged hereunder and all the rights of every Owner of any Bond hereunder against all claims and demands of all Persons whomsoever.

Section 805. Conditions Precedent. Upon the date of issuance of the Bonds, all conditions, acts and things required by the Federal or State Constitution, Title 37, Article 45.1, C.R.S., Title 11, Article 57, Part 2, C.R.S., this Ordinance, or any other applicable law to exist, to have happened and to have been performed precedent to or in the issuance of the Bonds shall exist, have happened, and have been performed; and the Bonds, together with all other obligations of the City, shall not contravene any debt or other limitation prescribed by the State Constitution.

Section 806. Efficient Operation and Maintenance. The City shall at all times operate the System properly and in a sound and economical manner; and the City shall maintain, preserve and keep the same properly or cause the same so to be maintained, preserved and kept, with the appurtenances and every part and parcel thereof in good repair, working order and condition, and shall from time to time make or cause to be made all necessary and proper repairs, replacements and renewals so that at all times the operation of the System may be properly and advantageously conducted. All salaries, fees, wages and other compensation paid by the City in connection with the maintenance, repair and operation of the System shall be reasonable and proper.

Section 807. Rules, Regulations and Other Details. The City, acting by and through the Council, shall establish and enforce reasonable rules and regulations governing the operation, use and services of the System. The City shall observe and perform all of the terms and conditions contained in this Ordinance, and shall comply with all valid acts, rules, regulations, orders and directions of any legislative, executive, administrative or judicial body applicable to the System or to the City, except for any period during which the same are being contested in good faith by proper legal proceedings.

Section 808. Payment of Governmental Charges. The City shall pay or cause to be paid all taxes and assessments or other governmental charges, if any, lawfully levied or assessed upon or in respect of the System, or upon any part thereof, or upon any portion of the Gross Pledged Revenues, when the same shall become due, and shall duly observe and comply with all valid requirements of any governmental authority relative to the System or any part thereof, except for any period during which the same are being contested in good faith by proper legal proceedings. The City shall not create or suffer to be created any lien upon the

System, or any part thereof, or upon the Gross Pledged Revenues, except the pledge and lien created by this Ordinance for the payment of the Bond Requirements of the Bonds and except as herein otherwise permitted. The City shall pay or cause to be discharged or shall make adequate provision to satisfy and to discharge, within 60 days after the same shall become payable, all lawful claims and demands for labor, materials, supplies or other objects which, if unpaid, might by law become a lien upon the System, or any part thereof, or the Gross Pledged Revenues; but nothing herein requires the City to pay or cause to be discharged or to make provision for any such tax, assessment, lien or charge, so long as the validity thereof is contested in good faith and by appropriate legal proceedings.

Section 809. Protection of Security. The City, the officers, agents and employees of the City, and the Council shall not take any action in such manner or to such extent as might prejudice the security for the payment of the Bond Requirements of the Bonds, the Parity Bonds, and any other securities payable from the Net Pledged Revenues or any Policy Costs relating thereto according to the terms thereof. No contract shall be entered into, nor any other action taken by which the rights of any Owner of any Bond or other security payable from Net Pledged Revenues or any Policy Costs relating thereto might be prejudicially and materially impaired or diminished.

Section 810. Prompt Payment of Bonds. The City shall promptly pay the Bond Requirements of the Bonds at the places, on the dates and in the manner specified herein and, in the Bonds, according to the true intent and meaning hereof.

Section 811. Use of Bond Fund, Supplemental Reserve and Reserve Funds. The Bond Fund, the Supplemental Reserve Fund and the Reserve Fund shall be used solely for and the moneys credited to such funds and accounts therein are hereby pledged, and a lien thereon is hereby created, for the purpose of paying the Bond Requirements of the Bonds to their respective maturities or any Redemption Date or Dates, subject to the provisions of Sections 506, 507, 508, 509, 604 and 1201 hereof.

Section 812. Other Liens. Other than as provided herein, there are no liens or encumbrances of any nature whatsoever on or against the System, or any part thereof, or on or against the Gross Pledged Revenues on a parity with or superior to the lien thereon of the Bonds.

Section 813. Corporate Existence. The City shall maintain its corporate identity and existence so long as any of the Bonds remain Outstanding, unless another body corporate and politic by operation of law succeeds to the powers, privileges, rights, liabilities, disabilities, duties and immunities of the City and is obligated by law to operate and maintain the System and to fix and collect the Gross Pledged Revenues as herein provided without adversely and materially affecting at any time the privileges and rights of any Owner of any Outstanding Bond.

Section 814. Disposal of System Prohibited. Except for the use of the System and services pertaining thereto in the normal course of business, or as provided in Section 815 hereof, neither all nor a substantial part of the System shall be sold, leased, mortgaged, pledged, encumbered, alienated or otherwise disposed of, until all the Bonds have been paid in full, as to all Bond Requirements, or unless provision has been made therefor, or until the Bonds have otherwise been redeemed, including, without limitation, the termination of the pledge as herein authorized; and the City shall not dispose of its title to the System or to any useful part thereof, including any property necessary to the operation and use of the System and the lands and interests in lands comprising the sites of the System.

Section 815. Disposal of Unnecessary Property. The City at any time and from time to time may sell, exchange, lease or otherwise dispose of any property constituting a part of the System and not useful in the construction, reconstruction or operation thereof, or which shall cease to be necessary for the efficient operation of the System, or which shall have been replaced by other property of at least equal value. Any proceeds of any such sale, exchange, lease or other disposition received and not used to replace such property so sold or so exchanged or otherwise so disposed of, shall be deposited by the City in the Sewer Enterprise Fund or into a special book account for the betterment, enlargement, extension, other improvement and equipment of the System, or any combination thereof, as the Council may determine, provided that any proceeds of any such lease received shall be deposited by the City as Gross Pledged Revenues in the Sewer Enterprise Fund.

Section 816. Competing System. So long as any of the Bonds are Outstanding, the City shall not grant any franchise or license to any competing facilities so that the Gross Pledged Revenues shall not be sufficient to satisfy the covenant in Section 821 hereof.

Section 817. Loss From Condemnation. If any part of the System is taken by the exercise of the power of eminent domain, the amount of any award received by the City as a result of such taking shall be paid into the Sewer Enterprise Fund or into a capital improvement account pertaining to the System for the purposes thereof, or, applied to the redemption of the Outstanding Bonds and any Outstanding Parity Bonds relating thereto, all as the City may determine.

Section 818. Employment of Management Engineers. If the City defaults in paying the Bond Requirements of the Bonds or any Parity Bonds, and any other securities or Policy Costs relating thereto payable from the Gross Pledged Revenues promptly as the same fall due, or an Event of Default has occurred and is continuing, or if the Net Pledged Revenues in any Fiscal Year fail to equal at least the amount of the Bond Requirements of the Outstanding Bonds, Parity Bonds, and any other securities (including all reserves therefor specified in the authorizing proceedings, including, without limitation, this Ordinance) or Policy Costs relating thereto payable from the Net Pledged Revenues in that Fiscal Year, the City shall retain a firm of competent management engineers skilled in the operation of such facilities to assist the management of the System so long as such default continues or so long as the Net Pledged Revenues are less than the amount hereinabove designated in this Section.

Section 819. Budgets. The Council and officials of the City shall annually and at such other times as may be provided by law prepare and adopt a budget pertaining to the System.

Section 820. Reasonable and Adequate Charges. While the Bonds remain Outstanding and unpaid, the fees, rates and other charges due to the City for the use of or otherwise pertaining to and services rendered by the System to the City, to its inhabitants and to all other users within and without the boundaries of the City shall be reasonable and just, taking into account and consideration public interests and needs, the cost and value of the System, the Operation and Maintenance Expenses thereof, and the amounts necessary to meet the Bond Requirements of all Bonds, the Parity Bonds, and any other securities payable from the Net Pledged Revenues, including, without limitation, reserves and any replacement accounts therefor.

Section 821. Adequacy and Applicability of Charges. There shall be charged against users of service pertaining to and users of the System, such fees, rates and other charges so that the Gross Pledged Revenues shall be adequate to meet the requirements of this and the preceding Sections hereof. Such charges pertaining to the System shall be at least sufficient so that the Gross Pledged Revenues annually are sufficient to pay in each Fiscal Year:

A. Operation and Maintenance Expenses. An amount equal to the annual Operation and Maintenance Expenses for such Fiscal Year,

B. Principal and Interest. An amount equal to 110% of both the principal and interest on the Bonds and any Parity Bonds then Outstanding in that Fiscal Year (excluding the reserves therefor), and

C. Deficiencies. Any amounts required to pay all Policy Costs, if any, due and owing and all sums, if any, due and owing to meet then existing deficiencies pertaining to any fund or account relating to the Gross Pledged Revenues or any securities payable therefrom.

Section 822. Limitations Upon Free Service. No free service or facilities shall be furnished by the System, except that if the City elects to use for City purposes any water facilities, or other services and facilities provided by the System or otherwise to use the System or any part thereof, the City is not required to pay for such use.

Section 823. Levy of Charges. The City shall forthwith and in any event prior to the delivery of any of the Bonds, fix, establish and levy the fees, rates and other charges which are required by Section 821 of this Ordinance, if such action is necessary therefor. No reduction in any initial or existing rate schedule for the System may be made:

A. Proper Application. Unless the City has fully complied with the provisions of Article V of this Ordinance for at least the full Fiscal Year immediately preceding such reduction of the initial or any other existing rate schedule; and

B. Sufficient Revenues. Unless the audit required by the Independent Accountant by Section 827 hereof for the full Fiscal Year immediately preceding such reduction discloses that the estimated revenues resulting from the proposed rate schedule for the System, after the

schedule's proposed reduction, shall be at least sufficient to produce the amounts required by Section 821 hereof.

Section 824. Collection of Charges. The City shall cause all fees, rates and other charges pertaining to the System to be collected as soon as is reasonable, shall reasonably prescribe and enforce rules and regulations or impose contractual obligations for the payment of such charges, and for the use of the System, and shall provide methods of collection and penalties, to the end that the Gross Pledged Revenues shall be adequate to meet the requirements of this Ordinance and any other ordinance supplemental thereto.

Section 825. Procedure for Collecting Charges. All bills for water services and all other services or facilities furnished or served by or through the System shall be rendered to customers on a regularly established basis. The fees, rates and other charges due shall be collected in a lawful manner, including, without limitation, discontinuance of service.

Section 826. Maintenance of Records. So long as any of the Bonds and any Parity Bonds payable from the Gross Pledged Revenues remain Outstanding, proper books of record and account pertaining to the Gross Pledged Revenues and the System shall be kept by the City, separate and apart from all other records and accounts.

Section 827. Audits Required. The City shall cause an audit for the Fiscal Year of the books and accounts pertaining to the Gross Pledged Revenues and the System to be completed by an Independent Accountant within 210 days following the close of each Fiscal Year.

Section 828. Accounting Principles. System records and accounts, and audits thereof, shall be currently kept and made, as nearly as practicable, in accordance with the then generally accepted accounting principles, methods and terminology followed and construed for utility operations comparable to the System, except as may be otherwise provided herein or required by applicable law or regulation or by contractual obligation existing on the effective date of this Ordinance.

Section 829. Insurance and Reconstruction. Except to the extent of any self-insurance, the City shall at all times maintain with responsible insurers fire and extended coverage insurance, worker's compensation insurance, public liability insurance and all such other insurance as is customarily maintained with respect to utilities of like character against loss of or damage to the System and against loss of revenues and against public and other liability to the extent reasonably necessary to protect the interests of the City and of each Owner of a Bond. If any useful part of the System shall be damaged or destroyed, the City shall, as expeditiously as may be possible, commence and diligently proceed with the repair or replacement of the damaged property so as to restore the same to use. The proceeds of any such insurance shall be payable to the City and (except for proceeds of any use and occupancy insurance) shall be applied to the necessary costs involved in such repair and replacement and to the extent not so applied shall (together with the proceeds of any such use and occupancy insurance) be deposited in the Sewer Enterprise Fund by the City as revenues derived from the operation of the System. If the costs of such repair and

replacement of the damaged property exceed the proceeds of such insurance available for the payment of the same, moneys in the Sewer Enterprise Fund shall be used to the extent necessary for such purposes, as permitted by Section 512 hereof.

Section 830. Federal Income Tax Exemption. The City covenants for the benefit of the Owners of the Bonds that it will not take any action or omit to take any action with respect to the Bonds, the proceeds thereof, any other funds of the City or any facilities financed with the proceeds of the Bonds if such action or omission (i) would cause the interest on the Bonds to lose its exclusion from gross income for federal income tax purposes under Section 103 of the Tax Code, (ii) would cause interest on the Bonds to lose its exclusion from alternative minimum taxable income as defined in Section 55(b)(2) of the Tax Code, except to the extent that such interest is taken into account in determining the annual adjusted financial statement income of applicable corporations (as defined in Section 59(k) of the Tax Code) for the purpose of computing the alternative minimum tax imposed on corporations; or (iii) would cause interest on the Bonds to lose its exclusion from State taxable income or State alternative minimum taxable income under present State law. In furtherance of this covenant, the City agrees to comply with the procedures set forth in the Tax Compliance Certificate with respect to the Bonds. The foregoing covenant shall remain in full force and effect notwithstanding the payment in full or defeasance of the Bonds until the date on which all obligations of the City in fulfilling the above covenant under the Tax Code and State law have been met.

Section 831. Continuing Disclosure. The City shall comply with the provisions of the Continuing Disclosure Certificate. Any failure by the City to perform in accordance with this Section shall not constitute an Event of Default under this Ordinance, and the rights and remedies provided by this Ordinance upon the occurrence of an Event of Default shall not apply to any such failure. The Paying Agent shall not have any power or duty to enforce this Section. No Owner of a Bond shall be entitled to damages for the City's non-compliance with its obligations under this Section; however, the Owners of the Bonds may enforce specific performance of the obligations contained in this Section by any judicial proceeding available.

ARTICLE IX
PRIVILEGES, RIGHTS AND REMEDIES

Section 901. Owners' Remedies. Each Owner of any Bond shall be entitled to all of the privileges, rights and remedies provided or permitted in this Ordinance, and as otherwise provided or permitted by law or in equity or by any statutes, except as provided in Sections 202 through 206 and 1201 hereof, but subject to the provisions herein concerning the pledge of and the covenants and the other contractual provisions concerning the Gross Pledged Revenues and the proceeds of the Bonds.

Section 902. Right to Enforce Payment. Nothing in this Article affects or impairs the right of any Owner of any Bond to enforce the payment of the Bond Requirements due in connection

with his or her Bond or the obligation of the City to pay the Bond Requirements of each Bond to the Owner thereof at the time and the place expressed in the Bond.

Section 903. Events of Default. Each of the following events is hereby declared an "Event of Default," provided however, that in determining whether a payment default has occurred pursuant to paragraphs A or B of this Section, no effect shall be given to payments made under the Insurance Policy:

A. Nonpayment of Principal. Payment of the principal of any of the Bonds is not made when the same becomes due and payable, either at maturity or by proceedings for prior redemption, or otherwise;

B. Nonpayment of Interest. Payment of any installment of interest on any of the Bonds is not made when the same becomes due and payable;

C. Cross Defaults. The occurrence and continuance of an "event of default," as defined in any Parity Bond Ordinance;

D. Failure to Reconstruct. The City unreasonably delays or fails to carry out with reasonable dispatch the reconstruction of any part of the System which is destroyed or damaged and is not promptly repaired or replaced (whether such failure promptly to repair the same is due to impracticability of such repair or replacement or is due to a lack of moneys therefor or for any other reason), but it shall not be an Event of Default if such reconstruction is not essential to the efficient operation of the System;

E. Appointment of Receiver. An order or decree is entered by a court of competent jurisdiction with the consent or acquiescence of the City appointing a receiver or receivers for the System or for the Gross Pledged Revenues and any other moneys subject to the lien to secure the payment of the Bonds, or if an order or decree having been entered without the consent or acquiescence of the City is not vacated or discharged or stayed on appeal within 60 days after entry;

F. Default Under Insurance Agreement. If an event of default shall have occurred and be continuing under the provisions of the Insurance Agreement; and

G. Default of Any Provision. The City defaults in the due and punctual performance of any other of the representations, covenants, conditions, agreements and other provisions contained in the Bonds or in this Ordinance on its part to be performed (other than Section 831 hereof), and such default continues for 60 days after written notice specifying such default and requiring the same to be remedied is given to the City and the Insurer specifying the failure and requiring that it be remedied, which notice may be given by the Paying Agent in its discretion and, except as provided in Section 1101 hereof, shall be given by the Paying Agent at the written request of the Owners of not less than 25 percent in aggregate principal amount of Bonds then Outstanding.

Section 904. Remedies for Defaults. Except as provided in Section 1101 hereof, upon the happening and continuance of any Event of Default, the Owner or Owners of not less than 25% in aggregate principal amount of the Bonds then Outstanding, including, without limitation, a trustee or trustees therefor, may proceed against the City and its agents, officers and employees to protect and to enforce the rights of any Owner of Bonds under this Ordinance by mandamus or by other suit, action or special proceedings in equity or at law, in any court of

competent jurisdiction, either for the appointment of a receiver or for the specific performance of any covenant or agreement contained herein or in an award of execution of any power herein granted for the enforcement of any proper legal or equitable remedy as such Owner or Owners may deem most effectual to protect and to enforce the rights aforesaid, or thereby to enjoin any act or thing which may be unlawful or in violation of any right of any Owner of any Bond, or to require the City to act as if it were the trustee of an expressed trust, or any combination of such remedies. All such proceedings at law or in equity shall be instituted, had and maintained for the equal benefit of all Owners of the Bonds.

Section 905. Receiver's Rights and Privileges. Any receiver appointed in any proceedings to protect the rights of such Owners hereunder, the consent to any such appointment being hereby expressly granted by the City, may enter and may take possession of the System, may operate and maintain the same, may prescribe fees, rates and other charges, and may collect, receive and apply all Gross Pledged Revenues arising after the appointment of such receiver in the same manner as the City itself might do.

Section 906. Rights and Privileges Cumulative. The failure of any Owner of any Outstanding Bond to proceed in any manner herein provided shall not relieve the City, or any of its officers, agents or employees of any liability for failure to perform or carry out any duty, obligation or other commitment. Each right or privilege of any such Owner (or trustee thereof) is in addition and is cumulative to any other right or privilege, and the exercise of any right or privilege by or on behalf of any Owner shall not be deemed a waiver of any other right or privilege thereof.

Section 907. Duties upon Defaults. Upon the happening of any Event of Default, the City shall do and perform all proper acts on behalf of and for the Owners of Bonds to protect and to preserve the security created for the payment of the Bonds and to insure the payment of the Bond Requirements promptly as the same become due. While any Event of Default exists, except to the extent it may be unlawful to do so, all Gross Pledged Revenues shall be paid into the Bond Fund and into bond or similar funds established for any Parity Bonds then Outstanding, pro rata based upon the aggregate principal amount of the Bonds and Parity Bonds then Outstanding. Except as provided in Section 1101 hereof, if the City fails or refuses to proceed as in this Section provided, the Owner or Owners of not less than 25% in aggregate principal amount of the Bonds then Outstanding, after demand in writing, may proceed to protect and to enforce the rights of the Owners of the Bonds as hereinabove provided, and to that end any such Owners of the Outstanding Bonds shall be subrogated to all rights of the City under any agreement, lease or other contract involving the System or the Gross Pledged Revenues entered into prior to the effective date of this Ordinance or thereafter while any of the Bonds are Outstanding.

ARTICLE X
AMENDMENT OF ORDINANCE

Section 1001. Privilege of Amendments.

A. Except as hereafter provided, this Ordinance may be amended or supplemented by ordinances adopted by the Council in accordance with law, without receipt by the City of any additional consideration, but with the written consent of the Insurer and, subject to Section 1101 hereof, the Owners of not less than a majority in aggregate principal amount of the Bonds Outstanding at the time of the adoption of such amendatory or supplemental ordinance excluding, pursuant to Section 101 B hereof, any Bonds which may then be held or owned for the account of the City. Notwithstanding the foregoing, no such ordinance shall permit:

(1) Changing Payment. A change in the maturity, terms of redemption or interest payment of any Outstanding Bond; or

(2) Reducing Return. A reduction in the principal amount of any Bond or the rate of interest thereon, without the consent of the Owner of the Bond; or

(3) Prior Lien. The creation of a lien upon or a pledge of revenues ranking prior to the lien or to the pledge created by this Ordinance; or

(4) Modifying Any Bond. A reduction of the principal amount or percentages or otherwise affecting the description of Bonds the consent of the Owners of which is required for any such modification or amendment; or

(5) Priorities Between Bonds. The establishment of priorities as between Bonds issued and Outstanding; or

(6) Modification of Less Than All the Bonds. The modification of or otherwise affecting the rights of the Owners of less than all of the Outstanding Bonds.

B. Notwithstanding the foregoing provisions of this Section, this Ordinance and the rights and obligations of the City and of the Owners of the Bonds may also be modified or amended at any time, with the written consent of the Insurer but without the consent of any Owners of the Bonds, but only to the extent permitted by law and only for any or all of the following purposes:

(1) to add to the covenants and agreements of the City in this Ordinance contained other covenants and agreements thereafter to be observed;

(2) to subject to the covenants and agreements of the City in this Ordinance additional System revenues, to be defined and treated as Gross Pledged Revenues, for the purpose of providing additional security for the Bonds and any Parity Bonds;

(3) in connection with the provision of a Reserve Fund Insurance Policy subsequent to the issuance of the Bonds;

(4) to provide for the appointment of a new Paying Agent;

(5) to make such provisions for the purpose of curing any ambiguity or of curing or correcting any formal defect or omission in this Ordinance, or in regard to questions arising under this Ordinance, as the City may deem necessary or desirable, and which shall not adversely affect the interests of the Owners of the Bonds; or

(6) in order to preserve or protect the excludability from gross income for federal income tax purposes of the interest allocable to the Bonds.

Section 1002. Notice of Amendment. Whenever the Council proposes to amend or modify this Ordinance under the provisions of this Article, it shall cause notice of the proposed amendment to be sent to Owners of all Outstanding Bonds at their addresses as the same last

appear on the registration records maintained by the Paying Agent or by electronic means to DTC or its successors, and to the Insurer. Such notice shall briefly set forth the nature of the proposed amendment and shall state that a copy of the proposed amendatory ordinance is on file with the City Manager for public inspection. Notice of the proposed amendment, together with a copy of the proposed amendatory ordinance, shall be delivered to the Rating Agencies then maintaining a rating on the Bonds at least 15 days in advance of the adoption of the amendment. A full transcript of all proceedings relating to the execution of such amendatory ordinance shall be provided to the Insurer.

Section 1003. Time for Amendment. If the ordinance is required to be consented to by the Owners of the Bonds, whenever at any time within one year from the date of the giving of such notice there shall be filed with the City Manager an instrument or instruments executed by the Owners of not less than a majority in aggregate principal amount of the Bonds then Outstanding, which instrument or instruments shall refer to the proposed amendatory ordinance described in such notice and shall specifically consent to and approve the adoption of such ordinance, the Council may adopt such amendatory ordinance and such ordinance shall become effective. If the ordinance is not required to be consented to by the Owners of the Bonds, the amendatory ordinance may be adopted by the Council at any time.

Section 1004. Binding Consent to Amendment. If the Owners of not less than a majority in aggregate principal amount of the Bonds Outstanding at the time of the adoption of such amendatory ordinance requiring consent of the Owners of the Bonds, or the predecessors in title of such Owners, shall have consented to and approved the adoption thereof as herein provided, no Owner of any Bond, whether or not such Owner shall have consented to or shall have revoked any consent as in this Article provided, shall have any right or interest to object to the adoption of such amendatory ordinance or to object to any of the terms or provisions therein contained or to the operation thereof or to enjoin or restrain the City from taking any action pursuant to the provisions thereof.

Section 1005. Time Consent Binding. Any consent given by the Owner of a Bond pursuant to the provisions of this Article shall be irrevocable for a period of 6 months from the date of the giving of the notice above provided for and shall be conclusive and binding upon all future Owners of the same Bond during such period. Such consent may be revoked at any time after 6 months from the date of such giving of such notice by the Owner who gave such consent or by a successor in title by filing notice of such revocation with the City Manager, but such revocation shall not be effective if the Owners of not less than a majority in aggregate principal amount of the Bonds Outstanding as in this Article provided, prior to the attempted revocation, consented to and approved the amendatory ordinance referred to in such revocation.

Section 1006. Unanimous Consent. Notwithstanding anything in the foregoing provisions of this Article, the terms and provisions of this Ordinance or of any ordinance amendatory thereof or supplemental thereto and the rights and the obligations of the City and of the Owners of the Bonds thereunder may be modified or amended in any respect upon the adoption by the City and upon the filing with the City Manager of an ordinance to that effect

and with the consent of the Insurer and the Owners of all the then Outstanding Bonds, such consent to be given as provided in Section 1003 hereof; and no notice to Owners of Bonds shall be required as provided in Section 1002 hereof, nor shall the time of consent be limited except as may be provided in such consent.

Section 1007. Exclusion of City's Bonds. At the time of any consent or of other action taken under this Article, the City shall furnish to the City Manager a certificate of the Director of Finance, upon which the City may rely, describing all Bonds to be excluded for the purpose of consent or of other action or of any calculation of Outstanding Bonds provided for in this Article, and the City shall not be entitled with respect to such Bonds to give any consent or to take any other action provided for in this Article, as provided in Section 101 B hereof.

Section 1008. Notation on Bonds. Bonds authenticated and delivered after the effective date of any action taken as in this Article provided may bear a notation by endorsement or otherwise in form approved by the Council as to such action; and after the approval of such notation, then upon demand of the Owner of any Bond Outstanding and upon presentation of his or her Bond for that purpose at the principal office of the Paying Agent, suitable notation shall be made on such Bond by the Paying Agent as to any such action. If the Council so determines, new Bonds, so modified as in the opinion of the Council conform to such action, shall be prepared, executed, authenticated and delivered; and upon demand of the Owner of any Bond then Outstanding, shall be exchanged without cost to such Owner for Bonds then Outstanding upon surrender of such Bonds.

Section 1009. Proof of Instruments and Bonds. The fact and date of execution of any instrument under the provisions of this Article, the amount and number of the Bonds held by any Person executing such instrument, and the date of his or her holding the same may be proved as provided by Section 1203 hereof.

Section 1010. Copies of Supplemental Ordinances to Rating Agencies. Copies of any supplemental or amendatory ordinance shall be sent by the City to the Rating Agencies at least 10 days prior to the effective date thereof.

ARTICLE XI
INSURANCE POLICY AND RESERVE POLICY PROVISIONS

Section 1101. Insurer To Be Deemed Owner, Rights of the Insurer, Payments by the Insurer: Notices.

A. Notwithstanding any provision of this Ordinance to the contrary, so long as the Insurer is not in default in its payment obligations under the Insurance Policy, the Insurer shall at all times be deemed the sole and exclusive Owner of the Outstanding Bonds for the purposes of all approvals, consents, waivers, institution of any action, and the direction of all remedies pursuant to this Ordinance, including but not limited to approval of or consent to any amendment of or supplement to this Ordinance which requires the consent or approval of the Owners of not less than a majority of the aggregate principal amount of the Bonds then Outstanding pursuant to this Ordinance; provided, however, that the Insurer shall not be

deemed to be the sole and exclusive Owner of the Outstanding Bonds with respect to any amendment or supplement to this Ordinance which seeks to amend or supplement this Ordinance for the purposes set forth in clauses A (1) through A (6) of Section 1001 hereof, and provided, further, that the Insurer shall not have the right to direct or consent to City, Paying Agent or Owner action as provided herein, if:

(1) the Insurer shall be in default under the Insurance Policy;

(2) any material provision of the Insurance Policy shall be held to be invalid by a final, non-appealable order of a court of competent jurisdiction, or the validity or enforceability thereof shall be contested by the Insurer; or

(3) a proceeding shall have been instituted in a court having jurisdiction in the premises seeking an order for relief, rehabilitation, reorganization, conservation, liquidation or dissolution in respect of the Insurer and such proceeding is not terminated for a period of 90 consecutive days or such court enters an order granting the relief sought in such proceeding.

B. To the extent that the Insurer makes payment of any principal of or interest on a Bond, it shall be fully subrogated to all of the Owner's rights thereunder in accordance with the terms of the Insurance Policy to the extent of such payment, including the Owner's rights to payment thereof.

C. In the event that the principal of or interest on a Bond shall be paid by the Insurer pursuant to the terms of the Insurance Policy: (1) such Bond shall continue to be "Outstanding" under this Ordinance, and (2) the Insurer shall be fully subrogated to all of the rights of the Owner thereof in accordance with the terms and conditions of paragraph B of this Section and the Insurance Policy.

D. This Ordinance shall not be discharged unless and until all amounts due to the Insurer have been paid in full or duly provided for.

E. The rights granted under this Ordinance to the Insurer to request, consent to or direct any action are rights granted to the Insurer in consideration of its issuance of the Insurance Policy. Any exercise by the Insurer of such rights is merely an exercise of the Insurer's contractual rights and shall not be construed or deemed to be taken for the benefit of or on behalf of the Owners, nor does such action evidence any position of the Insurer, positive or negative, as to whether Owner consent is required in addition to consent of the Insurer.

F. No modification, amendment or supplement to this Ordinance shall become effective except upon obtaining the prior written consent of the Insurer.

G. No contract shall be entered into, nor any action taken by the City or the Paying Agent pursuant to which the rights of the Insurer or security for or sources of payment of the Bonds under this Ordinance may be impaired or prejudiced except upon obtaining the prior written consent of the Insurer.

H. The provisions of this Article shall be of no force or effect if the Bonds are not insured by an Insurer.

ARTICLE XII
MISCELLANEOUS

Section 1201. Defeasance. If, when the Bonds shall be paid in accordance with their terms (or payment of the Bonds has been provided for in the manner set forth in the following

paragraph), then this Ordinance and all rights granted hereunder shall thereupon cease, terminate and become void and be discharged and satisfied.

Payment of any Outstanding Bond shall prior to the maturity or Redemption Date thereof be deemed to have been provided for within the meaning and with the effect expressed in this Section if (a) in case said Bond is to be redeemed on any date prior to its maturity, the City shall have given to the Paying Agent in form satisfactory to it irrevocable instructions to give on a date in accordance with the provisions of Section 405 hereof, notice of redemption of such Bond on said Redemption Date, such notice to be given in accordance with the provisions of Section 405 hereof, (b) there shall have been deposited with the Paying Agent or a Trust Bank either moneys in an amount which shall be sufficient, and/or Federal Securities which shall not contain provisions permitting the redemption thereof at the option of the issuer, the principal of and the interest on which when due, and without any reinvestment thereof, will provide moneys which, together with the moneys, if any, deposited with or held by the Paying Agent or Trust Bank at the same time, shall be sufficient to pay when due the Bond Requirements due and to become due on said Bond on and prior to the Redemption Date or maturity date thereof, as the case may be, and (c) in the event said Bond is not by its terms subject to redemption within the next sixty days, the City shall have given the Paying Agent in form satisfactory to it irrevocable instructions to give, as soon as practicable in the same manner as the notice of redemption is given pursuant to Section 405 hereof, a notice to the Owner of such Bond that the deposit required by (b) above has been made with the Paying Agent or Trust Bank and that payment of said Bond has been provided for in accordance with this Section and stating such maturity or Redemption Date upon which moneys are to be available for the payment of the Bond Requirements of said Bond. Neither such securities nor moneys deposited with the Paying Agent or Trust Bank pursuant to this Section or principal or interest payments on any such Federal Securities shall be withdrawn or used for any purpose other than, and shall be held in trust for, the payment of the Bond Requirements of said Bond; provided any cash received from such principal or interest payments on such Federal Securities deposited with the Paying Agent or other Trust Bank, if not then needed for such purpose, shall, to the extent practicable, be reinvested in securities of the type described in (b) of this paragraph maturing at times and in amounts sufficient to pay when due the Bond Requirements to become due on said Bond on or prior to such Redemption Date or maturity date thereof, as the case may be. At such time as payment of a Bond has been provided for as aforesaid, such Bond shall no longer be secured by or entitled to the benefits of this Ordinance, except for the purpose of any payment from such moneys or securities deposited with the Paying Agent or other Trust Bank.

The release of the obligations of the City under this Section shall be without prejudice to the right of the Paying Agent to be paid reasonable compensation for all services rendered by it hereunder and all its reasonable expenses, charges and other disbursements incurred on or about the administration of and performance of its powers and duties hereunder.

Upon compliance with the foregoing provisions of this Section with respect to all Bonds then Outstanding, this Ordinance may be discharged in accordance with the provisions of this

Section but the liability of the City in respect of the Bonds shall continue; provided that the Owners thereof shall thereafter be entitled to payment only out of the moneys or Federal Securities deposited with the Paying Agent or other Trust Bank as provided in this Section.

Section 1202. Delegated Powers. The officers, employees and agents of the City be, and they hereby are, authorized and directed to take all action necessary or appropriate to effectuate the provisions of this Ordinance, including, without limitation:

A. Final Certificates. the execution of such certificates as may be reasonably required by the Purchaser, including the Continuing Disclosure Certificate and Insurance Agreement, if any;

B. Paying Agent Agreement. the execution and delivery of an agreement with the Paying Agent necessary or desirable to evidence the acceptance by the Paying Agent of its duties hereunder;

C. Escrow Agreement. the execution and delivery of an agreement with the Escrow Agent necessary or desirable to evidence the acceptance by the Paying Agent of its duties hereunder;

D. Official Statement. the execution and delivery of the final Official Statement; and

E. Bond Purchase Agreement. the execution and delivery of the Bond Purchase Agreement from the Purchaser.

F. Electronic Signatures. The use of electronic signatures to execute any of the documents described in this Section 1202 or elsewhere in this Ordinance, as authorized by Article 71.3 of Title 24, C.R.S., also known as the Uniform Electronic Transactions Act.

Section 1203. Evidence of Bond Owners. Any request, consent or other instrument which this Ordinance may require or may permit to be signed and to be executed by the Owners of any Bonds may be in one or more instruments of similar tenor and shall be signed or shall be executed by each such Owner in person or by his or her attorney appointed in writing. Proof of the execution of any such instrument or of an instrument appointing any such attorney, or the holding by any Person of the Bonds shall be sufficient for any purpose of this Ordinance (except as otherwise herein expressly provided) if made in the following manner:

A. Proof of Execution. The fact and the date of the execution by any Owner of any Bonds or his or her attorney of such instrument may be established by a certificate, which need not be acknowledged or verified, of an officer of a bank or trust company satisfactory to the City Manager or Director of Finance of any notary public or other officer authorized to take acknowledgments of deeds to be recorded in the state in which he or she purports to act, that the individual signing such request or other instrument acknowledged to him or her the execution thereof, or by an affidavit of a witness of such execution, duly sworn to before such notary public or other officer; the authority of the individual or individuals executing any such instrument on behalf of a corporate Owner of any securities may be established without further proof if such instrument is signed by an individual purporting to be the president or vice-president of such corporation with a corporate seal affixed and attested by an individual purporting to be its secretary or an assistant secretary; and the authority of any Person or Persons executing any such instrument in any fiduciary or representative capacity may be

established without further proof if such instrument is signed by a Person or Persons purporting to act in such fiduciary or representative capacity; and

B. Proof of Holdings. The amount of Bonds held by any Person and the numbers, date and other identification thereof, together with the date of his or her holding the Bonds, shall be proved by the registration records maintained by the Paying Agent.

Section 1204. Parties Interested Herein. Nothing in this Ordinance expressed or implied is intended or shall be construed to confer upon, or to give to, any Person, other than the City, the Paying Agent, the Insurer and the Owners of the Bonds, any right, remedy or claim under or by reason of this Ordinance or any covenant, condition or stipulation hereof; and all the covenants, stipulations, promises and agreements in this Ordinance contained by and on behalf of the City shall be for the sole and exclusive benefit of the City, the Paying Agent, the Insurer, the Surety Provider and the Owners of the Bonds.

Section 1205. Notices. Except as otherwise may be provided in this Ordinance, all notices, certificates, requests or other communications pursuant to this Ordinance shall be in writing and shall be sufficiently given and shall be deemed given by personal delivery, electronic means, or when mailed by first class mail, and either delivered or addressed as follows:

If to the City at:

City and County of Broomfield
One DesCombes Drive
Broomfield, Colorado 80020
Attention: Director of Finance

If to the Paying Agent or Escrow Agent at:

UMB Bank, n.a.
1670 Broadway
Denver, Colorado 80202
Attention: Corporate Trust and Escrow Services

Any of the foregoing Persons may, by notice given hereunder to each of the other Persons, designate any further or different addresses to which subsequent notices, certificates, requests or other communications shall be sent.

Section 1206. Additional Notices to Rating Agencies. The Paying Agent hereby agrees that if at any time (a) the City shall redeem any portion of the Bonds Outstanding prior to maturity, but excluding redemptions pursuant to Section 402 hereof, (b) the City shall provide for the payment of any portion of the Bonds pursuant to Section 1201 hereof, (c) a successor Paying Agent is appointed hereunder, or (d) any supplement to this Ordinance shall become effective or any Person shall waive any provision of this Ordinance, then, in each case, the Paying Agent shall give notice to each Rating Agency.

Section 1207. Business Days. If the date for making any payment or the last date for performance of any act or the exercising of any rights, as provided in this Ordinance, shall not

be a Business Day, such payment may be made or act performed or right exercised on the next succeeding Business Day, with the same force and effect as if done on the nominal date provided in this Ordinance, and no interest shall accrue for the period after such nominal date.

Section 1208. Effective Date. This Ordinance shall be in full force and effect seven days after final publication.

Section 1209. Disposition of Ordinance. This Ordinance, as adopted by the Council, shall be numbered and recorded by the City Clerk in the official records of the City. The adoption and publication shall be authenticated by the signatures of the Mayor and City Clerk, and by the certificate of publication.

Introduced and approved after first reading on October 14, 2025, and ordered published in full.

Introduced a second time and approved on October 28, 2025, and ordered published.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

_____

City and County Attorney

ORDINANCE NO. 2290

An ordinance concerning the financing of police and courts buildings and approving the execution and delivery of a Site Lease Agreement, Lease Purchase Agreement, and related documents

Recitals.

Whereas, the City and County of Broomfield, Colorado (the "City") is a political subdivision of the State of Colorado (the "State") a body corporate and politic, a home-rule city and county pursuant to Article XX of the constitution and a city and county pursuant to Sections 10, 11, 12 and 13 of Article XX of the constitution;

Whereas, the City is authorized pursuant to Article XX, Section 6 of the Colorado Constitution and Section 2.1 of the Charter to purchase, lease, receive, hold, and enjoy, or sell and dispose of real and personal property;

Whereas, pursuant to Section 14.9(a) of the Charter, in order to provide necessary land, buildings, equipment and other property for governmental or proprietary purposes, the City may enter into rental or leasehold agreements;

Whereas, pursuant to Section 14.9(b) of the Charter, the City Council of the City (the "City Council") may provide for payment of installments thereof out of the general ad valorem tax levy, by the imposition of rates, tolls, or service charges for the use of such property or any part thereof, out of any other available municipal revenues or by any combination of the foregoing methods;

Whereas, because there is a need for a police building and improvements to the existing courts building in the City, the City Council has determined and hereby determines that it is in the best interest of the City and its inhabitants and is a public purpose for the City to finance the acquisition, construction, installation and equipping of a police building and a courts building, including any legally permitted costs and expenditure in connection therewith (the "Project");

Whereas, the City Council has determined and hereby determines that it is in the best interest of the City and its inhabitants for the City to finance a portion of the Project by entering into a lease financing as hereinafter provided;

Whereas, the City Council hereby determines that the leased property under the Site Lease and the Lease (hereinafter defined) will consist of certain land and buildings owned by the City (all as more particularly described in Exhibit A to the Site Lease and the Lease, the "Leased Property");

Whereas, the City Council has determined and hereby determines that it is in the best interests of the City and its inhabitants to provide for the financing of the Project by entering into a Site Lease Agreement between the City, as lessor, and UMB Bank, n.a. (the "Trustee"), acting solely in its capacity of trustee, as lessee (the "Site Lease"), pursuant to which the City will lease the Leased Property to the Trustee, and a Lease Purchase Agreement between the Trustee, as lessor, and the City, as lessee (the "Lease"), pursuant to which the Trustee will lease the Leased Property back to the City;

Whereas, pursuant to the Lease, and subject to the right of the City to terminate the Lease and other limitations as therein provided, the City will pay certain Base Rentals and Additional Rentals (as such terms are defined in the Lease) in consideration for the right of the City to use the Leased Property;

Whereas, the City's obligation under the Lease to pay Base Rentals and Additional Rentals shall be from year to year only; shall constitute currently budgeted expenditures of the City; shall not constitute a mandatory charge or requirement in any ensuing budget year; and shall not constitute a general obligation or other indebtedness or multiple fiscal year financial obligation of the City within the meaning of any constitutional, statutory, or Charter limitation or requirement concerning the creation of indebtedness or multiple fiscal year financial obligation, nor a mandatory payment obligation of the City in any ensuing fiscal year beyond any fiscal year during which the Lease shall be in effect;

Whereas, contemporaneously with the execution and delivery of the Site Lease and the Lease, the Trustee will execute and deliver an Indenture of Trust (the "Indenture") pursuant to which there will be executed and delivered certain certificates of participation (the "Certificates") dated as of their date of delivery that shall evidence proportionate interests in the right to receive certain Revenues (as defined in the Lease) under the Lease, shall be payable solely from the sources therein provided and shall not directly or indirectly obligate the City to make any payments beyond those appropriated for any fiscal year during which the Lease shall be in effect;

Whereas, the net proceeds of the Certificates will be used to finance the Project and pay the Costs of Execution and Delivery of the Certificates;

Whereas, the City has previously issued its of Certificates of Participation, Series 2017 (the "2017 Certificates"), which 2017 Certificates are currently outstanding in the aggregate principal amount of $10,890,000, and mature on December 1, 2027;

Whereas, contemporaneously with the issuance of the Certificates, the City has determined to utilize unrestricted funds of the City to fully discharge, pay and defease the 2017 Certificates;

Whereas, in connection with the discharge and defeasance of the 2017 Certificates, the City will enter into an escrow agreement (the "Escrow Agreement") with UMB Bank, n.a.,

acting as Escrow Agent, pursuant to which UMB Bank, n.a., will pay the principal of and interest on the 2017 Certificates until final maturity on December 1, 2027;

Whereas, Section 11-57-204 of the Supplemental Public Securities Act, constituting Title 11, Article 57, Part 2, C.R.S., as amended (the "Supplemental Act"), provides that a public entity, including the City, may elect in an act of issuance to apply all or any of the provisions of the Supplemental Act;

Whereas, there has been presented to the City Council and are on file with the City Clerk of the City (the "City Clerk") the following: (i) the proposed form of the Site Lease; (ii) the proposed form of the Lease; (iii) the proposed form of the Continuing Disclosure Certificate to be provided by the City in connection with the execution and delivery of the Certificates (the "Disclosure Certificate"); (iv) the proposed form of the Certificate Purchase Agreement (the "Certificate Purchase Agreement") between the Trustee and the initial purchaser of the Certificates and acknowledged by the City; and (v) the Preliminary Official Statement (the "Preliminary Official Statement") relating to the Certificates;

Whereas, pursuant to Section 11-57-203, C.R.S., the City desires to delegate to the City Manager and the Director of Finance the independent authority to accept the proposal to purchase the Certificates by execution of the Certificate Purchase Agreement and to make final determinations relating to the Certificates, subject to the parameters contained in Section 4 of this Ordinance;

Whereas, capitalized terms used herein and not otherwise defined shall have the meanings set forth in the Lease.

Now, therefore, be it ordained by the City Council of the City and County of Broomfield, Colorado:

Section 1. Recitals Incorporated. The foregoing recitals are incorporated herein by reference and adopted as findings and determinations of the City Council.

Section 2. Ratification and Approval of Prior Actions. All action heretofore taken (not inconsistent with the provisions of this Ordinance) by the City Council or the officers, agents or employees of the City relating to the Site Lease, the Lease, the Project, and the sale, execution and delivery of the Certificates is hereby ratified, approved and confirmed.

Section 3. Finding of Best Interests. The City Council hereby finds and determines, pursuant to the Constitution, the laws of the State, and the Charter, that undertaking the Project and financing the costs thereof pursuant to the terms set forth in the Site Lease, the Lease, and the Indenture are necessary, convenient, and in furtherance of the City's purposes and are in the best interests of the inhabitants of the City, and the City Council hereby authorizes and approves the same.

Section 4. Supplemental Act; Parameters. The City Council hereby elects to apply all of the provisions of the Supplemental Act to the Site Lease and the Lease and in connection therewith delegates to each of the Mayor of the City (the "Mayor"), the City and County Manager of the City (the "City Manager") and the Finance Director of the City (the "Finance Director") the independent authority to make any determination delegable pursuant to Section 11-57-205 of the Supplemental Act, in relation to the Site Lease and the Lease, and to execute a sale certificate (the "Sale Certificate") setting forth such determinations, including without limitation, the term of the Site Lease, the term of the Lease, and the rental amount to be payable by the City pursuant to the Lease, subject to the following parameters and restrictions:

(a) the Site Lease Termination Date shall be no later than December 31, 2057;

(b) the Lease Term shall end no later than December 31, 2047;

(c) the aggregate principal amount of the Base Rentals payable by the City pursuant to the Lease shall not exceed $100,000,000;

(d) the maximum annual repayment amount of the Base Rentals payable by the City pursuant to the Lease shall not exceed $7,900,000;

(e) the maximum total repayment amount of Base Rentals payable by the City pursuant to the Lease shall not exceed $166,000,000;

(f) the purchase price of the Certificates shall not be less than 98% of the aggregate principal amount of the Certificates; and

(g) the maximum net effective interest rate on the interest component of the Base Rentals relating to the Certificates shall not exceed 5.50%.

Pursuant to Section 11-57-205 of the Supplemental Act, the City Council hereby delegates to each of the Mayor, the City Manager and the Finance Director the independent authority to acknowledge the Certificate Purchase Agreement for the purchase of the Certificates, in substantially the form presented to the City Council and on file with the City, and to execute any agreement or agreements in connection therewith; provided that the Certificate Purchase Agreement may be completed, corrected, or revised as deemed necessary or appropriate by the parties thereto in order to carry out the purposes of this Ordinance. In addition, the Mayor, the City Manager, and the Finance Director are hereby each independently authorized to determine if obtaining an insurance policy for all or a portion of the Certificates is in the best interests of the City, and if so, to select an insurer to issue an insurance policy, execute a commitment relating to the same and execute any related documents or agreements required by such commitment. Each of the Mayor, the City Manager, and the Finance Director are also hereby independently authorized to determine if obtaining a reserve fund insurance policy for the Certificates is in the best interests of the City, and if so, to select a surety provider to

issue a reserve fund insurance policy and execute any related documents or agreements required by such commitment.

The delegation set forth in this Section 4 shall be effective for one year following the date hereof.

Section 5. Determination of Leased Property. The City Council hereby determines that the real property that will serve as the Leased Property under the Site Lease and the Lease shall consist of one or more of the following: (i) the Police Department detention Center/Training Building, Paul Derda Recreation Center, the Community Center on Spader Way and the Service Center Administration Building. The City Council hereby delegates to the City Manager the authority to determine whether any or all of the Police Department detention Center/Training Building, Paul Derda Recreation Center, the Community Center on Spader Way and the Service Center Administration Building will be included as the Leased Property under the Site Lease and the Lease in order to finance the Project. Such determination shall be set forth in a certificate signed by the City Manager.

Section 6. Approval of Documents. The Site Lease, the Lease, and the Disclosure Certificate, in substantially the forms on file with the City Clerk, are in all respects approved, authorized and confirmed, and the Mayor is hereby authorized and directed for and on behalf of the City to execute and deliver the Site Lease, the Lease, and the Disclosure Certificate, in substantially the forms and with substantially the same contents as are on file with the City Clerk, provided that such documents may be completed, corrected or revised as deemed necessary or appropriate by the parties thereto in order to carry out the purposes of this Ordinance and to comply with the terms of the Sale Certificate. The execution of the Site Lease, the Lease, and the Disclosure Certificate by the Mayor shall be conclusive evidence of the approval by the City Council of such documents in accordance with the terms hereof and thereof.

Section 7. Official Statement. The Mayor, the City Manager, and the Finance Director are hereby independently authorized to prepare or cause to be prepared the Preliminary Official Statement in connection with the offering and sale of the Certificates, and to deem the Preliminary Official Statement (in substantially the form of the Preliminary Official Statement on file with the City Clerk) as final for purposes of Rule 15c2-12 of the Securities and Exchange Commission. The Mayor, the City Manager and the Finance Director are hereby independently authorized to prepare or to cause to be prepared, and to approve a final Official Statement, in substantially the form of the Preliminary Official Statement on file with the City Clerk, and such preparation and approval is in all respects approved and authorized. The Mayor, the City Manager and the Finance Director are hereby independently authorized and directed to execute and deliver the final Official Statement, for and on behalf of the City, in substantially the form and with substantially the same content as the Preliminary Official Statement, provided that such document may be completed, corrected, or revised as deemed necessary or appropriate by the City Manager, the Finance Director, or the City Attorney of the City. The distribution of the Preliminary Official Statement and the final Official

Statement (in substantially the form of the Preliminary Official Statement) to prospective purchasers of the Certificates is hereby ratified, approved, and authorized.

Section 8. Authorization to Execute Collateral Documents. The City Clerk is hereby authorized and directed to attest all signatures and acts of any official of the City in connection with the matters authorized by this Ordinance and to place the seal of the City on any document authorized and approved by this Ordinance. The Mayor, the City Clerk, the City Manager, the Finance Director and other appropriate employees and officials of the City are hereby authorized and directed to execute and deliver for and on behalf of the City any and all additional certificates, documents, instruments and other papers, and to perform all other acts that they deem necessary or appropriate in order to implement and carry out the transactions and other matters authorized by this Ordinance. The approval hereby given to the various documents referred to above includes an approval of such additional details therein as may be necessary and appropriate for their completion, deletions therefrom and additions thereto as may be approved by bond counsel prior to the execution of the documents. The execution of any document or instrument by the aforementioned officials or employees of the City or members of the City Council shall be conclusive evidence of the approval by the City Council of such document or instrument in accordance with the terms hereof and thereof.

The Mayor, the City Clerk, the City Manager, the Finance Director and all other employees and officials of the City that are authorized or directed to execute any agreement, document, certificate, instrument, or other paper in accordance with this Ordinance (collectively, the "Authorized Documents") are hereby authorized to execute Authorized Documents electronically via facsimile or email signature. Any electronic signature so affixed to any Authorized Document shall carry the full legal force and effect of any original, handwritten signature. This provision is made pursuant to Article 71.3 of Title 24, C.R.S., also known as the Uniform Electronic Transactions Act. It is hereby determined that the transactions described herein may be conducted and related documents may be stored by electronic means. Copies, telecopies, facsimiles, electronic files, and other reproductions of original executed documents shall be deemed to be authentic and valid counterparts of such original documents for all purposes, including the filing of any claim, action, or suit in the appropriate court of law.

Section 9. No General Obligation Debt. No provision of this Ordinance, the Site Lease, the Lease, the Indenture, the Disclosure Certificate, the Certificate Purchase Agreement, the Certificates, the Preliminary Official Statement, or the final Official Statement shall be construed as creating or constituting a general obligation or other indebtedness or multiple fiscal year financial obligation of the City within the meaning of any constitutional, statutory, or Charter provision, nor a mandatory charge or requirement against the City in any ensuing fiscal year beyond the then current fiscal year. The City shall have no obligation to make any payment with respect to the Certificates except in connection with the payment of the Base Rentals and certain other payments under the Lease, which payments may be terminated by the City in accordance with the provisions of the Lease. Neither the Lease nor the Certificates

shall constitute a mandatory charge or requirement of the City in any ensuing fiscal year beyond the then current fiscal year and shall not constitute or give rise to a general obligation or other indebtedness of the City within the meaning of any constitutional, statutory, or Charter debt limitation and shall not constitute a multiple fiscal year direct or indirect debt or other financial obligation whatsoever. No provision of the Site Lease, the Lease or the Certificates shall be construed or interpreted as creating an unlawful delegation of governmental powers nor as a donation by or a lending of the credit of the City within the meaning of Sections 1 or 2 of Article XI of the Colorado Constitution. Neither the Site Lease, the Lease nor the Certificates shall directly or indirectly obligate the City to make any payments beyond those budgeted and appropriated for the City's then current fiscal year.

Section 10. Reasonableness of Rentals. The City Council hereby determines and declares that the Base Rentals payable by the City under the Lease, in the maximum amount authorized pursuant to Section 4 hereof, constitute the fair rental value of the Leased Property and do not exceed a reasonable amount so as to place the City under an economic compulsion to renew the Lease or to exercise its option to purchase the Trustee's leasehold interest in the Leased Property pursuant to the Lease. The City Council hereby determines and declares that the period during which the City has an option to purchase the Trustee's leasehold interest in the Leased Property (i.e., the entire maximum term of the Lease) does not exceed the useful life of the Leased Property.

Section 11. No Recourse against Officers and Agents. Pursuant to Section 11-57-209 of the Supplemental Act, if a member of the City Council, or any officer or agent of the City acts in good faith, no civil recourse shall be available against such member, officer, or agent for payment of the principal, interest, or prior redemption premiums on the Certificates. Such recourse shall not be available either directly or indirectly through the City Council or the City, or otherwise, whether by virtue of any constitution, statute, rule of law, enforcement of penalty, or otherwise. By the acceptance of the Certificates and as a part of the consideration of their sale or purchase, any person purchasing or selling the Certificates specifically waives any such recourse.

Section 12. Repealer. All bylaws, orders, resolutions and ordinances, or parts thereof, inconsistent herewith are hereby repealed to the extent only of such inconsistency. This repealer shall not be construed to revise any such bylaw, order, resolution or ordinance, or part thereof, heretofore repealed.

Section 13. Severability. If any section, subsection, paragraph, clause, or other provision of this Ordinance for any reason is invalid or unenforceable, the invalidity or unenforceability of such section, subsection, paragraph, clause, or other provision shall not affect any of the remaining provisions of this Ordinance, the intent being that the same are severable.

Section 14. Charter Controls. Pursuant to Article XX of the State Constitution and the Charter, all State statutes that might otherwise apply in connection with the provisions of this Ordinance are hereby superseded to the extent of any inconsistencies between the provisions

of this Ordinance and such statutes. Any such inconsistency is intended by the City Council and shall be deemed made pursuant to the Charter.

Section 15. Ordinance Irrepealable. After the Certificates are executed and delivered, this Ordinance shall be and remain irrepealable until the Certificates have been fully paid, satisfied, and discharged, as provided in the Indenture.

Section 16. Effective Date. This Ordinance shall take effect seven (7) days after passage and publication pursuant to Section 6.5 of the Charter.

Introduced and approved after first reading on October 14, 2025, and ordered published in full.

Introduced a second time and approved on October 28, 2025, and ordered published.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

_____

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

F. Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7F.

Presented By
Robert Smith, Director of Economic Vitality

Community Goals
☑ Financial Sustainability and Resilience

Overview

View Correspondence
View Presentation

The purpose of this memo is to present financial information related to the second amendment of the 2025 City and County of Broomfield and the Broomfield Urban Renewal Authority Budgets, financial information related to the proposed 2026 budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District, information related to the proposed increases to utility rates for the Broomfield Enterprise Funds, information related to the proposal of two enterprise revenue bonds and police building and courts remodel certificate of participation, and information related to the Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) programs.

Attachments

Memo for 10_28_2025_2nd Amd to 2025 Budget; Adoption of 2026 Budget (CCOB, BURA, ALID); Utility Rates Ord; URAF; PPTR; Bond Ords.pdf
URAF_2026_RESOLUTION NO. 2025-153.pdf
PPTR_2026_RESOLUTION NO. 2025-154.pdf

Memo for 2nd Amendment to the 2025 Budget and Adoption of the 2026 CCOB, BURA, and ALID Budgets; second reading of amending water, sewer, reclaimed water and stormwater rate ordinance; second reading of two enterprise revenue bonds and police building certificate of participation ordinances; URAF and PPTR programs for 2026
Prepared By: J. Stephanie Chen, Budget Manager

Summary

View Correspondence
View Presentation

Comprehensive Budget Process

The City and County of Broomfield's budget development is a comprehensive, year-long process designed to ensure fiscal responsibility, transparency, and meaningful community and Council engagement. This memorandum represents the culmination of extensive collaborative work that has unfolded throughout 2025, with multiple touchpoints providing City Council and the community opportunities to review, discuss, and shape the financial direction of our organization. This deliberate, methodical approach ensures that budget decisions are informed by current data, community needs, economic conditions, and strategic priorities while maintaining the highest standards of transparency and public accountability.

The Governmental Accounting Standards Board (GASB) sets the accounting and financial reporting standards that state and local governments must follow. Its purpose is to ensure that financial statements are consistent, transparent, and useful to the public, elected officials, and oversight bodies. GASB standards help governments show how public funds are managed, spent, and accounted for, promoting accountability and public trust. Our Broomfield budgets are built using GASB standards, which means our financial reporting and budgeting processes follow the same professional principles used nationwide to ensure accuracy, consistency, and transparency in how we manage public resources.

Year-Long Budget Development Timeline

The 2026 budget process began in early 2025 and has included the following key milestones:

- January-March 2025: Initial financial forecasting and departmental needs assessment
- March 8, 2025: Council Focus Session - 2.C. Conditions of/and influences on Broomfield's economic and fiscal status, 2.H. Anticipated Development and the impacts on fiscal sustainability
- April 15, 2025: Council Study Session - First Quarterly Enterprise Funds Study Session - Council review of enterprise fund status, capital projects, maintenance programs, 2024 financial results, and long-term financial sustainability strategies
- May 8, 2025: Council Study Session - Early introduction to the 2026 budget process and year-to-date financial information
- July 15, 2025: Council Study Session - Second Quarterly Enterprise Funds Study Session - Council review of enterprise fund updates, development projections, and initial utility rate recommendations with subject matter expert consultant AECOM
- August 19, 2025: Council Study Session - Economic and Fiscal Update and Draft Operating and Capital Budgets Study Session - Comprehensive presentation to Council on Broomfield's economic and financial outlook, including CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments
- August 21, 2025: Community Briefing - Public presentation and opportunity for public questions on Economic Long Range Financial Plan and Financial Status Briefing
- September 3, 2025: City Council received the 2026 Proposed Budget and supporting documentation
- September 4, 2025: 2026 Proposed Budget and supporting documents made available for public review and comment on Broomfield.org/Finance
- September 18 and September 25, 2025: Budget Study Sessions with opportunities for public comment - 2026 Proposed Operating & Capital Budgets with department representatives
- October 14, 2025: City Council Meeting - Public Hearing per Chapter 12.7 of the Charter for the 2026

Operating and Capital Budgets, with first reading of key ordinances
- October 21, 2025: City Council Study Session - Final Quarterly Enterprise Funds update of 2025
- October 28, 2025: City Council Meeting - Second reading of ordinances and adoption of budgets (this meeting) with public hearing

Strategic Context and Fiscal Discipline

1. Financial Sustainability and Resilience - Ensuring Broomfield's long-term fiscal health in an uncertain economic environment
2. Transparency and Public Engagement - Providing multiple opportunities for community input and Council deliberation
3. Data-Driven Decision Making - Utilizing comprehensive financial modeling, economic forecasting, and historical analysis
4. Prioritization of Core Services - Focusing resources on mandates, obligations, and critical needs
5. Infrastructure Investment - Addressing deferred maintenance and preparing for future growth
6. Responsible Debt Management - Maintaining our strong credit rating while financing essential capital projects

Summary of Items for Consideration

The City and County of Broomfields budget includes all government operations as well as Enterprise Funds (Water, Sewer, Stormwater and Reuse). The proposed budgets and related documents were available for public review and comment on Broomfield.org/Finance on September 4, 2025.

The staff memorandum from October 14, 2025 regarding the public hearing for City and County of Broomfield (CCOB), Arista Local Improvement District (ALID), Broomfield Urban Renewal Authority (BURA) budgets; first reading of Ordinance No. 2286 amending water, sewer, reclaimed water and stormwater rate ordinance; first reading of two enterprise revenue bonds and police building certificate of participation ordinances (Ordinances No. 2288, 2289 and 2290), included a detailed discussion of the proposed resolutions and ordinances.

It is important to note that the proposed budget is consistent with the October 14, 2025 memorandum and initial proposed budget, with the exception of one change:

- The operational expenditures are expected to increase by 5.8% as opposed to 5.9% due to the combination of a reduction to the amount recommended for the District Attorney (DA) budget discussed during the hearing on October 14, 2025, and a small increase in the budget used for non-profit distributions under the Human Services Fund.

This change is specific to the proposed 2026 budget for CCOB and is reflected in Resolution 2025-142. It does not alter the proposed budgets for BURA or ALID, the water project agreements, enterprise rate ordinance, or any of the bond ordinances considered on first reading during the October 14, 2025 meeting.

The content of this staff memorandum is consistent with the October 14, 2025 memorandum, with additional information provided for the following:

- Information regarding the 2025R Budget - 2nd Amendment.
- Details regarding the non-residential utility rates and license fees for 2026 are provided to clarify what is included in Ordinance 2286 in response to questions from the October 14, 2025 meeting.
- Additional details regarding how the 2025 rate increase was utilized to directly improve water, sanitary sewer, and stormwater resources for Broomfield residents and businesses.
- Details regarding the Utility Rate Assistance Fund program for 2026 as proposed in Resolution No. 2025-153.
- Details regarding the Partial Property Tax Refund program for 2026 as proposed in Resolution No. 2025-154.

City and County of Broomfield Budget

2025 Budget - 2nd Amendment Summary

- The 2025 City and County budget has been amended one time since its adoption to reflect capital project rollovers, grant rollovers, and operational budget adjustments.
- The following attachments are included with this memo to provide fund level details of the 2025 revised budget adjustments. These tables referenced below reflect cumulative prior amendment #1, in addition to the new adjustments in this proposed second (2nd) amendment to the 2025 budget. Revenue and expenditure adjustments (increases and decreases) are also included for reference.
    - 2025 Revised Budget Summary - General Governmental Funds
    - 2025 Revised Budget Summary - Governmental Capital Funds
    - 2025 Revised Budget Summary - Governmental Debt Service Fund
    - 2025 Revised Budget Summary - Enterprise Funds
    - 2025 Revised Budget Summary - Fiduciary Funds
- The second proposed City and County amendment, Resolution No. 2025-141, sets the final 2025 amended budget to reflect expenditures of $775,190,595.

2026 Budget

- The 2026 Proposed City and County of Broomfield Budget has been prepared to reflect expected revenues and expenditures. A set of summary budget tables are included with the resolutions under consideration.
- The 2026 Proposed Budget for the City and County of Broomfield total expenditures are $844,125,005. This amount includes interfund activities and transfers to reserves.
- Tables 1A-4C summarize the 2026 Proposed Budget for the City and County of Broomfield.
- Proposed Resolution No. 2025-142, if adopted, would approve the 2026 Budget for the City and County.

Broomfield Urban Renewal Authority

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2025 Budget - 2nd Amendment Summary

- The proposed BURA budget amendment, Resolution No. 2025-143-UR, is the second amendment proposed since its adoption and reflects unexpended capital improvement project budgets, and revenue adjustments which impacts expense budgets since the adoption of the fiscal year 2025 budget.
    - The proposed BURA budget amendment also reflects a slight decrease in expenditures for a total of $57,118,701.
    - BURA Budget Tables summarize the 2025 revised budget for BURA.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for BURA. In some URAs, planned uses of fund balance are being used for capital expenditures. The BURA proposed total revenues for 2026 are $65,119,746, and the proposed total expenditures are $49,978,125.
    - Tables 1-13 summarize the 2026 Proposed Budget for the BURA.
    - Proposed Resolution No. 2025-144-UR, if adopted, would approve the 2026 Budget for the Broomfield Urban Renewal Authority.

Arista Local Improvement District

The Arista Local Improvement District (ALID) was established in August 2005 to facilitate the construction of transportation facilities in the Arista Development.

2025 Budget - 2nd Amendment Summary

- The 2025 ALID budgeted expenditures have not changed, therefore, no amendment is required at this time.

2026 Budget

- The 2026 Proposed Budget has been prepared to reflect expected revenues and expenditures for the ALID. Attached is a copy of the budget message and budget tables for the ALID for the 2026 Proposed Budget. Anticipated total revenues for 2026 are $45,000. Proposed total expenditures for 2026 are $45,000.
    - Table 1 summarizes the 2026 Proposed Budget for ALID.
    - Proposed Resolution No. 2025-145-AID, if adopted, would approve the 2026 Budget for the Arista Local Improvement District.

Enterprise Rate Ordinance

City Council held quarterly enterprise study sessions on April 15, 2025, July 15, 2025, and October 21, 2025, to review staff's updates on the status of the enterprise funds. The April meeting covered capital projects, maintenance programs, 2024 financial results, steps for ensuring long-term financial sustainability, and the proposed Fiscal Leadership on Water (FLOW) Advisory Committee. The July meeting covered similar topics as well as an overview of development projections and future rate recommendations. The October meeting included an update regarding ongoing capital and maintenance programs for 2025, as well as a presentation from the FLOW Advisory Committee.

City Council also received updates on the Enterprise Funds during the Economic and Fiscal Update held at a Study Session on August 19, 2025. Topics addressed included CIP plan considerations, upcoming bond issuances, Enterprise Fund sustainability, and utility rate adjustments.

In 2025, the City and County of Broomfield implemented the first utility rate increase of a comprehensive five-year financial plan to address the financial sustainability of the enterprise funds. This increase was necessary as the costs of providing safe, reliable water service continued to rise due to aging infrastructure requiring increased maintenance and replacement, new regulatory requirements and unfunded mandates,

and a substantial backlog of critical system repairs and upgrades. Recognizing the financial burden this placed on residents, Council established the Utility Rate Assistance Fund (URAF) to help eligible households manage the impact.

The five-year plan includes a year two increase totaling $16.89 per month for the average single-family home (9,000 gallons) starting in 2026. Staff anticipates that continued adjustments in future years should be expected due to the annual application of the utility's long-range model, the criticality of ongoing infrastructure support, and to accommodate costs from unknown, but anticipated, state and federal mandates. The URAF to help eligible households remains in the budget for 2026, with minor adjustments.

Bond Ordinances

Police Building/Courts Remodel

This item is presented for the City Council's consideration and authorization to issue $100M in bonds to fund the Police Building/Courts Remodel. This financing utilizes Certificates of Participation (COPS), where the City will finance the project's construction by collateralizing existing City facilities via a Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, and Escrow Agreement. A Preliminary Offering Statement, Indenture, and Disclosure Certificate are also required. Selected facilities that will be borrowed against include Paul Derda Recreation Center, the Broomfield Community Center, the Detention Center, and the Service Center Administration Building. The anticipated maximum annual debt payment resulting from the financing will not exceed $7.9M and the annual payments will come from the City's general fund; however, the debt does not create a general obligation debt or multiple-year fiscal obligation, as the annual debt service payment is subject to annual appropriation.

As part of the 2023 property tax revenue increase, funding was designated to support the construction of the new Police building. In collaboration with our financial advisors, staff determined that using the set-aside property tax dollars to retire the 2017 Certificates of Participation (COPs) represents a sound long-term financial strategy. By applying these funds and coordinating the payoff of prior debt, the City can help offset the financial impact of issuing new debt for the upcoming Police and Courts facility. Recent credit rating upgrades and the City's strong financial position further reinforce confidence in our ability to manage debt responsibly.

The term of the financing will mature on or before December 31, 2047. The anticipated net effective interest rate will not exceed 5.50%. Additionally, as part of this financing, the City will also pay off its 2017 Certificates of Participation (COP) that have a current outstanding balance of $10.89M utilizing unencumbered cash on hand. The 2017 COPs were to mature on December 1, 2027. They were originally issued in 2010 to fund facilities needed to provide county services and for parks and recreation activities, and were refinanced in 2017.

Water Tanks

This item is presented for the City Council's consideration and authorization to issue $80M in Water Revenue bonds for funding the new water tanks. Broomfield's water system model identifies capital improvements that will be needed as Broomfield develops, including the construction of the proposed Water Tanks. The model specifically focuses on the phased development of the areas north of W. 144th Avenue that are quickly developing. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $5.9M and the term of the bonds will mature on or before December 1, 2047.
The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Water Activity Enterprise and does not impact the City's general fund. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement.

Related to the issuance of the Water Bonds, staff will be presenting to the City Council on October 28, 2025 as part of agenda item 7(G) - Water Tanks Construction Agreement, proposed Resolution No. 2025-152

authorizing the reimbursement to the water enterprise fund from bond proceeds (if needed) for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to award a construction contract up to the amount of the advanced funds and begin construction before the bonds' closing. It is expected that a construction contract will be presented to the City Council for approval in November and construction to begin on or about January 1, 2026. An amendment to the construction contract would then be presented to the City Council for approval once the bond proceeds are available for appropriation. Construction of the water tanks is projected to last 36 months.

Wastewater Treatment Facility Improvements

This item is presented for the City Council's consideration and authorization to issue $125M in Sewer Revenue and Refunding bonds for funding the Wastewater Treatment Facility Expansion. The anticipated maximum annual debt payment resulting from the bonds shall not exceed $11M and the term of the bonds will mature on or before December 1, 2047. The anticipated net effective interest rate will not exceed 5.50%. The debt will originate from the Sewer Activity Enterprise and does not impact the City's general fund. As a part of this financing, the City will also refund and discharge its 2012 Sewer Revenue Refunding Bonds with an outstanding balance of $15.315M that matures on December 1, 2031. Related documents the City Council will be asked to approve include the Preliminary Official Statement of the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement.

The Wastewater Treatment Facility Improvements are being driven by expected future increases in population and regulatory requirements from the CDPHE that will require significant expansion to the current facility to adequately treat the increase in wastewater and maintain compliance with current and future regulatory requirements. Project drivers include capacity, asset renewal, biosolids, reuse, and regulation. Construction is to begin in 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

This memo will affirm and clarify the planned continuation of the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) programs into the 2026 fiscal year, as outlined in the proposed 2026 Budget for the City and County of Broomfield. These programs are designed first and foremost to support residents experiencing financial burden, while also serving as key components of the City's broader commitment to Council Goals, Financial Sustainability and Resilience, and Organizational Health.

The adjustments provide a summary of operational updates to ensure both programs remain efficient, fiscally responsible, and responsive to community needs within the budgeted resource allocations.

Financial Considerations

2025 Budget - 2nd Amendment

Resolutions 2025-141 and 2025-143-UR outline the financial considerations related to the second amendment to the 2025 budgets for both the City and County of Broomfield and Broomfield Urban Renewal Authority.

2026 Budget

Resolutions 2025-142, 2025-144-UR, and 2025-145-AID outline the financial considerations related to the adoption of the 2026 Budgets for the City and County of Broomfield, the Arista Local Improvement District, and the Broomfield Urban Renewal Authority.

Enterprise Ordinances

Ordinance No. 2286 Amending Water, Sewer, Reclaim Water, and Stormwater Fees outlines the financial considerations related to this agenda item.

Bond Ordinances

Ordinance No. 2288 upon approval, authorizes debt financing of up to $80M for the Water Tanks and

approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, and Bond Purchase Agreement related thereto.

Ordinance No. 2289 upon approval, authorizes debt financing of up to $125M for the Wastewater Treatment Facility Improvements and approves as to form the Preliminary Official Statement for the Bonds, Paying Agent Agreement, Disclosure Certificate, Bond Purchase Agreement, and Escrow Agreement related thereto.

Ordinance No. 2290 upon approval, authorizes debt financing of up to $100M for the Police Building/ Courts Remodel and approves as to form the Preliminary Official Statement, Indenture, Site Lease Agreement, Lease Purchase Agreement, Sale Certificate, Disclosure Certificate, Escrow Agreement related thereto.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Programs

Resolution 2025-153 outlines the financial and programmatic considerations related to the Utility Rate Assistance Fund (URAF) Program.

Resolution 2025-154 outlines the financial and programmatic considerations related to the Partial Property Tax Refund (PPTR) Program.

Prior Council or Other Entity Actions

2025 Budget

October 22, 2024: Council approved Resolution 2024-149 adopting the 2025 CCOB Budget; BURA approved Resolution 2024-150-UR adopting the 2025 City and County of Broomfield Budget
March 11, 2025: Council approved Resolution 2025-44 amending the 2025 CCOB Budget; BURA approved Resolution 2025-52-UR amending the 2025 BURA Budget

2026 Budget

August 19, 2025: Staff provided information and insights to inform the Council on Broomfield's economic and financial outlook, influencing the 2025 revised budget and the 2026 operating and capital proposed budgets.
August 21, 2025: Staff provided an overview of how Broomfield intends to fulfill the community goal of financial sustainability and resilience at the Broomfield 101: Economic and Fiscal Update Community Forum.
September 3, 2025: The City Council received the 2026 Proposed Budget and supporting documentation.
September 4, 2025: The 2026 Proposed Budget and supporting documents were made available for public view and comments on the City's website.
September 18 and September 25, 2025: Study Sessions to discuss the 2026 Proposed Operating & Capital Budgets with department representatives.
October 14, 2025: Public Hearing per Chapter 12.7 of the Charter for the 2026 Operating and Capital Budgets for the City and County of Broomfield, Broomfield Urban Renewal Authority and the Arista Local Improvement District.

Enterprise Ordinances

April 15, 2025: Staff held the first 2025 quarterly Enterprise Funds study session and provided an overview to City Council on the status of the enterprise funds.
May 13, 2025: Creation of FLOW Advisory Committee approved by City Council.
July 15, 2025: Staff held the second 2025 quarterly Enterprise Funds study session, providing an update on the enterprise funds and initial recommendations on utility rate adjustments, along with a presentation by subject matter expert consultant AECOM.
October 14, 2025: First reading of ordinance number 2286.
October 21, 2025: Staff will provide an overview to City Council in a Broomfields Enterprise Funds study session and initial results of additional repair and replacement capital added during the 2025 budget.

Bond Ordinances

August 19, 2025: Staff provided information and insights to City Council on Broomfield's high credit rating

and the organization's "superior ability to repay short-term debt obligations," providing guidance to ensure Broomfield's financial stability while requesting new bonds to finance the 2026 capital improvement projects for the new Police Building / Courts Remodel and Water and Sewer infrastructure improvements.
October 14, 2025: First reading of ordinance numbers 2288, 2298, and 2290.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
November 1, 2022: Council Approved the 2023 PPTR Program with Resolution No. 2022-123.
January 23, 2024: Council Approved the Expansion of the PPTR Program in 2024 with Resolution No. 2024-27.
October 22, 2024: Council Approved the URAF Program with Resolution No.2024-165.
October 22, 2024: Council Approved the 2025 Budget with Resolution No. 2024-149.
December 3, 2024: Council Approved the 2025 PPTR Program with Resolution No. 2024-105.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

2025 and 2026 Budget
If Council desires to approve the proposed 2025 budget amendment, the appropriate motion is...
That Resolution 2025-141 be adopted.

If Council desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-142 be adopted.

If BURA desires to approve the proposed 2025 budget amendment, the appropriate motion is…
That Resolution 2025-143-UR be adopted.

If BURA desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-144-UR be adopted.

If ALID desires to approve the proposed 2026 budget, the appropriate motion is…
That Resolution 2025-145-AID be adopted.

Amending Enterprise Ordinance

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2286 be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to water, sewer, water reclamation, and stormwater charges and fees as set forth in these ordinances would be effective January 1, 2026.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If the Council desires to approve the changes to the Broomfield Municipal Code, the appropriate motion is…

That Ordinance No. 2288 Issuing Enterprise Revenue Bond (Water Tanks) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2289 Issuing Enterprise Revenue Bond (Wastewater Treatment - Phase 1B) be adopted on the second and final reading and ordered published in full.

That Ordinance No. 2290 Issuing Certificates of Participation (Police and Courts Buildings) be adopted on the second and final reading and ordered published in full.

Effective Date: If approved, changes to the Broomfield Municipal Code related to the issuance of new bonds as set for in the ordinances would be effective January 1, 2026.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program

If the Council desires to proceed with the staff recommendations for the continuation of the Utility Rate Assistance Fund Program in 2026, the appropriate motion is…

That Resolution 2025-153 be adopted.

If the Council desires to proceed with the staff recommendations for the continuation of the Partial Property Tax Refund Program in 2026, the appropriate motion is…

That Resolution 2025-154 be adopted.

Alternatives

Budget

Per Charter, the City Council must adopt a budget. If it fails to do so, the budget will be put on future agenda(s) until such time as it is approved. If Council fails to adopt the budget, the amounts appropriated for the operation of the current fiscal year shall be deemed adopted for the next fiscal year on a month-to-month basis, with all items in it prorated accordingly, until such time as the Council adopts the budget for the next fiscal year.

Amending Enterprise Ordinance

If Council does not approve the recommended utility rate ordinance, the existing fee structure would remain in place. CCOB's Enterprise funds' financial sustainability and resiliency would weaken. The ability to obtain favorable financing for necessary projects, including wastewater treatment facility expansion and water tanks, would be put at risk.

Two Enterprise Revenue Bonds and Police Building Certificate of Participation Ordinances

If Council does not approve the recommended two enterprise revenue bonds and police building certificate of participation ordinances, CCOB would not defease the existing certificates of participation and would not move forward with the issuance of the bonds. CCOB would not be able to finance the necessary projects, which include the Wastewater Treatment Facility Expansion, Water Tanks, and new Police Building.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program
Do not approve staff recommendations. If not approved, provide an alternative direction.

Background - Budget

Broomfield has grown and evolved significantly over the past twenty years from an emerging suburban community into a large, thriving, and maturing urban-suburban community. Since the consolidation of our community in 2001, Broomfield has provided effective and efficient city and county programs and services. Today, Broomfield is home to nearly 80,000 residents, living in more than 34,000 housing units and thousands of businesses. While much of Broomfield's 34 square miles is built out, there is a continued focus on developing and evolving while maintaining long-term financial sustainability and resilience.

Budget Process and Philosophy

The budget is a planning tool that is used to meet the results of the March 3, 2023, Council Focus Session, where the Community Goals were solidified with an emphasis on Goal #1: Financial Sustainability and Resilience. Therefore, the budget process is flexible and responsive to organizational and community needs and economic conditions.

In addition, staff will continue with a comprehensive, clear, and transparent approach by bringing forth a consolidated number of budget amendments for the Council's review and consideration, and for transparency for Broomfield residents. Each budget amendment is designed to address specific topic areas outlined below.

- **Budget Amendment 1** (Q1): reflects the carryover of capital and grant projects from the prior fiscal year and any additions to operational budgets (i.e., increased cost for Spring Cleanup).

- **Budget Amendment 2** (In conjunction with adopting the following fiscal year's budget; Q4): reflects the current state of actual revenues and expenditures, including any supplemental requests, and sets the foundation for the following year's budget.
  This amendment also includes the prior year's audited financials (actual beginning fund balances), which helps inform the ability to fund future year financial shifts.

- **Budget Amendment 3** (Q4): if needed, addresses grants, which often require financial adjustments based on project or program status of implementation and execution due to the timing of the grant award.

Current and future budgeting processes are designed to ensure operational and capital success, focusing on creating a culture of accountability and intentionality while basing the budget on revenue and expenses. This helps to drive forward a sustainable, disciplined structure of reallocating funds and not continuing to increase expenditures arbitrarily.

Proposed Budgets

2025 Revised Budget Summary

On October 22, 2024, City Council passed Resolution 2024-149 to adopt the 2025 budget for the City and Council of Broomfield. Additionally, the Broomfield Urban Renewal Authority approved resolution 2024-150-UR to adopt the 2025 budget for BURA. Since the adoption, the budgets have been amended one (1) time to reflect capital project rollovers, grant rollovers, and additional capital and operational budget adjustments. As can be seen in the table below, adjustments to the City and County of Broomfield budget in amendment #1 is listed as well as the proposed adjustments in amendment #2.

CITY AND COUNTY OF BROOMFIELD
REVISED BUDGET SUMMARY - ALL FUNDS*

Fund	Original Budget 2025	Budget Amendments #1 2025	Budget Amendment #2 2025	Amended Budget 2025
Beginning Fund Balance	**$ 304,842,581**			**$ 408,834,091**
Revenues				
General Governmental Funds	$ 201,022,977	$ 14,388,112	$ 13,956,978	$ 229,368,067
Governmental Capital Funds	89,039,461	18,228,553	9,687,422	117,955,436
Enterprise Funds	83,761,446	(1,479,300)	(4,564,126)	77,718,020
Fiduciary Funds	223,100,356	-	-	223,100,356
Total Revenues	**$ 596,924,240**	**$ 31,137,365**	**$ 19,080,274**	**$ 648,141,879**
Expenditures				
General Governmental Funds	$ 216,385,986	$ 13,140,495	$ 5,475,993	$ 235,002,474
Governmental Capital Funds	103,310,912	73,107,734	4,355,292	181,773,938
Enterprise Funds	99,516,325	47,506,010	(2,731,036)	144,291,298
Fiduciary Funds	214,122,885	-	-	214,122,885
Total Expenditures	**$ 633,336,108**	**$ 133,754,239**	**$ 7,100,248**	**$ 775,190,595**
Ending Fund Balance	**$ 268,430,713**			**$ 281,785,375**

** Excludes transfers to reserves and interfund transfers*

2025 Operating and Capital Fund Revised Budget

Budget adjustments are made in order to respond to the changing demands of our operations in addition to the continued economic fluctuations occurring at the local, state, and national levels. In 2025, the City and County of Broomfield eliminated what had traditionally been the second amendment of the year. The Finance Department worked directly with departments to discuss needs and work strategically to accommodate needs by reallocating current budgets while continuing to monitor throughout the year to determine if budget adjustments were actually needed. Based on this collaborative effort, staff have been able to reduce the overall workload within the organization and minimize the number of times the budget needs to be reviewed, adjusted and considered by City Council.

The proposed operating fund budget adjustments include both personnel and non-personnel adjustments for programs and initiatives. While capital fund adjustments are the result of revising capital projects due to aspects such as timing or changes in project priorities since the adoption of the 2025 5-Year CIP Plan. The table below includes highlights of operational revisions to the 2025 budget.

2025 Revised Budget Highlights*		
Department or Category	**Description**	**Amount**
City & County Attorney	2025 Increase for Insurance Premiums	$ 70,000
Courts	Above Mid-Point Pay Request: Lead Court Clerk Hire	4,142
Human Resources	New Full-Time FT: HR Project Manager	71,498
Police	Increase to Axon Agreement	234,625

Police	Increase to Inmate Food Services Contract	172,050
Police	Increase to Psychological Support Contract	50,000
Police	Dual Sim Card Monthly Fees with First Net	36,500
Police	Inmate Medicine Expenses	38,252
Police	Outside Fund Award Funded Motorola Service Agreement for Back Up Dispatch Center Equipment	12,775
Police	Brower Resilience Visits	2,500
	Total	**$ 692,342**
*Personnel Highlights are pro-rated for partial year		

The 2025 revised operating budget includes a number of cost increases associated with existing contractual obligations. The 2025 budget process was completed in the middle of 2024, prior to a number of contractual amendments being executed, so adjustments are made during the 2nd amendment to appropriate the additional funds needed to meet these obligations.

In addition to the Budget Highlights noted above, the 2025 revised operating budget also includes a number of non-personnel budget reductions as part of the organization's efforts to optimize budgets. Travel and training budgets were reduced by $859,813 and other identified non-personnel budgets were reduced by $1,041,450. This effort was collaborative across the entire organization, with a focus on maintaining services to residents.

In total, staffing levels and service demands resulted in the addition of 4.13 FTE in 2025, as detailed in the Expenditures: 2025 Personnel Changes table.

Expenditures: 2025 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
City & County Manager	1.00	303,987	Economist (1.0FT), Administrative Analyst (1.0FT), Case Manager II - Housing (-1.0FT)
Community Development	-1.00	(133,296)	Senior Transportation Planner (-1.0FT)
Economic Vitality & Development	-2.00	(254,758)	Economist (-1.0FT), Administrative Analyst (-1.0FT), Administrative Support I/II LTA (2.0FT), Administrative Support I/II LTA (-2.0FT)
Human Resources	1.00	65,533	HR Project Manager (1.0FT)
Human Services	2.80	172,795	Case Managers II LTA (2.0FT), Case Manager II LTA (-2.0FT), Case Manager II (1.0FT) Workforce Specialist II LTA (0.8PT), Human Services Management Analyst (-0.8), Non-Profit & Community Engagement Manager (1.0), Human Services Grants Specialist (0.8)
Library, Arts & History, and CSU Extension	0.33	(1,718)	Creative Technologist (-0.8PT), Patron Services Associate (1.0FT), Creative Technologies (-0.6PT), Patron Services Associate (0.73PT)
Public Health & Environment	0.00	(2,845)	Human Services Management Analyst (-0.2), Human Services Grants Specialist (0.2)
Total	**4.13**	**$ 149,698**	
*Includes internal transfers. Costs prorated for partial year. Public Works to Public Works / Water Utilities reorganization is not included.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and estimated taxes and benefits			

2025 Broomfield Urban Renewal Authority Revised Budget

This is the second amendment to the 2025 BURA budget. This amendment reflects updated revenues and expenditures projected through the end of the year based on year-to-date information. The BURA Budget Tables summarize the 2025 proposed revisions to the budget.

2025 BURA Revenues - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 70,511,588	$ 605,615	$ 71,117,203
Debt Service	5,056,106	(607,935)	4,448,171

2025 BURA Expenditures - Amendment #2			
Fund	**2025 Original Budget**	**Budget Revisions**	**2025 Revised Budget**
General Operations	$ 54,215,747	$ 2,902,954	$ 57,118,701
Debt Service	4,459,171	-	4,459,171

2026 Proposed Budget Summary

Planning for Increased Financial Stability

The City and County are guided by conservative revenue projections, reasonable cost assumptions (expenses), deploying strategic development decisions, effectively managing staffing patterns, and using

data-driven decision-making models to keep operational costs in check.

Transitioning into 2026, Broomfield's economic and financial position is fundamentally sound, but we remain in an ever-increasing volatile environment. This reality reinforces the need for prudent financial flexibility, conservative planning assumptions, and disciplined decision-making to ensure long-term sustainability.

Broomfield's two largest primary revenue sources are property tax and sales/use tax, with sales tax showing minimal growth in 2025 (measured at the halfway point through the year, sales tax is projected to end 1-2% higher than 2024). The minimal sales tax growth is expected to continue to build in 2026, a trend anticipated to continue into 2027. Additional retail and commercial investments in the pipeline begin to come online in 2027 (e.g., Macerich's HiFi area at FlatIron and the initial phase of McWhinney's Center Street area). Conversely, the property tax revenue is expected to fall in 2026 and remain stable in 2027. The property tax revenue reduction is occurring due to State changes in the property assessment rates and the decline in property market values.

Due to decreased property assessment rates, property owners will see lower tax bills, which correlates to the decreased county property tax revenue by approximately $6.5-7.5 million annually. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

The 2026 proposed budget reflects the organization's continued focus on balancing current needs and obligations while preparing to meet the organization's and community's future needs by prioritizing expenditures into Mandates, Obligations, and Critical needs. Broomfield's economic fundamentals continue to provide sustained economic and employment opportunities while ensuring a sound fiscal base for CCOB budgets.

Guiding Principle: Residential Growth and Service Capacity

Broomfield currently has the revenue to sustain current service levels, but each new residential development adds demand and costs to systems already operating near capacity. Sales tax revenue growth—expected as new commercial development comes online in 2027—will help, but will not fully offset rising expenditures. Property taxes remain outside local control and subject to state formulas and market values; those factors created a $6.6M - $7.5 decrease in general fund revenue, which is not anticipated to return.

Balancing Housing Needs with Community Capacity

While the Front Range continues to face an affordable housing shortage that calls for regional solutions, Broomfield must thoughtfully balance this need with our community's existing capacity. Demand for services is strong — recreation programs often fill quickly, fields are well used, the Library serves at or near capacity, and our core utilities, such as the wastewater treatment facility, are preparing for future growth. Broomfield has also made prior commitments to additional residential development through business development agreements. Looking ahead, future decisions will shape how we continue to provide high-quality services, invest in infrastructure, and remain fiscally responsible, while also contributing to broader housing solutions across the region.

Disciplined Development and Long-Term Financial Sustainability

Broomfield continues to take a thoughtful, yet disciplined, approach to development as the foundation for achieving long-term financial strength and sustainability. Our strategy emphasizes balanced growth and a diversified economy—ensuring that both residential and commercial development occur in alignment with community needs and fiscal realities.

Maintaining and strengthening the ratio of residential to commercial development is paramount as we move into the future. A healthy balance not only supports a diversified tax base and resilient economy but also ensures that service demands and infrastructure investments are financially sustainable over time.

By adhering to this disciplined approach, Broomfield positions itself to manage near-term fiscal challenges

while preserving the flexibility to invest in community priorities and future opportunities.

Broomfield recognizes that a strong community is made up of thriving neighborhoods and residential areas, combined with commercial areas and developments home to businesses in key sectors, such as finance, information technology, aerospace, and business/professional services. Broomfield is also successful in attracting and growing businesses in next-generation economic sectors, such as quantum computing, phonetics, and advanced manufacturing. Recent firms choosing and growing in Broomfield include Sierra Space, SiNaptic, Quantinuum, and Raven Space Systems.

Development and increasing redevelopment in the community continue to build on this economic and financial foundation. These developments provide sought-after locations for businesses to locate and grow, places for residents and visitors to shop, dine, and gather, and places where existing and new residents will call home. Current construction is underway around FlatIrons Crossing (the HiFi area: both the Novel FlatIron residential and new commercial space), MidPoint's flex/innovation space (255 Midway), the Simms Technology Park, and Harvest Hill apartments. Horizontal construction will soon start in Baseline's mixed-use Center Street development. Combined, these current developments total nearly 500 new residential units (over 200 income-aligned), about 500,000 square feet of new work space, and over 100,000 square feet of (already leased) shopping and dining space.

The 2026 proposed spending plan recognizes that our community looks to its local government as innovators and leaders. It supports this influential work by refocusing and committing to the identified Community Goals, with the fundamental goal of Fiscal Sustainability remaining paramount to a healthy and robust future.

Emphasis on Prioritizing Needs

As Broomfield continues to maintain economic and fiscal stability, our strategic approach includes a prudent and pragmatic fiscal approach to anticipate and withstand future economic or financial disruptions in the short and long term.

The proposed 2026 budget prioritizes expenditures in the following categories:

- **Mandates**: Regulatory requirements issued by the federal or state level that result in the need for funding.
- **Obligations**: Contractual requirement or agreement.
- **Critical Need**: This is essential to the organization's effective operations. Failure to fund it would threaten public health, the environment, or community safety, or create a more significant liability or risk to the organization.

Any funding request not categorized by a mandate, obligation, or critical need but necessary to provide ongoing programs and services would be defined as an 'other' this year. In 2026, only projects classified as 'other' that were moved forward were partially funded by grants.

The 2026 Recommended Budget reflects a collaborative effort across all departments. New services and their associated costs will be strategically timed for review only when budget flexibility improves – something not anticipated in 2026, and possibly not until the second half of 2027.

All departments determined needs based on the following high-level categories and corresponding thought-provoking questions, serving as the foundational lens through which all budgeting and resource allocation requests were reviewed:

- **Safety**: Eliminating or reducing a hazard/threat
- **Operational Cost vs. Revenue**: Is there a revenue offset that will help reduce costs?
- **Asset Maintenance**: Ability to extend the life cycle of a current asset
- **Comprehensive Plan**: Approach and alignment with existing roadmap

- **Operational Support**: Will the request create additional demand on existing resources or require new support?
- **Alternatives**: Does the alternative require greater resources, financially or otherwise?
- **Cost Sharing Opportunities**: Ability to leverage outside funding awards
- **Urgency**: Is there an immediate need that the request will satisfy?
- **Public Benefit & Quality of Life Impact**: Ability to benefit across various sectors
- **Socio-Economic Equity**: Determining the applicability within Broomfield's vulnerable populations or underrepresented
- **Sustainability**: Ability to address/correct the construct that will benefit the environment

For the fifth consecutive year, staff recommends maintaining Public Safety, Public Works, and Water Utilities as a top priority while continuing to adapt to growth, addressing deferred maintenance while moving forward with an asset management approach, and shifting to new and long-term fiscal realities.

Public Safety

This commitment is demonstrated by keeping the Broomfield Police Department organizationally separate from general employee groups. This approach has enabled the City and County of Broomfield to strengthen its police force effectively, resulting in a substantial increase in essential personnel to better serve the community. The Full-Time Equivalents (FTEs) grew from 242 in 2021 to 277 in 2025, a 14% increase. Concurrently, the police budget expanded from $34 million in 2021 to $44 million in 2025, marking a 27% increase. This investment is directly linked to Broomfield maintaining the lowest crime rate per capita in the metro area.

District Attorney – 17th Judicial District

The proposed budget for Broomfield's population share of the District Attorney's office is based on preliminary calculations received from Adams County in August 2025. On August 12, 2025, the District Attorney submitted his budget documents to Broomfield staff. Following that submission, Broomfield requested a meeting with the Adams County Board of Commissioners and leadership to discuss the request.

This meeting, held in mid-September, included the Mayor, Mayor Pro Tem, City Manager, and City Attorney. The discussion focused on the scope of services included in the DA's request, as well as the Family Justice Center, which is addressed in greater detail below.

Adams County is also in the process of finalizing its budget. On October 1, 2025, the District Attorney presented his budget request to the Adams County Board of Commissioners; however, the Board has not yet approved the request. Broomfield staff attended the presentation and will continue to monitor developments to ensure Broomfield's final budget reflects only its proportional share of approved expenses.

Broomfield's proposed budgeted amount for the DA reflects a budgeted amount that does not include costs for the proposed Family Justice Center (FJC). Per statute, Broomfield is only responsible for its per-population share for "the necessary expenses of maintaining an office for the transaction of official business" of the District Attorney.

While the intent of the FJC is admirable, the District Attorney has indicated that 75% of individuals to be served will be non-judicial clients. This represents not an expansion of existing prosecutorial services, but rather the creation of an entirely new entity, infrastructure, and team, as shown by 9 FTE in his budget request to Adams and Broomfield counties. While there is a connection with the domestic violence case work completed by the DA's office, this is a separate endeavor that warrants further scrutiny and should be subject to discussions about the creation of a regional and distinct intergovernmental entity before Broomfield commits taxpayer resources.

In addition, the revised proposed budgeted amount for the District Attorney does not include the cost of one FTE (an attorney) that Broomfield has solely funded since 2021 to reduce backlog following COVID. This was

a separate agreement with the DA, and three years later, after that backlog has been addressed, that cost should not be part of the base budget.

Public Works and Water Utilities

Our focus on infrastructure over the past several years has led to significant growth in resources dedicated to roads, streets, maintenance, and water. Full-time equivalents (FTEs) increased from 158 in 2021 to 220 in 2025 – a 39% rise (note: this includes 14 FTEs transferred to Public Works/Water Utilities from Community Development and Strategic Initiatives related to Construction Inspections and Energy and Sustainability, respectively). Investments in Public Works and Water Utilities have enabled staff to optimize infrastructure, boost productivity, and better manage assets. This directly impacts overall operations and effectiveness.

Broomfield has made major strides in core infrastructure and utility maintenance over the past five years. The Street Pavement Management Program expanded significantly, with more miles treated and a dramatic increase in crack sealing. Water Utilities strengthened operations with annual waterline replacements, full fire hydrant flushing and maintenance, and near-complete valve maintenance. The Sewer Collections Program has advanced to completing annual program system cleaning and inspection on a regular cycle. Meanwhile, the Stormwater Maintenance Program, established in 2021, now conducts annual program system cleaning and inspections each year. These operational improvements are supported by a five-year financial sustainability plan that ensures the long-term health of infrastructure, high-quality service delivery, and protection of public health and the environment.

Given the challenges and uncertainty in the economy and marketplace, the 2026 Proposed Budget relies on conservative fiscal policies and projections supporting balanced annual spending. The 2026 Proposed Budget was built using a combination of Council direction with existing planning documents, including, but not limited to, the Comprehensive Plan, the Long Range Financial Plan, and financial/economic modeling, to synthesize the work over the past several years of taking a comprehensive methodological approach to Broomfield's future.

2026 Areas of Focus & Key Highlights

- Broomfield has not acquired any additional general obligation (GO) debt since 2017. Broomfield will be defeasing prior debt and remains committed to maintaining and increasing our existing Aa2 bond rating, which means the organization has a "superior ability to repay short-term debt obligations." The rating is one of the highest within the state of Colorado. This high rating is essential. Having debt of 5% of revenues is considered appropriately leveraged and reflects the government's ability to repay debt.
- Broomfield will continue to leverage grant funding as part of efforts to diversify revenue sources. In 2025, overall, less grant revenue was available on the Federal and State levels. As of August 2025, CCOB has received 91 grants, representing an increase from 69 grants in 2024. This total reflects both new grant applications and recurring awards that continue from year to year. In 2025 alone, more than 35 new grant applications have been submitted, with 28 awarded to date. These awards total approximately $5.6 million, compared to $4 million last year. We will continue to seek grants in 2026 to pursue funding from private, local, and state sources. New grant funding to be explored in 2026 includes: Courts' First Defense Counsel Appearance, incentives for Norm Smith UST removal reimbursement, the Recycling Rebate Program, and Special Supplemental Nutritional Funds for Women, Infants, and Children (WIC).
- Police Facility construction is anticipated to begin in early 2026.
- Courts Remodel design to begin in 2026.
- Maintain the achieved goal of 20% reserves into 2026 and future years.
- Continue to explore opportunities for development of the former Event Center site: This development is expected to be a revenue generator for the community.
- Implementation of the selected City and County Enterprise Resource Planning (ERP) Software that will modernize our existing 30+ year manual/spreadsheet system to begin early 2026.
- Update the 2016 Comprehensive Plan in 2026, providing the Council, community, and our

organization an opportunity to play a critical role in shaping the vision for the next decade and beyond.
- Implementing the first organizational strategic plan to guide the 2026 work plan.
- Issuance of three bonds: Quarter one 2026, Certificate of Participation for the PD/Courts, and two in the Enterprise Funds for the Water Tanks & Wastewater Expansion - Phase IB.

This list alone requires us to be especially prudent in the upcoming year and beyond. We are operating in a constrained environment – both financially and with staffing capacity – and must therefore be intentional and strategic in every decision we make. The 2026 and 2027 budgets will require a reallocation methodology, not a reprioritization model – meaning that to add anything, other programs must be reduced or removed to accommodate new or enhanced funding. As we gain clearer insights into programmatic outcomes, we must be willing to have courageous conversations about whether programs and services are being fully maximized, widely utilized, effectively measured, and delivering the intended outcomes. If they are not, we must work together to thoughtfully realign our efforts and resources toward initiatives that deliver the greatest benefit to our community.

2026 Budget Highlights

Revenue Projections

Broomfield's two largest primary revenue sources are property tax and sales/use tax, accounting for 60% of Broomfield's revenue base. Sales tax is showing minimal growth for 2026. The minimal growth in sales tax is a trend anticipated to continue into 2027, while retail and commercial investments in the pipeline begin to come online in late 2027 (ie, Macerich development).

Conversely, the property tax rates are not expected to move in any direction but downward. Due to decreased property assessment rates, property owners will see lower tax bills. This reduction will decrease county property tax revenues by approximately $6.5-7.5 million annually – $3-4 million from residential properties and $3.5 million from commercial properties. This revenue decline is expected to be long-term, representing the new baseline for county property tax collections.

Across all revenue streams[1], 2026 projected revenues are expected to increase by 5.2% from $332 million to $349 million compared to the 2025 revised budget per Table 1C of the proposed budget. This increase is primarily driven by anticipated revenues from Fiber contracts, building permits and use tax revenues.

The 2026 proposed budget was built with the projected increases in Utility Rates for water, sewer, reclaimed water, and stormwater.

Expenditure Projections

Broomfield continues to monitor the ongoing uncertainties surrounding the economic environment and is prepared to react as needed. The budget process is an example of staff working collaboratively to mitigate the impacts of these uncertainties.

Operational expenditures are expected to increase by 5.8% from the 2025 original budget to the 2026 proposed budget.

Total expenditures (Table 3B), which include the operating, capital, additions to reserves, and debt service obligations across all funds, is an estimated $897 million, excluding inter-fund transfers. This represents an increase of 41% in expenditures from the 2025 original budget to the 2026 proposed budget. This increase is primarily driven by large capital projects, such as the new Police building, Court building remodel, and the Water and Sewer projects.

Personnel

Over the last four years, Broomfield has implemented a market-driven, competitive compensation philosophy to lead the market. This was based on the legal requirements to comply with new federal equal pay mandates and aligned with the City Council's direction on employee compensation. In year five, Broomfield is working to maintain the progress while navigating economic uncertainties. Human Resources completes market evaluations every other year to ensure positions within CCOB are paid competitively against the Denver Metro market. This data is used to project salaries and personnel costs for the proposed budget. In 2026, Human Resources will not be conducting market evaluations.

Ongoing personnel costs and adding new positions to meet the community's needs are the primary drivers of the 5.8% operational budget increase referenced in the expenditures section.

Below is a list of the Personnel Changes implemented as part of the 2026 operating budget.

1Excludes Fiduciary Funds and Budgeted Bond Revenues

Expenditures: 2026 Personnel Changes*			
Department	**FTE Change**	**Personnel Costs****	**Notes**
Human Services	0.10	13,463	Business Solutions & System Administrator (0.1FT)
Information Technology	-1.00	-	Accessibility Specialist LTA Expiration (-1.0FT)
Parks, Recreation, & Senior Services***	2.25	219,958	Lead Parks Tech (1.0FT), Parks Tech II PT to FT (0.25FT), Preschool Director (1.0FT)
Public Health & Environment	0.40	18,982	Business Solutions & System Administrator (-0.1FT), Administrative Support II PT to FT LTA (0.5FT)
Water Utilities	3.00	334,561	Cross Connection Foreman (1.0FT), Senior Water Utilities Locator (1.0FT), Senior Sewer Utilities Locator (1.0FT)
Total	**4.75**	**$ 586,964**	
*Includes internal transfers.			
**Personnel Costs are based on 2025 Actual for filled positions and Mid-Point for vacant positions and est. taxes and benefits; does not include any non-personnel budgets associated with new FTE			
***Department has self-funded these positions with budget realignments - reducing temp and non-personnel budgets			

Non-Personnel

Non-personnel-related expenses include the supplies, equipment, and contractual service costs necessary to provide the programs and services in Broomfield. Some examples include:

- Fuel
- Vehicle Maintenance Supplies (i.e. air & oil filters, tires, etc)
- Electronic Equipment (i.e. telephones, computers, headsets, etc)
- Training and Development of staff
- Professional Services (i.e. outside auditors, specialized legal services)
- Insurance expenses
- Utilities
- Software (Annual License Fees, such as Google)

As part of the annual budget process, the budget staff meets with departments to discuss non-personnel requests and the drivers of individual items. Items like fuel are a basic necessity for the organization to accomplish its work and are subject to market conditions; thus, Broomfield has very little control over this type of expenditure. For other non-personnel items, the organization manages costs by finding alternatives or adjusting work procedures to eliminate or minimize expenses wherever possible.

Operating Budget Highlights

Below is a list of some highlights of the 2026 operating budget.

2026 Operating Budget Highlights		
Department or Category	**Description**	**Amount**
Assessor	One (1) 5-Month Overlap (Assessment Supervisor)	$ 66,708
City and County Clerk	Two (2) 2-Month Overlap (Recording & Motor Vehicle Specialist, Recording & Licensing Specialist)	25,141
City & County Manager	Hazardous Mitigation Plan Update - FEMA Mandate	65,000
Community Development	Two (2) Reclassifications (Senior Landscape Architect to Landscape Manager, Combination Inspector to Landscape Associate/Tech)	54,272
Parks, Recreation, & Senior Services	One (1) FT (Lead Parks Technician)*	-
Parks, Recreation, & Senior Services	One (1) PT to FT (Parks Technician II)*	-
Parks, Recreation, & Senior Services	One (1) TM to FT (Preschool Director)*	21,401
Police	One (1) FT Continuation (Victim Advocate) if Grant is discontinued	112,712
Police	Three (3) Reclassifications (Records Specialist to Records Supervisor, Budget Analyst to Budget Supervisor/Manager, Office Manager to Senior Operations Manager)	73,871
Public Health & Environment	Personnel Costs Transitions	(8,555)
Public Health & Environment	One (1) PT to FT LTA (Admin Support II)	33,899
Public Health & Environment	One (1) Reclassification (Environmental Health Specialist I to Environmental Health Specialist II)	5,953
Water Utilities	Three (3) New FT (Cross Connection Foreman, Senior Water Utility Locator, Senior Sewer Utility Locator)	381,107
Water Utilities	SCADA Environment Security Scanning Software (w/IT)	69,571
	Total	**$ 901,081**
*Department's non-personnel budget will be reduced for the personnel changes		

2026 Capital Improvement Plan Considerations

Using a conservative approach and understanding the constraints of Broomfield's finances, staff will continue to evaluate and prioritize projects based on mission essentials and those that affect the health and safety of the community. To proactively prevent unintended consequences with any changes in the funding of CIP, staff will continue to seek guidance from Council.

The 2026 Five Year Capital Improvement Project (CIP) Plan was developed in a parallel process at the same time as Broomfield's operating budgets. This process included an extensive year-long collaboration across all departments to ensure that all projects and community requests were considered. CIP requests are rated and prioritized using the same "buckets" described earlier in the document. Ensuring that our limited resources are focused on mandates, obligations, and critical infrastructure projects reinforces our financial sustainability and resilience goal. Finally, staff has worked to shift the focus of funding from new capital projects towards preventative maintenance, repair, and rehabilitation to ensure that Broomfield is focusing efforts on adequately addressing its existing infrastructure.

The 2026 budget for Capital Projects includes

- $142.9 million in expenditures for the General Governmental Funds
  - $100 million for the Police Building and Courts remodeling projects
- $217.2 million in expenditures for the Enterprise (Utility) Funds.
  - $70 million for the two new Water Tanks project
  - $114 million for Wastewater Treatment Facility Expansion Project

2026 Broomfield Urban Renewal Authority Budget

The Broomfield Urban Renewal Authority (BURA) was organized to finance various improvement projects within the Authority's boundaries. Incremental tax revenues, including sales, use, and property, are the primary funding sources for BURA.

2026 BURA revenues are budgeted at $65.1 million, representing a 7.7% decrease compared to the 2025 original BURA budget. BURA expenditures in 2026 are budgeted at $50.0 million. BURA also pays the City and County of Broomfield to cover administration costs and professional services related to the development of urban renewal areas. The 2026 budget includes $5.5 million for administrative and professional services expenditures.

2026 Arista Local Improvement District Budget

The Arista Local Improvement District (ALID) was established to facilitate the construction of transportation facilities in the Arista Development. The ALID is supported by a 0.2% sales tax collected on all taxable sales within its boundaries, and the revenue generated by the tax has been pledged to support the Arista Metro District's (AMD) debt service on bonds sold to construct the parking structure.

The only allowable use of the revenue is to support the funding of public transportation services or improvements, the 2026 budget for the ALID exists solely to authorize payments to AMD, as noted. The 2026 proposed ALID budget includes $45,000 in sales tax revenue and $45,000 in expenditures related to the AMD debt service for the construction of the parking structure.

Background - Enterprise/Utility Fee

Utilities are funded by four enterprise funds that are specifically dedicated to the Water, Wastewater, Reclaimed, and Stormwater/Flood Management utilities. Each enterprise operates as a self-supporting entity. Revenues generated from monthly utility bills are the largest source of revenue for each utility, accounting for generally between 85% to 90% of revenues in each fund. Other significant sources of funds include development fees and funding from the Mile High Flood District (MHFD). These cumulative funding sources cover day-to-day operations, capital and rehabilitation projects, and annual programs. A robust enterprise fund presents a significant strategic advantage, empowering the city to issue revenue bonds.

This mechanism is crucial for financing substantial capital projects, much like the extensive bonded projects anticipated in 2026. The ability to leverage revenue bonds ensures that vital infrastructure and development initiatives can proceed.

As previously noted, to prepare for critical utility infrastructure needs, Broomfield adjusted water and sewer rates last year. This was, in part, to support two upcoming enterprise bond issues – one to fund two new water storage tanks and another to expand our wastewater treatment facility. Staff has contracted with bond underwriting firms, Stifle & Piper Sandler, who have extensive Colorado market experience in issuing Enterprise Fund bonds. CCOB is still targeting issuance in quarter one 2026.

Staff has provided additional detailed information on how water and sewer rates are directly influenced by the process of repairing and replacing aging infrastructure, known as asset renewal. Here is the linked

document - Water Utilities System Asset Renewal - Key Aspects of Establishing Rates.

In addition to preparing Broomfield to support the two upcoming enterprise bond issues, the rate increase implemented in 2025 was able to be immediately utilized to implement the water meter replacement program and improve maintenance of existing assets, including the following notable improvements:

Potable Water Improvements

- Flushing 483 miles: 100% (vs. 19% in 2022).
- Hydrants 4,478: 100% maintained (vs. 47% in 2021).
- Backflow devices 2,737: 97.17% compliance (exceeds CDPHE 90%).

Sewer and Stormwater Improvements

- Sewer video inspections: Currently at 90%; 100% by year-end (vs. 20% in 2023).
- Sewer cleaning: Currently at 98%; 2-year full-cycle program (vs. 40% in 2022).
- Storm video inspections: Currently at 87%; 100% by year-end (vs. 9.6% in 2021). Cleaning: 100% of 2025 target (vs. 0% in 2021).
- Street sweeping: 3,381 miles swept in 2025 (+95% vs. 2023).

2026 Proposed Recommendations: Water, Sewer, Reclaimed, and Stormwater Rates

As detailed in the budget adopted by the Council in 2025, the five-year plan includes a year two increase totaling $16.89 per month for the average single-family home starting in 2026. This represents a 15% increase for utility rates across all funds, with a 9% ($1.00) increase for stormwater service fees, and aligns with projections presented in the original five-year plan presented in 2024 (also see October 22, 2024, memorandum). Similarly, the non-residential water, sewer, and reclaimed rates will increase by 15% and stormwater service fees will increase by 9%. License fees for water, sewer, and reclaimed water for new development will increase by 4%.

Staff has completed a comprehensive fiscal analysis to evaluate anticipated revenues from utility rates as well as projected expenses based on necessary costs associated with day-to-day operations, capital and rehabilitation projects, and annual maintenance requirements. The fiscal analysis includes multiple interdependent variables, and adjusting any one component impacts several other variables within the model, requiring a holistic re-evaluation of all dependencies within the five-year comprehensive plan.

This increase is essential to ensure the long-term financial sustainability of our enterprise funds while maintaining essential services and infrastructure. The recommended rate structure ensures sufficient funding for both ongoing maintenance of existing water infrastructure and necessary capital improvements. The proposed increase allows the utility to maintain a proactive maintenance schedule consistent with capital improvement planning recommendations, protecting the community's investment in water infrastructure while avoiding more costly emergency repairs. Deferring maintenance on water system components creates significant financial risk, as delayed repairs typically result in substantially higher replacement costs and potential service disruptions that impact the entire community.

It is important to understand why this rate increase cannot easily be reduced to a lesser amount. Each percentage point reduction in the proposed rate change would result in approximately $500,000 less annual revenue to the enterprise fund. Such reductions would necessitate corresponding cuts to maintenance programs, capital projects, or service levels to maintain a balanced budget.

Given the essential nature of water services and the potential for deferred maintenance to compound costs over time, the proposed increase represents the minimum funding level necessary to ensure reliable, long-term service delivery to our community.

In 2025, the increase for the water utility bill was only on the base fees, and there was no increase for the water usage rates. As discussed and presented last year, in 2026, the proposal also includes an increase to the water usage rate, and therefore, the monthly difference in the water bill will be dependent on how much water the residence typically utilizes.

The projected impact on an average monthly bill for a single-family home and a multi-family home are shown in the tables below.

The example provided below uses an average single-family home bill of 9,000 gallons for water and 6,000 gallons for sewer. The 9,000 gallons/month for water is based on a 4-year historical average of 107,000 gallons per year for a typical single-family home. Staff will be providing a Utility Bill Estimator tool and linking it on our website to help residents calculate how the proposed increase would apply to their home utility bill based on their specific household water usage.

Impact on Average Monthly Bill for a Single Family Home (9,000 gal)

	Rates		Average Bill		
Fee Type	2025	2026	2025	2026	Difference
Water Meter Base Charge	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Tier 1 (0-5k gal)	*$2.39*	*$2.75*	*$11.95*	*$13.75*	*$1.80*
Water Usage Tier 2 (6-9k gal)	*$3.82*	*$4.39*	*$15.28*	*$17.56*	*$2.28*
Water Usage Tier 3 (> 9k gal)	*$5.41*	*$6.22*	*$0.00*	*$0.00*	*$0.00*
Sewer Service Charge	$5.44	$6.26	$32.64	$37.56	$4.92
Sewer Fed Mandate Charge	$0.52	$0.52	$3.12	$3.12	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$11.00	$12.00	$11.00	$12.00	$1.00
Total Bill			**$119.90**	**$136.79**	**$16.89**

Projected 4-Year Outlook for Single-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$119.90	$136.79	$146.37	$156.61
Percentage Change		*14%*	*7%*	*7%*

Impact on Average Monthly Bill for a Multi-Family Home (3,000 gal)

	Rates		Average Bill		Difference
Fee Type	2025 Rate	2026 Rate	2025	2026	Difference
Water Base Fee	$36.91	$42.45	$36.91	$42.45	$5.54
Water Usage Charge	*$2.55*	*$2.93*	*$7.65*	*$8.79*	*$1.14*
Sewer Service Charge	$5.44	$6.26	$21.76	$25.04	$3.28
Sewer Fed Mandate Charge	$0.52	$0.52	$2.08	$2.08	$0.00
Sewer Env Comp Base Charge	$9.00	$10.35	$9.00	$10.35	$1.35
Stormwater Base Charge	$6.60	$7.20	$6.60	$7.20	$0.60
Total Bill			**$84.00**	**$95.91**	**$11.91**

Projected 4-Year Outlook for Multi-Family Home Bill

	2025	2026	2027	2028
Anticipated Bill	$84.00	$95.91	$102.62	$109.81
Percentage Change		*14%*	*7%*	*7%*

The tables below show the proposed non-residential water base and usage rate changes as well as the proposed license fee changes.

Impact on Non-residential Rates

Fee Type	2025	2026	Difference	%
Water Usage Charge	$3.22	$3.70	$0.48	15%
Water Base Charge - 3/4"	$36.91	$42.45	$5.54	15%
Water Base Charge - 1.0"	$61.50	$70.73	$9.23	15%
Water Base Charge - 1.5"	$123.00	$141.46	$18.46	15%
Water Base Charge - 2.0"	$196.79	$226.33	$29.54	15%
Water Base Charge - 3.0"	$369.00	$424.39	$55.39	15%
Water Base Charge - 4.0"	$615.02	$707.33	$92.31	15%
Water Base Charge - 6.0"	$1,230.02	$1,414.64	$184.62	15%
Water Base Charge - 8.0"	$1,968.04	$2,263.43	$295.39	15%
Water Base Charge - 10.0"	$2,829.07	$3,253.70	$424.63	15%

License fees are the fees that are paid by developers and builders for new connections to the water and sanitary sewer systems. The purpose of license fees is to provide funds to pay for the capital costs of expanding the water utility to serve new growth.

Impact on License Fees

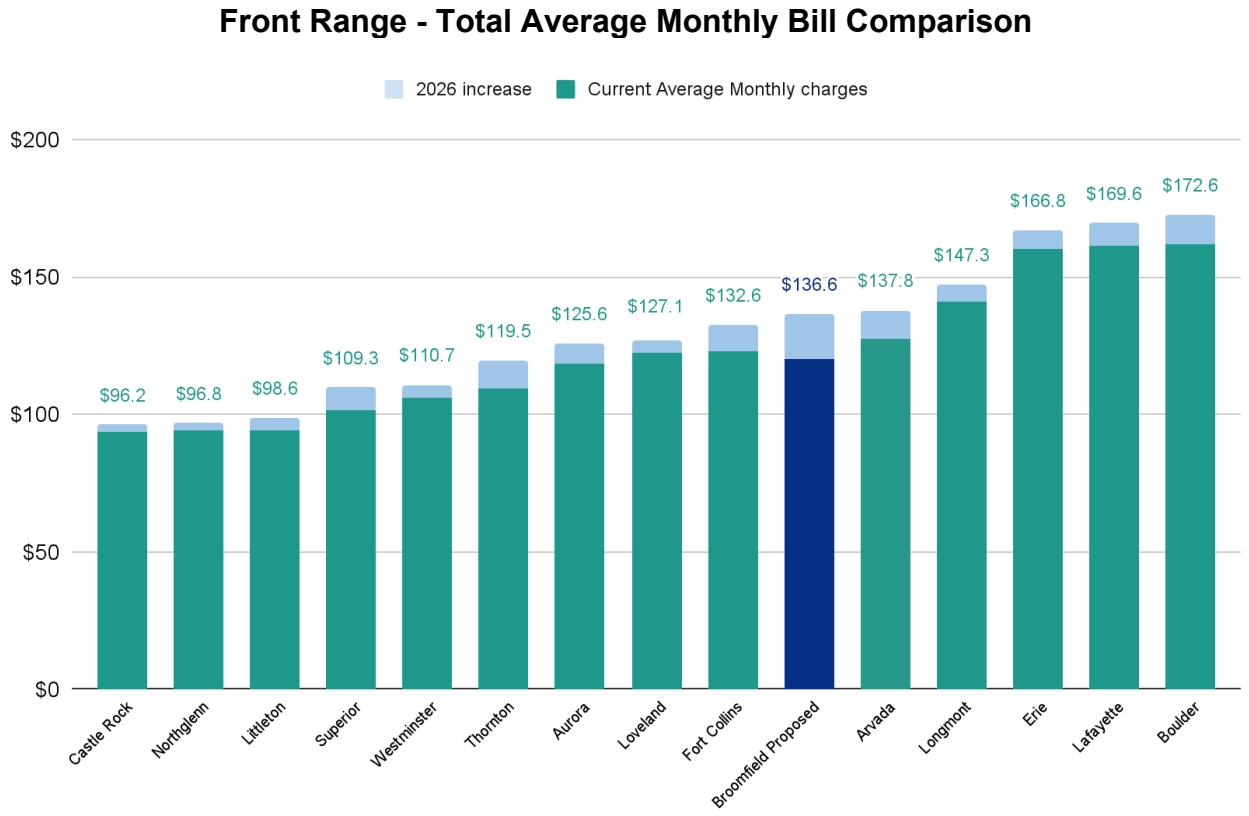
Fee Type	2025	2026	Difference	%
Water License	$37,850	$39,350	$1,500	4%
Sewer License	$14,900	$15,500	$600	4%
Reclaimed License	$13,780	$14,350	$570	4%

Front Range - Average Monthly Bill Comparison

The graph below shows Broomfield's total average monthly utility bill for water, sewer, and stormwater

compared to our neighboring municipalities. The comparison reflects where Broomfield is currently and how it would compare if the Council approves the proposed utility rates. The average monthly bill is normalized across all municipalities based on 9,000 gallons of water usage and 6,000 gallons of Average Winter Consumption (AWC) for sewer charges.

The 2026 rate increases shown in the graph below are not finalized, as the communities are going through a similar budget process as Broomfield, but staff have added the projected/proposed increases for municipalities where a projected increase is available, as shown in the light blue.



The degree to which neighboring municipalities increase their utility rates depends highly on how well they have managed their Enterprise Funds over the past decade, the growth versus expense challenges the municipality faces, and other factors unique to each entity.

Communication Plan:

Staff will be providing information for the community to learn about the proposed fee increase and how it could impact them directly. Updates have been included on the Broomfield.org website, including the proposed rates, estimated impacts for single-family homes and specific types of multifamily residential developments such as apartments, townhomes, and condominiums, and a Utility Bill Estimator tool for residents' use. Staff will also include information on the City and County of Broomfield's communications channels and work with Our Broomfield magazine, which was indicated in the Community Survey as a common place where residents seek to learn about Broomfield information, to share information about the rate change.

Additional information will be shared in late 2025 before the new rates take effect.

Utility Rate Assistance Fund (URAF) and Partial Property Tax Refund (PPTR) Program in 2026

The City and County of Broomfield (CCOB) is committed to supporting residents facing financial challenges, particularly with utility costs and property taxes. To this end, two key programs were established: the Utility Rate Assistance Fund (URAF) and the Partial Property Tax Refund (PPTR) Program.

The PPTR Program, launched in February 2023, was created in response to the increasing burden of property taxes and broader cost-of-living pressures. It provides refunds for seniors aged 65+, veterans with an 80% documented disability, and adult homeowners with 100% documented disabilities.

The URAF Program, launched in 2025 and administered by the Housing Division, helps residents with utility affordability. Building on the operational success of the 2024 PPTR Program signifies a significant step in CCOB's commitment to its residents.

Staff recommends continuing both programs in the 2026 fiscal year and both are included in the proposed 2026 Budget. Both programs will continue to accept new applications through October 30, 2026, or until funding has been exhausted, whichever occurs first. Resolutions 2025-153 and 2025-154 include clarifications and adjustments to the URAF and PPTR programs. These changes aim to ensure the programs remain efficient, fiscally responsible, and responsive to community needs, aligning with Council Goals, Financial Sustainability and Resilience, and Organizational Health.

Utility Rate Assistance Fund (URAF) Program 2025 and 2026 Update

In 2025, City Council Resolution 2024-165 established the Utility Rate Assistance Fund (URAF) program, directing staff to provide quarterly credits or refunds to eligible households with incomes up to 100% of the Area Median Income (AMI).

A review of 2025 URAF applications by the Housing Division revealed that 74% of applicants, the vast majority, had incomes at or below 60% AMI. Consequently, staff recommended reducing the 2026 eligibility threshold to 60% AMI, a change first discussed during the July 2025 second quarterly update for Enterprise Funds.

In 2025, eligible households received monthly reimbursements for utility fees, covering about 50% of the increase from 2024. The maximum annual refund was capped at $240 per household. Reimbursement rates varied by housing type: $20 for single-family detached homes, $18 for townhomes, duplexes, and mobile homes, and $17 for apartments and condominiums. The proposal for 2026 is to maintain these same assistance levels for eligible residents. Eligibility will be based on the total adjusted earnings of all household members aged 18 and older. Residents who pay their water utility bill directly to Broomfield will receive the refund as a credit on their utility account. For residents who pay their water utility as part of rent, via an HOA or other third party, the refund will be issued in check form to the resident.

Broomfield's Housing Division, which also manages the partial property tax refund program, will continue to administer the URAF program, maintaining quarterly payouts based on Council feedback from the July 2025 enterprise funds update.

To support the 2025 URAF program rollout, two nine-month Limited Term Assignment (LTA) full-time staff positions were added to the Housing Division. The 2026 budget does not allocate funds for new staff to

manage the Utility Rate Assistance Fund (URAF). Instead, the administration will leverage current staff within the Housing Division of Economic Vitality. These staff members will track the time and costs associated with administering the program without additional long-term assistance (LTA) capacity. Updates will be provided during quarterly enterprise updates, and the Housing Division will continue to advertise the URAF program via social media, Broomfield's website, Our Broomfield, and alongside other housing initiatives throughout 2026. If additional advertising, postage, or other related expenses are determined to be necessary specifically for URAF, an amendment to the 2026 budget will be requested in 2026.

Utility Rate Assistance Fund (URAF) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 100% AMI	0% - 60% AMI
Payment Frequency	Quarterly	Quarterly

During the October 14, 2025 City Council meeting, a resident reported concern regarding the eligibility of mobile home residents for the URAF program. It should be noted, residents of mobile home communities are eligible for the program. Since their utility bill is typically paid through a third party, the resident would be issued a quarterly check rather than a credit toward their utility bill to ensure the program benefits the resident directly. In 2025, mailers were sent to mobile home residents to inform them about the program. As of October 1, 2025, approximately 12 mobile home residents have applied for and been approved for the URAF. Broomfield staff will continue to focus on outreach to mobile home residents in 2026.

URAF Program Data

URAF Program Data as of September 30, 2025		
URAF - Data Points	2025	2026
Program Budget	Program Credits*: $600,000 Program Checks: $493,100 Personnel: $104,300 URAF specific Advertising: $7,000 URAF Software: $8,300 URAF Equipment: $8,000	Program (credits/checks): $350,000 Personnel: $35,000 URAF specific Advertising: $0 URAF Software: $0 URAF Equipment: $0
Budget Expended	Program Credits: $132,879 Program Checks: $18,639 Personnel: $66,810 URAF Advertising/Postage: $7,620 Software: $8,300 Equipment: $4,492	N/A
Total Payments Processed	Through 2025 Q3: 3833	N/A
Total Applications Processed	1813	N/A
Eligibility	One of the following docs: IRS Tax Form, SS, SNAP, LEAP, etc.	Required - IRS Tax Form No tax filing - Proof of all income (SS, Bank Statements, Paystubs, etc.)
AMIs Served	0-30% ▫ 40% 31-60% ▫ 34% 61-80% ▫ 19% 81-100% ▫ 7%	0-30% 31-60% N/A N/A
Communication Efforts	Phone Calls: 1171 Emails: 446 Consultations: 429 (96 Spanish)	N/A N/A N/A
Outreach Events	31	N/A

*As part of the 2025 Budget - 1st Amendment, program credits were budgeted at $1,479,300; as part of the 2025 Budget - 2nd Amendment, program credits are now budgeted at $600k.

Partial Property Tax Refund (PPTR) Program - 2025 Update and 2026 Recommendation

The Partial Property Tax Refund (PPTR) Program, established by Resolution No. 2022-123 and expanded with Resolution No. 2024-27 and Resolution No. 2024-105, offers financial relief to specific demographics facing increasing property tax burdens and general cost-of-living pressures. Eligible participants include seniors aged 65 and older, veterans with a documented disability of 80% or more, and adult homeowners with 100% documented disabilities.

While the Housing Division will continue to utilize 2021 tax year data as the program's baseline, the 2026 refund is anticipated to be lower than in 2025 due to the recently adopted House Bill 24B-1001. Despite these adjustments, the program is expected to continue providing significant support to qualifying households.

Partial Property Tax Refund (PPTR) Modifications		
Program Attribute	2025	2026
Average Median Income (AMI) eligibility	0% - 80% AMI	0% - 80% AMI
Program Final Application Date	October 30, 2025	October 30, 2026

PPTR Program Data

PPTR Program Data as of October 13, 2025		
PPTR - Data Points	2025	2026
Program Budget	Program ≤ 60% AMI: $402,000 Program 61-80%: $100,000	Total Program: $600,000 Anticipated utilization ≤ 60% AMI: $500,000 61-80%: $100,000
Budget Expended	Program ≤ 60% AMI: $401,693 Program 61-80%: $90,016	N/A
Total Payments Processed	963	N/A
Total Applications Processed	1265	N/A
AMIs Served/Processed	0-30% ▫ 41.5% 31-60% ▫ 36.0% 61-80% ▫ 18.5% Ineligible ▫ 4.0%	0-30% 31-60% 61-80%
Communication Efforts	Phone Calls: 517 Emails: 332 Consultations: 397 (77 Spanish)	N/A N/A N/A
Outreach Events	33	N/A

Bond Issuances

Until 2021, Broomfield did not have a formal Debt Policy. Since adopting one, we have aligned with industry and government standards by capping total debt at no more than 10% of the City's assessed value. As of the close of fiscal year 2024, Broomfield's total debt was at 5.25% of assessed value – well below industry standards.

In 2023, debt service accounted for 4.6% of total revenues, and in 2024, that decreased slightly to 4.2%, reflecting our intentional focus on managing and reducing outstanding obligations. For context, debt service levels under 5% of total revenue are typically considered "best in class."

As we look ahead, the staff has strategically timed the issuance of new debt to coincide with the defeasance of the 2017 Certificates of Participation (COP) for the County building. This approach will help offset the impact of new debt issuance for the upcoming Police and Courts facility. While we expect to slightly exceed the 5% debt-to-revenue ratio following issuance, our strong financial standing provides confidence in our ability to manage this responsibly. In the past two years, Broomfield has earned three credit rating upgrades, which is a significant achievement

Conclusion and Next Steps

The 2026 budget represents a disciplined, data-driven approach to maintaining Broomfield's financial sustainability while meeting our community's needs. Through careful stewardship of public resources, strategic infrastructure investments, and thoughtful prioritization of mandates, obligations, and critical needs, this budget positions our organization to navigate current fiscal challenges while preparing for future opportunities.

Key Takeaways

The proposed 2026 budget demonstrates our commitment to:

- **Fiscal Responsibility**: Maintaining 20% reserves and managing debt prudently
- **Infrastructure Investment**: Addressing critical water, sewer, and public safety facility needs
- **Community Support**: Continuing programs like URAF and PPTR to assist residents facing financial challenges
- **Operational Excellence**: Optimizing existing resources before requesting new ones

Action for Council - October 28, 2025

7.A Resolution - City and County Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-141 - 2025 Budget - 2nd Amendment
- Resolution 2025-142 - 2026 CCOB Budget

7.B Resolution - Broomfield Urban Renewal Authority (BURA) Proposed Revised 2025 Budget and 2026 Budget

- Resolution 2025-143-UR - 2025 BURA Budget - 2nd Amendment
- Resolution 2025-144-UR - 2026 BURA Budget

7.C Resolution - Arista Local Improvement District (ALID) Proposed 2026 Budget

- Resolution 2025-145-AID - 2026 ALID Budget

7.D Public Hearing - Ordinance Section Reading - Amending Water, Sewer, Reclaimed and Stormwater Fees

- Ordinance 2286 - Enterprise Rate Ordinance

7.E Public Hearing - Ordinance Second Reading - Enterprise Revenue Bonds and Police Building Certificate of Participation

- Ordinance 2288 - Water Tanks Bond
- Ordinance 2289 - Wastewater Treatment Bond
- Ordinance 2290 - Police/Courts COP

7.F Resolution - Approval of the Continuation of the Partial Property Tax Refund (PPTR) Program and Utility Rate Assistance Fund (URAF) Program

- Resolution 2025-153 - URAF Program Continuation
- Resolution 2025-154 - PPTR Program Continuation

Looking Ahead

Following the adoption of the 2026 budget, staff will:

- Issue bonds in Q1 2026 for Police/Courts facility and enterprise projects
- Begin construction on the Police building, Water tanks, and Wastewater Expansion Project
- Implement the updated URAF and PPTR programs
- Come before Council Dec. 9th with an amendment focused on grants received in 2025
- Continue quarterly Enterprise Fund updates to Council
- Collaborate with FLOW on recommendations for the 5-Year Water Utilities Capital Improvement Plan (CIP) and rate adjustments for the 2027 budget.
- Monitor economic conditions and provide budget updates as needed
- Prepare for the 2027 budget process with continued emphasis on financial sustainability

Staff remains committed to transparent communication, data-driven decision-making, and collaborative problem-solving as we work together to serve our community and achieve our shared goals.

RESOLUTION NO. 2025-153

A resolution authorizing the continuation of the Utility Rate Assistance Program for 2026

Be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

The Utility Rate Assistance Fund (URAF) program is hereby authorized and approved to continue for calendar year 2026 in an amount not to exceed $350,000 to provide financial assistance up to $240 per household in the calendar year, payable on a quarterly basis for each qualified household meeting the income eligibility threshold.

Section 2.

The household income eligibility threshold for the Utility Rate Assistance Fund program in calendar year 2026 will be 60% of the area median income.

Section 3.

The City and County Manager is directed and shall continue to administer the URAF program in accordance with the parameters set forth in this resolution for calendar year 2026.

Section 4.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

RESOLUTION NO. 2025-154

A resolution authorizing the continuation of the Partial Property Tax Refund Program for 2026

Be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

The Partial Property Tax Refund (PPTR) program is hereby authorized and approved to continue for calendar year 2026 in an amount not to exceed $600,000 to provide financial assistance up to $1,000 per household in a calendar year for each qualified household meeting the income eligibility threshold.

Section 2.

The eligibility requirements of the Partial Property Tax Refund Program, as previously approved and funded, will apply to the 2026 Program. As previously approved, for residents that qualify under the 60% Area Median Income (AMI), the refund calculation will be done on the entire property tax bill. For residents that qualify under the 61% to 80% AMI, the refund calculation will be done on City and County of Broomfield and School District portions of the property tax bill only.

Section 3.

The City and County Manager is directed and shall continue to administer the PPRT program in accordance with the parameters set forth in this resolution for calendar year 2026.

Section 4.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

City and County of Broomfield

City Council Regular Meeting

G. Resolution - Water Tanks Construction Agreement

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7G.

Presented By
Ken Rutt, Director of Public Works

Community Goals
☑ Financial Sustainability and Resilience

Overview

View Correspondence and visit BroomfieldVoice.com (link to project page OR remove if not applicable)
View Presentation

To approve Resolution Numbers 2025-131, 2025-137, and 2025-152 regarding the construction of the Broomfield Water Tanks.

Attachments

Memo for Broomfield Water Tanks Construction and Engineering Agreements (rev 10_07) USE THIS ONE_.pdf
Resolution No_ 2025-131 - Garney.pdf
Resolution No_ 2025-137 - Burns & McDonnell.pdf
Resolution No. 2025-152 Intent to be Reimbursed for Certain Expenses Relating to the Construction of Water Improvements .pdf
Garney Agreement - A133ExhibitA-2019 Oct 2025 Garney Vendor Signed.pdf
Exhibit A1 - Broomfield Tanks GMP 10.8.25.pdf
Exhibit A2 - 135303_IFC Drawings FINAL (1).pdf
Exhibit A3 - 135303 Broomfield Tanks IFC Specifications.pdf
Exhibit A4 - Broomfield Tanks & P.S. - Assumptions.pdf
Tanks Burns & McD ESDC agreement.pdf

Memo for Broomfield Tanks Amendment Two to the Construction Agreement; a Consulting Agreement with Burns & McDonnell for Engineering Services; and authorizing the reimbursement to the general fund from bond proceeds
Prepared By: Ken Rutt - Director Water Utilities, Jeff Ruger - Deputy Director Water Utilities, RondaJo Ackerman Alford, CIP & Construction Superintendent

Summary

View Correspondence
View Presentation

The necessity for additional water storage to support both the communities located east of Main Street and growth in northeast Broomfield has been recognized since the city and county limits were established in 2001. The proposed tank site in Anthem 24 was identified over 20 years ago as the location for a future water tank due to its high ground elevation. Broomfield's water system model confirmed the need for future water system capital expansion at this site. This led staff to work with the Anthem 24 developer to set aside property for future water storage, which was incorporated into the Anthem 24 plat in 2015 and finalized in 2016.

At the October 18, 2022, study session, Broomfield staff provided the Council with a comprehensive overview of Broomfield's water resources, covering past, present, and future aspects. This presentation underscored the importance of ongoing, proactive planning for and securing Broomfield's water supply, as well as ensuring critical storage as the community continues to expand.

Due to increasing potable water (drinking water) demands, Broomfield requires the ability to store additional water. As Broomfield develops, regular peak-hour usage will result in insufficient water supply and pressure at higher elevations. Additionally, this necessary water infrastructure will be essential to ensure adequate storage and supply for fire flows and mitigation efforts.

Broomfield's water system model identifies critical capital improvements that will be necessary as Broomfield develops. Additional water storage is needed to serve the communities east of Main Street and to the northern communities of Broomfield and ensure sufficient fire flows. The Council's approval of the site development plan amendment (dated September 7, 2023) at the July 24, 2024 council meeting recognized the urgency and strategic importance of this location for future water infrastructure.

Contractor Selection Process

Broomfield issued a competitive request for qualifications (RFQ) for a contractor to serve as the Construction Manager/General Contractor (CM/GC) for the project. The RFQ was open to all interested construction firms. Two Statements of Qualifications were received and the review committee, comprised of the Water Treatment Superintendent, Director of Water Utilities, Utilities Superintendent, Manager of Water Resources, design team and Broomfield staff, reviewed the qualifications. The firms were interviewed, and Garney Construction was selected based on qualifications, the number of tank projects completed successfully in Colorado, experience, and project approach.

The CM/GC agreement involves a two-step process:

1. Step One: Preconstruction Services - This authorizes Garney Construction Inc. to perform preconstruction services, which include reviewing design drawings, providing cost estimates, reviewing on-site conditions, reviewing vendor qualifications, and bidding the work. The initial agreement for these services was for $196,380 and did not require Council authorization. The preconstruction agreement was amended at the November 14, 2023 Council meeting to provide additional preconstruction services for the Council directed redesign of the Broomfield Tanks Project. (Resolution 2023-148)
2. Step Two: Guaranteed Maximum Price (GMP) Approval - This step involves approving the GMP as an amendment to the CM/GC agreement for the actual construction of the project. Staff is currently presenting Amendment Two to the Council for the Early Work Package (EWP) to allow for the procurement of key long-lead equipment and construction funding until bond funding can be secured.

Staff will present the Late Work Package (LWP) in March 2026 for the remaining project costs after receiving the bond funding.

Staff is now presenting Amendment Two of the CM/GC to Council to allow for the procurement of key long-lead equipment (electrical equipment, pumps, and generator), and construction funding for the project until bonding for the project can be secured.

Engineering Proposal

Staff proposes an engineering services agreement with Burns & McDonnell Engineering:

- Engineering Services During Construction (ESDC) of the Early Work Package (Resolution 2025-137).

Resolution Authorizing Reimbursement of Advanced Funds

Staff anticipates the total project cost for the Broomfield Tanks Project to not exceed $80M. Proposed Ordinance No. 2288, if approved on 2nd Reading on October 28, 2025, authorizes bond financing to cover the entirety of the estimated $80M in project costs. Proposed Resolution No. 2025-152 authorizes the reimbursement to the water fund from bond proceeds for advancements made by the City for the project prior to the bonds closing in early 2026. This process enables the City to approve Amendment Two to the CM/GC with Garney for the Early Work Package and begin construction on or about January 1, 2026 while also being eligible to be reimbursed the $4.4M once bond proceeds are available. This is a common tool used by local governments when they have advanced funds to pay project costs prior to the issuance of bonds or other funding on capital projects.

Should the reimbursement resolution fail to receive approval, work cannot commence until after the bond funding has been secured and Council approval obtained at a subsequent council meeting in March 2026 or later. Consequently, the construction team will need to rebid the project. Given the tariffs on materials and equipment, the cost of the project is expected to increase. The currently selected construction team for the project would also be reallocated to another project by the CMGC. This delay in project initiation will result in a postponement of the construction team's mobilization and the start of site work during the initial summer season. The ongoing postponement of this essential project will lead to an escalation of pressure irregularities within the distribution system.

Staff recommends approval of:

- Proposed Resolution No. 2025-131 - Approving the Guaranteed Maximum Price Amendment Two to the Construction Agreement with Garney Construction Inc. for the Early Work Package in the amount of $4,400,000 and including authorization for a 10% contingency.
- Proposed Resolution No. 2025-137 - Approving a Consulting Agreement with Burns & McDonnell Engineering Inc. for Engineering Services During Construction in the amount of $700,000 and including authorization for a 10% contingency.
- Proposed Resolution No. 2025-152 - Expressing the intent of the City and County of Broomfield to be reimbursed for expenses relating to the construction of water improvements

Staff anticipates bringing forward in March 2026 upon securing the necessary bond financing, amendments to the construction agreement with Garney Construction for funding of the Late Work Package (LWP), and an amendment to the professional services engineering agreement for LWP ESDC costs.

Financial Considerations

As shown in the sources and uses of funds summary below, the project can be completed within the budgeted amount.

Sources and Uses of Funds	Amount
Fund 1 Fund 40 Available Change of Use Funds	$5,630,000
Amendment Two to the Construction Agreement with Garney for the Guaranteed Maximum Price (GMP) for the Early Work Package (EWP) (Proposed Resolution No. 2025-131)	-$4,400,000
Construction Contingency for the Construction Agreement with Garney Construction for the EWP (Proposed Resolution No. 2025-131)	-$440,000
Consulting Agreement with Burns & McDonnell, Inc. for Engineering Services During Construction (ESDC) for the Broomfield Tanks for the EWP (Proposed Resolution No. 2025-137)	-$700,000
Design Contingency for the Consulting Agreement for the ESDC for the Broomfield Tanks for the EWP (Proposed Resolution No. 2025-137)	-$70,000
Other Project Expenses: 20-day Letters, Third Party Geotechnical and Material Testing, CDPHE Permitting Fees, etc. for the early work portion	$20,000
Projected Balance	**$0**

Prior Council or Other Entity Actions

- Council approved the Amended Site Development Plan (partially buried) for Anthem 24 at the July 23, 2024 meeting.
- Council approved the consulting agreement with Burns & McDonnell for the Redesign of the Tanks (fully buried) and the amendment to the preconstruction agreement with Garney Construction at the November 14, 2023 Council meeting.
- Council approved funding for the Water Fund Capital Projects in the 2024 Budget.
- Council provided direction to staff at the January 10, 2023, study session to proceed with the project with partially buried tanks.
- Council authorized funds in the 2023 Budget for the Broomfield Tank Projects (North Area Water - Tank and 3.2MG Reuse Tank Lowell/Sheridan)
- Council approved an amendment to the consulting agreement with Burns & McDonnell, April 26, 2022, for the Broomfield Tanks: Design Project
- Council approved a consulting agreement with Burns & McDonnell on July 13, 2021, for preliminary design services and a feasibility report.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

If Council desires to proceed with the project and authorize reimbursement from the bond proceeds, the appropriate motion is…

That Resolution 2025-131 be adopted - Authorizing and Approving the Guaranteed Maximum Price Amendment Three to the Construction Agreement with Garney Construction, Inc. for the Broomfield Tanks Project Early Work Package (EWP)

That Resolution 2025-137 be adopted - Authorizing and Approving the Consulting Agreement with Burns & McDonnell Engineering, Inc. for Engineering Services During Construction for the Broomfield Tanks Project

That Resolution 2025-152 be adopted - A resolution expressing the intent of the City and County of Broomfield to be reimbursed for certain expenses relating to the construction of water improvements

Alternatives

Do not proceed with the approval of the contracts, which would halt the project and negatively impact Broomfield's ability to prepare for current and future infrastructure needs, and prepare for future conditions.

Approve the contracts, but do not proceed with the reimbursement resolution. This would mean that work cannot commence until after the bond funding has been secured in March 2026 or later. Consequently, the construction team will need to rebid the project.

RESOLUTION NO. 2025-131

A Resolution Authorizing and Approving the Guaranteed Maximum Price Amendment Two to the Construction Agreement with Garney Construction, Inc. for the Broomfield Tanks Project Early Work Package (EWP)

Be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

The Guaranteed Maximum Price Amendment to the AIA Document A 133-2019 Standard Form of Agreement attached hereto by and between the City and County of Broomfield and Garney Construction, Inc. for the Broomfield Water Tanks Project early work package in the amount of $4,400,000 is hereby approved.

Section 2.

The Mayor or Mayor Pro Tem is authorized to sign and the office of the City and County Clerk to attest the agreement, in form approved by the City and County Attorney.

Section 3.

The City and County Manager or a designee thereof is authorized to approve change orders in an aggregate amount not to exceed ten percent.

Section 4.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

RESOLUTION NO. 2025-137

A resolution Authorizing and Approving the Consulting Agreement with Burns & McDonnell Engineering, Inc. for Engineering Services During Construction for the Broomfield Tanks Project

Be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

The agreement, attached hereto, by and between the City and County of Broomfield and Burns & McDonnell Engineering Company, Inc. in the amount of $700,000 is hereby approved.

Section 2.

The Mayor or Mayor Pro Tem is authorized to sign and the Office of the City and County Clerk to attest the agreement, in form approved by the City and County Attorney.

Section 3.

The City and County Manager or a designee thereof is authorized to approve change orders in an aggregate amount not to exceed ten percent.

Section 4.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

RESOLUTION NO. 2025-152

A resolution expressing the intent of the City and County of Broomfield to be reimbursed for certain expenses relating to the construction of water improvements

Recitals.

Whereas, the City and County of Broomfield (the "City"), is a duly organized and existing home rule municipality of the State of Colorado, created and operating pursuant to Article XX, Section 6 of the Constitution of the State of Colorado and the home rule charter of the City;

Whereas, the members of the City Council of the City (the "Council") have been duly appointed and qualified;

Whereas, it is the current intent of the City to construct certain capital improvements to the water system of the City (the "Water Project");

Whereas, the City has determined that it is in the best interest of the City to finance the Water Project through a tax-exempt financing which may include the issuance of Water enterprise revenue bonds; or by any other means legally available to the City;

Whereas, the City has determined that it is necessary to make capital expenditures to acquire and construct the Water Project prior to the time that the City arranges for the specific financing of such Water Project;

Whereas, it is the City's reasonable expectation that when such financing occurs, the capital expenditures will be reimbursed with the proceeds of the financing;

Whereas, in order to comply with the provisions of the Internal Revenue Code of 1986, as amended (the "Code"), it is the City's desire that this resolution shall constitute the "official intent" of the Council to reimburse such capital expenditures within the meaning of Treasury Regulation §1.150-2.

Now, therefore, be it resolved by the City Council of the City and County of Broomfield, Colorado:

Section 1.

All action (not inconsistent with the provisions of this resolution) taken by the City and the officers, employees and agents of the City directed toward the tax-exempt financing is hereby ratified, approved and confirmed.

Section 2.

The City intends to finance approximately $80,000,000 to pay the costs of the Water Project, including the reimbursement of certain costs incurred by the City prior to the receipt of any proceeds of a financing, upon terms acceptable to the City, as authorized in an ordinance to be hereafter adopted and to take all further action which is necessary or desirable in connection therewith.

Section 3.

The officers, employees and agents of the City shall take all action necessary or reasonably required to carry out, give effect to and consummate the transactions contemplated hereby and shall take all action necessary or desirable to finance the Water Project and to otherwise carry out the transactions contemplated by this resolution.

Section 4.

The officers and employees of the City are hereby authorized and directed to take all action necessary or appropriate to effectuate the provision of this resolution.

Section 5.

The City shall not use reimbursed moneys for purposes prohibited by Treasury Regulation §1.150-2(h).

Section 6.

This resolution is intended to be a declaration of “official intent” to reimburse expenditures within the meaning of Treasury Regulation §1.150-2

Section 7.

If any section, paragraph, clause or provision of this resolution shall for any reason be held invalid or unenforceable, the invalidity or unenforceability of such section, paragraph, clause or provision shall not affect any of the remaining provisions of this resolution.

Section 8.

All acts, orders and resolutions of the City, and parts thereof, inconsistent with this resolution are hereby repealed to the extent only of such inconsistency.

Section 9.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

_____

City and County Attorney

DRAFT

AIA® Document A133® – 2019 Exhibit A

Guaranteed Maximum Price Amendment

This Amendment dated the «First » day of « November » in the year « 2025 », is incorporated into the accompanying AIA Document A133™–2019, Standard Form of Agreement Between Owner and Construction Manager as Constructor where the basis of payment is the Cost of the Work Plus a Fee with a Guaranteed Maximum Price dated the « First » day of « November » in the year « 2025 » (the "Agreement")
(In words, indicate day, month, and year.)

for the following **PROJECT:**
(Name and address or location)

Broomfield Tanks Project
« »
« »

THE OWNER:
(Name, legal status, and address)

City and County of Broomfield, Colorado municipal corporation and county
One Des Combes Drive Broomfield, Colorado 80020
« »« »
« »

THE CONSTRUCTION MANAGER:
(Name, legal status, and address)

Garney Companies, INC.
1700 Swift Street, Kansas City, MO 64116
« »« »
« »

TABLE OF ARTICLES

A.1 GUARANTEED MAXIMUM PRICE

A.2 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION

A.3 INFORMATION UPON WHICH AMENDMENT IS BASED

A.4 CONSTRUCTION MANAGER'S CONSULTANTS, CONTRACTORS, DESIGN PROFESSIONALS, AND SUPPLIERS

ARTICLE A.1 GUARANTEED MAXIMUM PRICE

§ A.1.1 Guaranteed Maximum Price

Pursuant to Section 3.2.6 of the Agreement, the Owner and Construction Manager hereby amend the Agreement to establish a Guaranteed Maximum Price. As agreed by the Owner and Construction Manager, the Guaranteed Maximum Price is an amount that the Contract Sum shall not exceed. The Contract Sum consists of the Construction Manager's Fee plus the Cost of the Work, as that term is defined in Article 6 of the Agreement.

ADDITIONS AND DELETIONS: The author of this document has added information needed for its completion. The author may also have revised the text of the original AIA standard form. An *Additions and Deletions Report* that notes added information as well as revisions to the standard form text is available from the author and should be reviewed.

This document has important legal consequences. Consultation with an attorney is encouraged with respect to its completion or modification.

AIA Document A201™–2017, General Conditions of the Contract for Construction, is adopted in this document by reference. Do not use with other general conditions unless this document is modified.

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§ A.1.1.1 The Contract Sum for the Early Work Package is guaranteed by the Construction Manager not to exceed Four Million Four-Hundred Thousand Dollars and No Cents ($4,400,000). It is anticipated that the overall project costs will total Fifty-Six Million Seven Hundred Fifty-Two Thousand Four Hundred and Seventy-Seven dollars and No Cents ($56,752,477); however, the Contract Sum may not be exceeded unless additional funds have been appropriated by the city and a written amendment to this Agreement or Change order has been approved by the City. The City plans to finance all amounts anticipated for the project that are in excess of the Contract Sum via a bond issuance in 2026. The anticipated overall project costs and timelines will be reevaluated and adjusted by amendment when the City has appropriated funds.

§ A.1.1.2 Itemized Statement of the Guaranteed Maximum Price. Provided below is an itemized statement of the Guaranteed Maximum Price organized by trade categories, including allowances; the Construction Manager's contingency; alternates; the Construction Manager's Fee; and other items that comprise the Guaranteed Maximum Price as defined in Section 3.2.1 of the Agreement.
(Provide itemized statement below or reference an attachment.)

See Exhibit A.1 – Owner's Summary of GMP
« »

§ A.1.1.3 The Construction Manager's Fee is set forth in Section 6.1.2 of the Agreement.

§ A.1.1.4 The method of adjustment of the Construction Manager's Fee for changes in the Work is set forth in Section 6.1.3 of the Agreement.

§ A.1.1.5 Alternates
§ A.1.1.5.1 Alternates, if any, included in the Guaranteed Maximum Price:

Item	Price
N/A	N/A

§ A.1.1.5.2 Subject to the conditions noted below, the following alternates may be accepted by the Owner following execution of this Exhibit A. Upon acceptance, the Owner shall issue a Modification to the Agreement.
(Insert below each alternate and the conditions that must be met for the Owner to accept the alternate.)

Item	Price	Conditions for Acceptance
N/A	N/A	N/A

§ A.1.1.6 Unit prices, if any:
(Identify the item and state the unit price and quantity limitations, if any, to which the unit price will be applicable.)

Item	Units and Limitations	Price per Unit ($0.00)
N/A	N/A	N/A

ARTICLE A.2 DATE OF COMMENCEMENT AND SUBSTANTIAL COMPLETION
§ A.2.1 The date of commencement of the Work shall be:
(Check one of the following boxes.)

[«X »] The date of execution of this Amendment.

[« »] Established as follows:
(Insert a date or a means to determine the date of commencement of the Work.)

«»

If a date of commencement of the Work is not selected, then the date of commencement shall be the date of execution of this Amendment.

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§ A.2.2 Unless otherwise provided, the Contract Time is the period of time, including authorized adjustments, allotted in the Contract Documents for Substantial Completion of the Work. The Contract Time shall be measured from the date of commencement of the Work.

§ A.2.3 Substantial Completion

§ A.2.3.1 Subject to adjustments of the Contract Time as provided in the Contract Documents, the Construction Manager shall achieve Substantial Completion of the entire Work:
(Check one of the following boxes and complete the necessary information.)

[« »] Not later than « » (« ») calendar days from the date of commencement of the Work.

[« »] By the following date: « 12/22/2028 »

§ A.2.3.2 Subject to adjustments of the Contract Time as provided in the Contract Documents, if portions of the Work are to be completed prior to Substantial Completion of the entire Work, the Construction Manager shall achieve Substantial Completion of such portions by the following dates:

Portion of Work	Substantial Completion Date
N/A	N/A

§ A.2.3.3 If the Construction Manager fails to achieve Substantial Completion as provided in this Section A.2.3, liquidated damages, if any, shall be assessed as set forth in Section 6.1.6 of the Agreement.

ARTICLE A.3 INFORMATION UPON WHICH AMENDMENT IS BASED

§ A.3.1 The Guaranteed Maximum Price and Contract Time set forth in this Amendment are based on the Contract Documents and the following:

§ A.3.1.1 The following Supplementary and other Conditions of the Contract:

Document	Title	Date	Pages
N/A	N/A	N/A	N/A

§ A.3.1.2 The following Specifications:
(Either list the Specifications here, or refer to an exhibit attached to this Amendment.)

Exhibit A.2 – Technical Specifications – Burns & McDonnell Project No. 13503 IFC May 2025
Current Edition of Broomfield Standards and Specifications
« »

Section	Title	Date	Pages
N/A	N/A	N/A	N/A

§ A.3.1.3 The following Drawings:
(Either list the Drawings here, or refer to an exhibit attached to this Amendment.)

Exhibit A.3 – Drawings – Burns & McDonnell Project No. 13503 IFC May 2025
« »

Number	Title	Date
N/A	N/A	N/A

§ A.3.1.4 The Sustainability Plan, if any:
(If the Owner identified a Sustainable Objective in the Owner's Criteria, identify the document or documents that comprise the Sustainability Plan by title, date and number of pages, and include other identifying information. The Sustainability Plan identifies and describes the Sustainable Objective; the targeted Sustainable Measures; implementation strategies selected to achieve the Sustainable Measures; the Owner's and Construction Manager's roles and responsibilities associated with achieving the Sustainable Measures; the specific details about design reviews,

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testing or metrics to verify achievement of each Sustainable Measure; and the Sustainability Documentation required for the Project, as those terms are defined in Exhibit C to the Agreement.)

Title	Date	Pages
N/A	N/A	N/A

Other identifying information:

§ A.3.1.5 Allowances, if any, included in the Guaranteed Maximum Price:
(Identify each allowance.)

Item	Price
Incl. in GMP	Incl. in GMP

§ A.3.1.6 Assumptions and clarifications, if any, upon which the Guaranteed Maximum Price is based:
(Identify each assumption and clarification.)

Exhibit A.4 – Assumptions & Clarifications – Garney GMP 9/9/2025
« »

§ A.3.1.7 The Guaranteed Maximum Price is based upon the following other documents and information:
(List any other documents or information here, or refer to an exhibit attached to this Amendment.)

N/A
« »

ARTICLE A.4 CONSTRUCTION MANAGER'S CONSULTANTS, CONTRACTORS, DESIGN PROFESSIONALS, AND SUPPLIERS

§ A.4.1 The Construction Manager shall retain the consultants, contractors, design professionals, and suppliers, identified below:
(List name, discipline, address, and other information.)

SM&RC – D115 Tank Design
« »

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ARTICLE A.5 ADDITIONAL PROVISIONS FOR COMPLIANCE WITH COLORADO LAW

The Parties agree that the following additional provisions are hereby incorporated into the Agreement and shall be incorporated consistent with Colorado law:

COLORADO LABOR. If the contract price exceeds $500,000, the Construction Manager shall employ not less than eighty percent of Colorado labor of each type or class of labor in the several classifications of skilled and common labor to perform the work under this Agreement in accordance with the provisions of C.R.S. §8-17-101 et seq.

INDEPENDENT CONTRACTOR. The Construction Manager is an independent contractor as provided in C.R.S. § 8-40-202(2). The Construction Manager is not entitled to workers' compensation benefits and the Construction Manager is obligated to pay federal and state income tax on monies earned pursuant to this Agreement.

FINAL PAYMENT. Upon satisfactory completion of the Work, the City Representative will provide the Construction Manager with a written acceptance of the Work as set forth in the Agreement. Final payment shall not be made until the City Representative has approved the payment and a notice of contractor's settlement has been published in accordance with C.R.S. §38-26-107. The City shall condition publication and final settlement upon receipt of any duly executed approvals of the corporate surety or sureties issuing the bonds required hereunder. Such final settlement shall be advertised as provided by statute at least twice, the last publication appearing at least ten (10) days prior to the date of final settlement. On the date of final settlement (or such later date as may be permitted by statute if claims are asserted or litigation is commenced alleging nonpayment of funds due for labor, materials, supplies, etc.), payment and final settlement shall be made in full.

OFFICIALS NOT TO BENEFIT. No elected or employed member of City government shall directly or indirectly be paid or receive any share or part of this Agreement or any benefit that may arise therefrom. The Construction Manager warrants that it has not retained any entity or person, other than a bona fide employee working solely for the Construction Manager, to solicit or secure this Agreement.

CHANGE ORDERS. Except as provided below and as provided in C.R.S. 24-91-103.6, the City shall have no duty or obligation whatsoever to compensate or to reimburse the Construction Manager for any additional work not specifically authorized as provided herein. In the event (i) the City requires additional compensable work to be performed by the Construction Manager prior to the execution or other finalization of a change order or contract amendment, and (ii) the Construction Manager has submitted to the City an estimate of the cost for the additional compensable work, then the City shall reimburse the Construction Manager for the costs associated with such additional work on a periodic basis in accordance with the terms of this Agreement and its amendments.

LIQUIDATED DAMAGES. Time is of the essence in completing the Work. Alternatively, and in lieu of actual damages for delay, in the event of delay in the completion of the Work as specified beyond the Completion Date, it would be difficult to determine the exact amount of the loss or damages suffered by the City due to delays in completion of the Work. However, the City has attempted to forecast a reasonable daily amount as compensation for the damages incurred due to late completion caused by the Construction Manager, based upon considerations which include, but are not limited to, public inconvenience and additional contract administration costs. Therefore, the Construction Manager will be liable to the City, as liquidated damages (and not as a penalty), in the amount of $2,000 for each and every calendar day beyond the Completion Date. The City reserves the right to deduct said liquidated damages from any amount due the Construction Manager under this Agreement or, at its option, to collect such liquidated damages directly from the Construction Manager or its surety.

This Amendment to the Agreement entered into as of the day and year first written above.

OWNER *(Signature)*	**CONSTRUCTION MANAGER** *(Signature)*
« »« »	Joel Heimbuck - Director of Operations
(Printed name and title)	*(Printed name and title)*

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GARNEY

10/8/2025 7:30

Broomfield Tanks & P.S. - IFC - May 2025 - Proprietary

	BREAKDOWN BY DIVISION	100% GMP - Proprietary (Submitted - 4/3/2025)	IFC - MAY 2025 - Proprietary (Submitted - 9/19/2025)	IFC - MAY 2025 - Proprietary VS 100% GMP - Proprietary (4/3/2025)	NOT TO EXCEED 7%	Brief Comments For +/-
					100% DESIGN COMPLETE	
1	Mobilization (Not to Exceed 7% of the Total Bid - Spec 01 29 00-5, 1.07, A.,2.,E.)	4,264,216	3,903,334	(360,882)	6.88%	Removed Broomfield Permits / Adjusted Durations to Exclude Reuse
2	Division 02 - Demolition	370,431	375,941	5,510		
3	Division 03 - Concrete	1,323,739	1,481,424	157,685		Concrete Supply / F&I Rebar / Formwork / FW Specialties / Post Tension Sub / Went Up
4	Division 04 - Masonry	273,674	271,335	(2,339)		
5	Division 05 - Metals	755,970	754,094	(1,876)		
6	Division 06 - Wood, Plastics & Composites	6,181	6,204	23		
7	Division 07 - Thermal and Moisture Protection	385,326	411,828	26,501		Waterproofing Sub Quote Went Up
8	Division 08 - Openings	78,815	83,111	4,295		
9	Division 09 - Finishes	430,083	315,110	(114,974)		Painting Sub Quote Went Down
10	Division 10 - Specialties	30,860	32,101	1,242		
11	Division 15 - Process Piping	1,154,134	1,508,091	353,957		DIP/ STL Pipe Price Went Up
12	Division 22 - Plumbing	53,753	56,519	2,766		
13	Division 23 - HVAC	339,051	339,051	-		
14	Division 26 - Electrical	4,774,744	5,183,460	408,716		See Schedule
15	Division 28 - Electronic Safety & Security	40,000	40,000	-		
16	Division 31 - Earthwork	9,604,153	9,539,105	(65,048)		Proposed Grading Backfill Contour Changes / Foundation Drain Changes
17	Division 32 - Exterior Improvements	2,625,632	2,558,263	(67,370)		Adjusted Erosion Control Blanket / Asphalt Paving Quantities
18	Division 33 - Utilities (Excludes Concrete WST, Horizontal Split-Case Pumps, & Surge Suppression System)	7,733,791	7,376,119	(357,672)		Remove Flex Couplings / PVC Price Went Down
19	Division 13 - Special Construction (Tank Cleaning, Disinfection & Testing)	53,095	59,695	6,600		
20	Division 31 - Drilled Shaft Foundations / Deep Foundation Integrity Testing	1,789,604	1,613,118	(176,486)		F/I Drilled Sub Went Down
21	Division 33 - Concrete Water Storage Tank	9,619,940	10,287,258	667,318		Concrete Supply / F&I Rebar / Formwork / FW Specialties / Post Tension Sub / Went Up
22	Division 33 - Horizontal Split-Case Pumps	572,226	560,823	(11,403)		Equipment Pricing Went Down
23	Division 33 - Surge Suppression System	-	-	-		
24	Division 40 - Process Integration	458,627	480,277	21,650		See Schedule
25	Division 41 - Material Processing & Handling Equipment	171,806	150,851	(20,956)		Equipment Pricing Went Down
26	Division 46 - Water & Wastewater Equipment	84,099	79,395	(4,704)		
	SUBTOTAL COSTS	**46,993,952**	**47,466,506**	**472,554**		

	ALLOWANCES, CONTINGENCIES, INDRECTS	100% GMP - Proprietary (Submitted - 4/3/2025)	IFC - MAY 2025 - Proprietary (Submitted - 9/19/2025)	IFC - MAY 2025 - Proprietary VS 100% GMP - Proprietary (4/3/2025)	Brief Comments For +/-
5.00%	Contingency - Owner's (Was 5% at 4/3/2025 Estimate)	2,349,698	2,373,325	23,628	
1.50%	Contingency - Material Escalation (Was 3% at 4/3/2025 Estimate - Current Pricing)	452,773	220,493	(232,279)	Current Pricing In Above Bid Items
1.50%	Contingency - Subcontractor Escalation (Was 3% at 4/3/2025 Estimate - Current Pricing)	458,324	238,057	(220,267)	Current Pricing In Above Bid Items
0.00%	Contingency - Preconstruction (Was 2% at 4/3/2025 Estimate)	939,879	0	(939,879)	100% Design Now
1.00%	Contingency - Tariff (Was 3% at 4/3/2025 Estimate - Material / Subcontractor)	911,097	305,700	(605,397)	Current Pricing In Above Bid Items
0.00%	SRF Funds - Per Broomfield (Was 5% at 4/3/2025 Estimate - No Per RJ Email 9/10/2025)	2,349,698	0	(2,349,698)	Removed Per RJ Email (9/10/2025)
	TOTAL COST - ALLOWANCES & CONTINGENCIES	**7,461,467**	**3,137,575**	**(4,323,892)**	
0.65%	Bonds (Was .65% at 4/3/2025 Estimate - Internal Update Starting 2025)	353,960	328,927	(25,034)	
1.50%	Insurance (Was 1.5% at 4/3/2025 Estimate - Internal Update Starting 2025)	816,831	759,061	(57,770)	
10.00%	Construction Fee (Was 10% at 4/3/2025 Estimate)	5,445,542	5,060,408	(385,134)	
	TOTAL COST - INDIRECTS	**6,616,333**	**6,148,396**	**(467,938)**	
	TOTAL COST - ENTIRE PROJECT	**61,071,753**	**56,752,477**	**(4,319,276)**	

TOTAL FOR TANKS & P.S. (ALL UNUSABLE / EXCESS MATERIAL WILL BE HAULED ACROSS THE STREET)	**56,752,477**	**(4,319,276)**

CITY AND COUNTY OF BROOMFIELD

BROOMFIELD TANKS AND PUMP STATION

3473 W 152ND AVE
BROOMFIELD, CO

ISSUED FOR CONSTRUCTION

MAY 2025

Burns & McDonnell Project No. 135303

no.	date	by	chk	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112

COLORADO LICENSED
NICOLE K. RICHARDSON
47887
05/08/2025
PROFESSIONAL ENGINEER

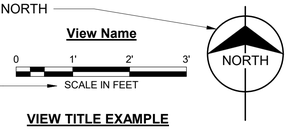
Cover

5/5/2025 4:58:49 PM

CITY AND COUNTY OF BROOMFIELD

NORTH ARROW MAY BE ROTATED TO TRUE NORTH

VIEW SCALE MAY BE REPLACED WITH "NTS" OR "NOT TO SCALE"



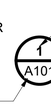
VIEW TITLE EXAMPLE

ONE OR TWO CHARACTER DISCIPLINE DESIGNATOR (MAY NOT BE PRESENT IF CALLOUT AND TITLE ARE ON DRAWINGS WITHIN THE SAME DISCIPLINE)

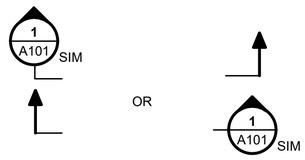
SIMILAR SECTION INDICATOR

LETTER OR NUMBER DESIGNATOR

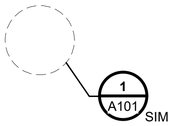
DRAWING SEQUENCE NUMBER INDICATES WHERE TITLE IS LOCATED (MAY NOT BE PRESENT IF CALLOUT AND TITLE ARE ON THE SAME DRAWING)



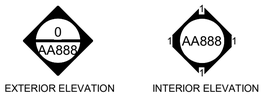
SECTION, DETAIL, AND ELEVATION SYMBOL IDENTIFIERS



SECTION CALLOUT EXAMPLE

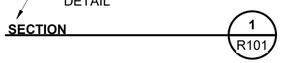


DETAIL CALLOUT EXAMPLE



ELEVATION CALLOUT EXAMPLE

"SECTION" MAY BE REPLACED WITH "ELEVATION" OR "DETAIL"



SECTION, DETAIL, OR ELEVATION TITLE EXAMPLE

SECTION, DETAIL, AND ELEVATION IDENTIFICATION SYSTEM

Contract Drawings

NUMBER	NAME
GENERAL	
0G-000	COVER SHEET
0G-001	INDEX OF DRAWINGS I
0G-002	INDEX OF DRAWINGS II
CIVIL	
0C-000	GENERAL CONSTRUCTION NOTES
0C-001	CIVIL NOTES, ABBREVIATIONS & LEGEND
0CX-101	EXISTING CONDITIONS & SURVEY CONTROL PLAN
0CD-101	DEMOLITION PLAN
0CS-102	OVERALL SITE PLAN
1CS-103	PUMP STATION SITE PLAN
2CS-104	TANK SITE PLAN
1CS-105	PUMP STATION CONTROL POINT PLAN
2CS-106	TANK CONTROL POINT PLAN
0CS-107	EAST SITE CONTROL POINT PLAN
0CS-108	CONTROL POINT TABLE I
0CS-109	CONTROL POINT TABLE II
0CS-110	CONTROL POINT TABLE III
0CG-101	OVERALL GRADING PLAN
1CG-102	PUMP STATION EXCAVATION PLAN
2CG-103	TANK EXCAVATION PLAN
1CG-104	PUMP STATION FINAL GRADING PLAN
2CG-105	TANK FINAL GRADING PLAN
2CG-301	TANK SECTIONS
0CE-101	INITIAL EROSION & SEDIMENT CONTROL PLAN
0CE-102	FINAL EROSION & SEDIMENT CONTROL PLAN
0C-500	CIVIL DETAILS I
0C-501	CIVIL DETAILS II
0C-502	CIVIL DETAILS III
0C-503	EROSION AND SEDIMENT CONTROL DETAILS I
0C-504	EROSION AND SEDIMENT CONTROL DETAILS II
0C-505	EROSION AND SEDIMENT CONTROL DETAILS III
STRUCTURAL	
0S-001	ABBREVIATIONS & LEGEND
0S-002	STATEMENT OF SPECIAL INSPECTIONS
0S-003	GENERAL STRUCTURAL NOTES
0S-500	STANDARD DETAILS I
0S-501	STANDARD DETAILS II
0S-502	STANDARD DETAILS III
0S-503	STANDARD DETAILS IV
0S-504	STANDARD DETAILS V
0S-505	STANDARD DETAILS VI
1S-001	STRUCTURAL GENERAL NOTES
1S-100	PUMP STATION FOUNDATION PLAN
1S-101	PUMP STATION FLOOR PLAN
1S-102	PUMP STATION ROOF PLAN
1S-103	ROOF SERVICE LOAD PLAN
1S-200	MASONRY ELEVATIONS
1S-300	PUMP STATION SECTIONS I
1S-301	PUMP STATION SECTIONS II
1S-302	PUMP STATION SECTIONS III
1S-500	PUMP STATION DETAILS I
1S-501	PUMP STATION DETAILS II
1S-502	PUMP STATION BRIDGE CRANE DETAILS
1S-503	FLAGSTONE SIGN PLAN & DETAILS

NUMBER	NAME
1S-504	GENERATOR SLAB FOUNDATION PLAN
1S-505	VAULT FOUNDATION PLAN AND SCHEDULE
2S-100	SOUTH POTABLE TANK FOUNDATION PLAN
2S-101	SOUTH POTABLE TANK ROOF PLAN
2S-102	NORTH POTABLE TANK FOUNDATION PLAN
2S-103	NORTH POTABLE TANK ROOF PLAN
2S-200	POTABLE TANK ELEVATION
2S-200A	POTABLE TANK ELEVATION B&W
2S-200B	POTABLE TANK ELEVATION COLOR
2S-300	SOUTH POTABLE TANK SECTIONS
2S-301	NORTH POTABLE TANK SECTIONS
2S-500	POTABLE TANK DETAILS I
2S-501	POTABLE TANK DETAILS II
2S-502	OVERFLOW MANHOLE PW-04 PLAN & SECTIONS
ARCHITECTURAL	
0A-001	ARCHITECTURAL LEGEND & ABBREVIATIONS
0A-002	ARCHITECTURAL GENERAL NOTES
1A-100	PUMP STATION LIFE SAFETY PLAN
1A-101	PUMP STATION FLOOR PLAN
1A-102	PUMP STATION ROOF PLAN
1A-200	ELEVATIONS NORTH & SOUTH ELEVATIONS
1A-201	ELEVATIONS EAST & WEST ELEVATIONS
1A-202	ENLARGED PLAN AND INTERIOR ELEVATIONS
1A-300	PUMP STATION BUILDING SECTIONS
1A-301	PUMP STATION WALL SECTIONS
1A-500	ARCHITECTURAL DETAILS I
1A-501	ARCHITECTURAL DETAILS II
1A-502	ARCHITECTURAL DETAILS III
1A-600	DOOR, WINDOW, & ROOM FINISH SCHEDULES
PLUMBING	
0P-001	PLUMBING GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS
0P-002	PLUMBING DETAILS AND SCHEDULES
0P-100	PLUMBING PLAN
PROCESS	
0D-001	PROCESS GENERAL NOTES, LEGEND, AND ABBREVIATIONS
0D-002	PUMP STATION PROCESS FLOW DIAGRAM
0D-003	EQUIPMENT AND VAULT SCHEDULE
0D-004	VALVE SCHEDULES
0D-005	PROCESS DETAILS
0D-100A	YARD PIPING PLAN I
0D-100B	YARD PIPING PLAN II
0D-101	VALVE VAULT PLANS
0D-102	VALVE VAULT ROOF PLANS
0D-300	VALVE VAULT SECTIONS
0D-500	PUMP STATION YARD PIPING DETAILS I
0D-501	PUMP STATION YARD PIPING DETAILS II
0D-502	PUMP STATION YARD PIPING DETAILS III
0D-503	PUMP STATION YARD PIPING DETAILS IV
0D-504	PUMP STATION YARD PIPING DETAILS V
0DP-100	YARD PIPING PLAN AND PROFILE 30" POTABLE TANK FILL/PS DISCHARGE STA. 00+00 TO STA. 02+84
0DP-101	YARD PIPING PLAN AND PROFILE 30" POTABLE TANK FILL STA. 00+00 TO STA. 05+33
0DP-102	YARD PIPING PLAN AND PROFILE 30" POTABLE TANK DISCHARGE STA. 00+00 TO STA. 06+24
0DP-103	YARD PIPING PLAN AND PROFILE 4" SAN SEWER STA. 00+00 TO STA. 04+80
0DP-104	YARD PIPING PLAN AND PROFILE 18"/24" POTABLE TANK OVERFLOW STA. 00+00 TO STA. 01+99
0DP-105	YARD PIPING PLAN AND PROFILE 18"/24" POTABLE TANK OVERFLOW STA. 00+00 TO STA. 01+82

COLORADO LICENSED PROFESSIONAL ENGINEER
47887
05/08/2025

no.	date	by	chk	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

BROOMFIELD TANKS
AND PUMP STATION
CITY AND COUNTY OF
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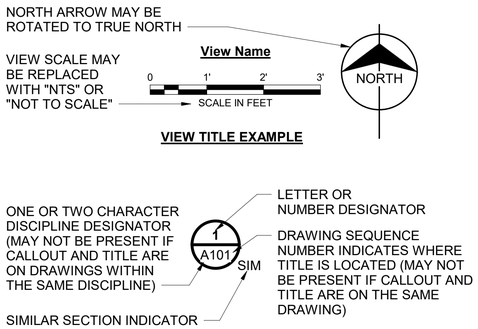
CITY AND COUNTY OF BROOMFIELD



Contract Drawings

NUMBER	NAME
0DP-106	YARD PIPING PLAN AND PROFILE 30" POTABLE COMB. OVERFLOW-DRAIN STA. 00+00 TO STA. 10+70
0DP-107	YARD PIPING PLAN AND PROFILE 30" POTABLE COMB. OVERFLOW-DRAIN STA. 10+70 TO STA. 20+05
0DP-108	YARD PIPING PLAN AND PROFILE CONTROL POINT TABLE
1D-100	PUMP STATION UPPER LEVEL PLAN
1D-101	PUMP STATION LOWER LEVEL PLAN
1D-102	ENLARGED POTABLE PUMP STATION PLAN
1D-300	POTABLE PUMP STATION SECTION
1D-301	POTABLE FILL VALVE SECTION
1D-400	POTABLE PUMP STATION ISOMETRIC
2D-100	NORTH POTABLE TANK PIPING PLAN
2D-101	SOUTH POTABLE TANK PIPING PLAN
MECHANICAL	
0M-001	MECHANICAL GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS
0M-002	MECHANICAL DETAILS
0M-003	MECHANICAL SCHEDULES
0M-100	MECHANICAL PLAN
0M-101	MECHANICAL ROOF PLAN
ELECTRICAL	
0E-001	ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES
0E-002	ELECTRICAL MATERIALS & AREA CLASSIFICATION
0E-003	ELECTRICAL DETAILS I
0E-004	ELECTRICAL DETAILS II
0E-005	ELECTRICAL DETAILS III
0E-006	ELECTRICAL DETAILS IV
0E-007	LIGHTING DETAILS - INTERIOR AND POLES
0ES-101	ELECTRICAL SITE PLAN - OVERALL
1ES-101	ELECTRICAL SITE PLAN - PUMP STATION
2ES-101	ELECTRICAL SITE PLAN - TANKS
1EI-100	LOWER LEVEL INSTRUMENTATION AND CONTROL PLAN
1EI-101	UPPER LEVEL INSTRUMENTATION AND CONTROL PLAN
1EL-100	LUMINAIRE SCHEDULE
1EL-101	UPPER LEVEL LIGHTING AND RECEPTACLE PLAN
1EP-100	LOWER LEVEL POWER AND GROUNDING PLAN
1EP-101	UPPER LEVEL POWER AND GROUNDING PLAN
1EP-102	ROOF POWER AND GROUNDING PLAN
1EP-600	POTABLE WATER ONE-LINE DIAGRAM
1EP-610	POTABLE WATER CONNECTION DIAGRAM
1EP-620	VFD SCHEMATIC
1EP-621	LIGHTING CONTROL SCHEMATIC
1EP-630	LOAD CALCULATIONS AND PANEL SCHEDULES
1EP-631	DUCTBANK SCHEDULE
1ET-600	POTABLE WATER -NETWORK ARCHITECTURE
P&IDS	
0I-001	LEGEND I P&ID
0I-002	LEGEND II P&ID
0I-003	POTABLE TANK P&ID
0I-004	POTABLE PUMP STATION I P&ID
0I-005	POTABLE PUMP STATION II P&ID
0I-006	POTABLE WATER INSTRUMENTATION P&ID
LANDSCAPING	
0L-100	EXISTING LANDSCAPE / SITE REMOVALS PLAN
0L-101	OVERALL SITE PLAN
0L-102	OVERALL GRADING & RESTORATION PLAN
1L-103	TRAIL HEAD AREA SITE PLAN ENLARGEMENT
0L-500	SITE DETAILS

NUMBER	NAME
0L-501	SITE DETAILS
2L-104	LANDSCAPE PLAN ENLARGEMENT @ TRAIL HEAD
2L-105	LANDSCAPE PLAN ENLARGEMEN @ IRVING COURT
IRRIGATION	
0I-106	IRRIGATION PLAN @ TRAIL HEAD
0I-107	IRRIGATION PLAN @ IRVING COURT
0I-108	IRRIGATION PLAN @ IRVING COURT IRRIGATION DETAILS

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GENERAL CIVIL NOTES:

1. BEARINGS AND COORDINATES ARE RELATIVE TO THE NAD 83 COLORADO STATE PLANES, CENTRAL ZONE, US FOOT (CO83-CF). SEE SHEET 0CX-101 FOR ADDITIONAL SURVEY AND COORDINATE INFORMATION.
2. ALL DIMENSIONS, ELEVATIONS, AND STATIONS ARE IN FEET, UNLESS INDICATED OTHERWISE.
3. CALLOUTS, COORDINATES, AND DIMENSIONS ARE POINTED TO OR MEASURED TO EDGE OF PAVEMENT, BACK OF CURB, OR OUTSIDE FACE OF FOUNDATION WALL, UNLESS INDICATED OTHERWISE.
4. THE CONTRACTOR SHALL CONTACT THE UTILITY NOTIFICATION CENTER OF COLORADO AT LEAST TWO BUSINESS DAYS PRIOR TO CONSTRUCTION, NOT INCLUDING DAY OF NOTIFICATION. CALL 811 OR 1-(800) 922-1987.
5. THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL REQUIRED PERMITS PRIOR TO THE COMMENCEMENT OF ANY WORK ON THE PROJECT, OR AS APPROVED BY THE OWNER. CONTRACTOR SHALL COORDINATE ALL REQUIRED INSPECTIONS WITH THE APPROPRIATE ADMINISTRATIVE AUTHORITY. COST OF ANY PERMITS AND FEES ASSOCIATED SHALL BE PAID BY CONTRACTOR.
6. ALL WORK SHALL BE SUBJECT TO INSPECTION BY AUTHORIZED PERSONNEL OF LOCAL AND GOVERNMENT REGULATORY AGENCIES AND THE CONTRACTOR.
7. THE CONTRACTOR SHALL CONFINE GRADING AND CONSTRUCTION ACTIVITIES TO WITHIN THE OWNER'S PROPERTY. DISTURBANCES TO THE PROPERTY SHALL BE RESTORED TO THE ORIGINAL CONDITION AS INDICATED.
8. IT SHALL BE THE CONTRACTOR'S RESPONSIBILITY TO NOTIFY THE ENGINEER OF ANY PROBLEM IN CONFORMING TO THE APPROVED GRADES AS INDICATED FOR ANY ELEMENT OF THE PROPOSED IMPROVEMENTS PRIOR TO CONSTRUCTION.
9. THE CONTRACTOR SHALL PROVIDE ALL TRAFFIC CONTROL NECESSARY TO COMPLETE THE WORK, INCLUDING ANY MOBILIZATION OF EQUIPMENT ON PUBLIC ROADWAYS. ALL TRAFFIC CONTROL DEVICES AND METHODS OF CONTROLLING TRAFFIC THROUGH CONSTRUCTION ZONES SHALL BE IN ACCORDANCE WITH THE LATEST EDITION OF THE "MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES" (M.U.T.C.D.), FEDERAL HIGHWAY ADMINISTRATION, AND ALL REVISIONS THERETO (INCLUDING STATE SUPPLEMENTS).
10. UNDERGROUND FACILITIES, STRUCTURES, AND UTILITIES HAVE BEEN PLOTTED FROM AVAILABLE SURVEYS AND RECORDS; AND, THEREFORE, THEIR LOCATIONS MUST BE CONSIDERED APPROXIMATE ONLY. IT IS POSSIBLE THERE MAY BE OTHERS, THE EXISTENCE OF WHICH ARE PRESENTLY NOT KNOWN OR SHOWN. IT IS THE CONTRACTOR'S RESPONSIBILITY TO DETERMINE THEIR EXISTENCE AND EXACT LOCATION AND TO AVOID DAMAGE THERETO. CONTRACTOR SHALL PROVIDE THE COST OF ANY POTHOLING OR UNDERGROUND INVESTIGATIONS DEEMED NECESSARY TO IDENTIFY AND LOCATE EXISTING FACILITIES AND/OR UTILITIES.
11. THE CONTRACTOR IS RESPONSIBLE FOR THE PREVENTION OF DAMAGE TO ADJACENT PROPERTY. NO PERSON SHALL EXCAVATE ON LAND SO CLOSE TO THE PROPERTY LINE AS TO ENDANGER ANY ADJOINING IMPROVEMENTS, SIDEWALK, ALLEY OR UTILITY WITHOUT SUPPORTING AND PROTECTING SUCH PROPERTY FROM SETTLING, OR OTHER DAMAGE THAT MIGHT RESULT FROM THE WORK PRESCRIBED ON THIS PLAN. THE LOCAL AGENCY WILL HOLD THE CONTRACTOR RESPONSIBLE FOR CORRECTION OF DAMAGE TO ADJACENT PROPERTY, PUBLIC OR PRIVATE.
12. WHEN CONSTRUCTION WORK RESTRICTED TO BEING PERFORMED WITHIN EASEMENTS, CONTRACTOR SHALL CONFINE WORK WITHIN THE PERMANENT AND TEMPORARY EASEMENTS.
13. THE CONTRACTOR SHALL PROVIDE ADEQUATE DRAINAGE FOR PROPERTIES ADJACENT TO THE PROJECT DURING CONSTRUCTION.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PRESERVING PROPERTY MONUMENTATION, AND WILL BE REQUIRED TO RE-ESTABLISH, AT HIS/HER EXPENSE, ANY MONUMENTATION WHICH IS DAMAGED OR DESTROYED DURING CONSTRUCTION OPERATIONS. SUCH MONUMENTATION SHALL BE RE-ESTABLISHED BY A LICENSED LAND SURVEYOR IN ACCORDANCE WITH STATE LAWS.
15. CONTRACTOR IS RESPONSIBLE FOR THE SAFE AND SECURE STORING OF GOODS, MATERIALS, AND EQUIPMENT ONSITE. CONTRACTOR SHALL COORDINATE THE FINAL LOCATION OF STORAGE AND LAYDOWN AREAS WITH THE OWNER PRIOR TO CONSTRUCTION.
16. ALL WORK SHALL BE CONDUCTED IN A PROFESSIONAL WORKMANSHIP MANNER USING QUALITY MATERIALS.
17. CONTRACTOR SHALL RESTORE ALL EARTH AREAS OUTSIDE OF THE PROPOSED PAVEMENT AND/OR CRUSHED ROCK SURFACING LIMITS AND WITHIN THE PROJECT LIMITS IN ACCORDANCE WITH THE PROJECT SPECIFICATIONS.
18. TREES AND SHRUBS WITHIN THE CONSTRUCTION LIMITS WHICH ARE IN DIRECT CONFLICT WITH PROPOSED NEW CONSTRUCTION SHALL BE PROTECTED AND REMOVED AND SAVED BY THE CONTRACTOR. TREES AND SHRUBS WHICH ARE NOT IN DIRECT CONFLICT SHALL BE SAVED AND PROTECTED FROM DAMAGE.
19. THE CONTRACTOR SHALL PROVIDE ALL TEMPORARY POWER, PROCESS, AND UTILITY SERVICE BYPASSES AND CONNECTIONS REQUIRED BY THE WORK AND TO SUSTAIN CONTINUOUS OPERATIONS OF THE FACILITY.
20. THE CONTRACTOR SHALL DEVELOP A DEWATERING AND EROSION CONTROL PLAN WITHIN THE GUIDELINES AND CONSTRAINTS OUTLINED IN THE DRAWINGS. ALL EROSION AND SEDIMENT CONTROL MATERIALS AND PROCEDURES SHALL BE IN ACCORDANCE WITH LOCAL PRINCIPLES AND THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) SPECIFICATIONS. IF NECESSARY, DESIGNER/BUILDER SHALL OBTAIN ALL PERMITS TO COMPLY WITH NPDES AND STATE REQUIREMENTS.
21. ALL WORK SHALL BE CONDUCTED IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS AND LOCAL AND GOVERNMENT CODES, ORDINANCES, AND REGULATIONS. IN CASE OF CONTRADICTION OR DISCREPANCY BETWEEN REQUIREMENTS, CONTRACTOR SHALL INCORPORATE WHICHEVER IS MOST STRINGENT. WHERE A QUESTION REMAINS ON WHICH REQUIREMENT IS MOST STRINGENT, CONTRACTOR SHALL SUBMIT ISSUE TO THE ENGINEER IN WRITING. THE DECISION OF THE ENGINEER SHALL BE CONSIDERED FINAL.
22. NO ACTIVITY MAY USE UNSUITABLE MATERIAL (E.G. TRASH, DEBRIS, CAR BODIES, ASPHALT, ETC.). MATERIAL USED FOR CONSTRUCTION OR DISCHARGED MUST BE FREE FROM TOXIC POLLUTANTS IN TOXIC AMOUNTS (SEE SECTION 307 OF THE CLEAN WATER ACT).
23. TEMPORARY FILLS MUST BE REMOVED IN THEIR ENTIRETY AND THE AFFECTED AREAS RETURNED TO PRE-CONSTRUCTION ELEVATIONS. ALL TEMPORARILY DISTURBED AREAS SHALL BE RESTORED TO THE PRE-CONSTRUCTION CONDITIONS.
24. CONTRACTOR SHALL SUBMIT A CONCRETE JOINTING PLAN TO ENGINEER FOR APPROVAL. MINIMUM JOINTING PATTERN SHOULD BE 10'X10' UNLESS OTHERWISE NOTED.

CIVIL LEGEND AND SYMBOLOGY

SCREENED OR GRAYSCALE ITEMS REPRESENT EXISTING FEATURES

LINE SYMBOLOGY

- E — ELECTRIC LINE (BURIED)
- G — GAS LINE (BURIED)
- FO — FIBER OPTIC LINE (BURIED)
- SS — SANITARY SEWER
- ST — STORM SEWER
- W — WATER LINE
- SSFM — SAN SEWER FORCE MAIN
- ROAD CENTERLINE
- PL — PROPERTY LINE
- UD — UNDERDRAIN
- IRR — IRRIGATION
- W(M) — WATER LINE (MAPPED)
- 5600 — CONTOUR (EXIST)
- 5600 — CONTOUR (PROPOSED)
- XXX — FENCE
- BUILDING OUTLINE
- P/E — UTILITY EASEMENT
- R/W — RIGHT-OF-WAY
- SWALE CENTERLINE
- PROPOSED WATER ALIGNMENT
- LIMITS OF SITE DRONE SURVEY

SYMBOLS (UTILITIES)

- SANITARY SEWER MH
- STORMWATER MH
- WATER MH
- WATER VALVE
- HYDRANT
- PROPOSED WATER MH
- PROPOSED WATER VAULT

SYMBOLS (MISC)

- CONIFEROUS TREE
- DECIDUOUS TREE
- SIGN POST
- LIGHT POLE
- EXCAVATION SLOPE

PATTERNS

- CONCRETE
- ASPHALT
- GRAVEL
- DEMO
- RAIN GARDEN

ABBREVIATIONS:

@	AT
Ø	DIAMETER
'	FOOT OR FEET
"	INCH OR INCHES
#	NUMBER
%	PERCENT
APPROX	APPROXIMATE
ASPH	ASPHALT
ASTM	AMERICAN SOCIETY FOR TESTING & MATERIALS
ATG	ADJUST TO GRADE
BC	BACK OF CURB
BLDG	BUILDING
BO	BY OTHERS
BOP	BOTTOM OF PIPE
BSC	BOLTED SLEEVE COUPLING
C&G	CURB AND GUTTER
CATV	CABLE TELEVISION
CCOB	CITY AND COUNTY OF BROOMFIELD
CDOT	COLORADO DEPARTMENT OF TRANSPORTATION
CL	CENTERLINE
CIS	CENTER IN SLAB
CMP	CORRUGATED METAL PIPE
CNTR	CENTER
CO	CLEAN-OUT
CONC	CONCRETE
CONSTR	CONSTRUCTION
CP	CONTROL POINT
CWA	CONCRETE WASHOUT AREA
DESC	DESCRIPTION
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DND	DO NOT DISTURB
DWG	DRAWING
E	EAST OR EASTING
EBOX	ELECTRIC BOX
ECB	EROSION CONTROL BLANKET
EFF	EFFLUENT
ELEC	ELECTRIC
EL OR ELEV	ELEVATION
EOA	EDGE OF ASPHALT
ESMT	EASEMENT
ETC	ETCETERA
EW	EACH WAY
EXIST	EXISTING
EXP	EXPANSION
FC	FACE OF CURB
FF	FINISHED FLOOR
FG	FINISHED GRADE
FH	FIRE HYDRANT
FL	FLOWLINE
FT	FOOT OR FEET
GAL	GALLON
GM	GAS METER
GS	GALVANIZED STEEL
HDPE	HIGH DENSITY POLYETHYLENE
HMA	HOT MIX ASPHALT
HP	HIGHPOINT

ABBREVIATIONS (CONT):

ICV	IRRIGATION CONTROL VALVE
IP	INLET PROTECTION
INV	INVERT
LF	LINEAR FEET
LOC	LIMITS OF CONSTRUCTION
LP	LIGHT POLE
MAX	MAXIMUM
MH	MANHOLE
MHFD	MILE HIGH FLOOD DISTRICT
MIN	MINIMUM
N	NORTH OR NORTHING
N/A	NOT APPLICABLE
NO	NUMBER
OC	ON CENTER
POC	POINT OF CURVATURE
PI	POINT OF INTERSECTION
PCC	PORTLAND CEMENT CONCRETE
PP	POWER POLE
PRC	POINT OF REVERSE CURVATURE
PROP	PROPOSED
PT	POINT OF TANGENCY
PVMT	PAVEMENT
R	RADIUS
R&R	REMOVE AND REPLACE
R/W OR ROW	RIGHT-OF-WAY
RCP	REINFORCED CONCRETE PIPE
RS	ROCK SOCK
S	SOUTH
SAN	SANITARY
SCH	SCHEDULE
SCL	SEDIMENT CONTROL LOG
SDWK	SIDEWALK
SF	SILT FENCE
SM	SEEDING AND MULCHING
SPEC	SPECIFICATION
SSA	STABILIZED STAGING AREA
STA	STATION
STD	STANDARD
STRUC	STRUCTURAL
TBA	TO BE ABANDONED
TBD	TO BE DETERMINED
TBR	TO BE REMOVED (BY CONTRACTOR)
TBR&R	TO BE REMOVED AND REPLACED (BY CONTRACTOR)
TBRBO	TO BE REMOVED BY OTHERS
TBR&RBO	TO BE REMOVED AND REPLACED BY OTHERS
TC	TOP OF CURB
TH	THICKNESS
TOW	TOP OF WALL
TP	TOP OF PAVEMENT
TPED	TELEPHONE PEDESTAL
TRANSF	TRANSFORMER
TYP	TYPICAL
UIP	USE IN PLACE
VTC	VEHICLE TRACKING CONTROL
W	WEST
WM	WATER METER
WMH	WATER MANHOLE
WQCV	WATER QUALITY CAPTURE VOLUME
WTR	WATER
WV	WATER VALVE
WWF	WELDED WIRE FABRIC

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date: MAY 2025	detailed by: C. HARRIS
designed by: C. HARRIS	checked by: J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

CIVIL NOTES, ABBREVIATIONS & LEGEND

project: 135303	contract:
drawing: 0C-001	rev.: 1
sheet:	of: sheets
file: 135303_0C-001-X_NAL.dwg	

COLORADO LICENSED · JOSHUA LEE · 45206 · PROFESSIONAL ENGINEER · 05/08/2025

POINT TABLE			
POINT	ELEVATION	NORTHING	EASTING
CP 101	5405.36	1233070.8960	3130599.9970
CP 102	5416.03	1233451.2810	3130650.0720
CP 103	5418.38	1233516.3540	3130724.6260
CP 104	5409.94	1233648.2320	3130629.8380
CP 105	5449.20	1233665.7370	3130866.5030
CP 106	5429.61	1233920.7860	3131728.8230

KING COURT
IRVING COURT
LOWELL BLVD
W 152ND AVENUE
EXISTING RETAINING WALL
EXISTING LANDSCAPING BOULDER (TYP)
EXISTING BENCH AND LOOKOUT
EXISTING BROZOVICH MA 8-13 WELL WORKOVER EASEMENT
50'
100'
PARCEL NO. 157308306117
CITY AND COUNTY OF BROOMFIELD
TRACT E 3.67 AC
PARCEL NO. 157308306114
CITY AND COUNTY OF BROOMFIELD
TRACT B 98.31 AC
EXISTING WOODEN FENCE WITH ORNAMENTAL PILLARS
EXISTING RETAINING WALL
EXISTING SIGN
EXISTING SIGN (TYP)
EXISTING WOODEN PRIVACY FENCE
EXISTING XCEL ELECTRIC VAULT
EXISTING CONCRETE SIDEWALK
EXISTING CONCRETE CURB AND GUTTER
EXISTING ASPHALT PARKING LOT
EXISTING CAPPED AND ABANDONED UNDERGROUND GAS LINE
EXISTING LANDSCAPING BOULDER (TYP)
EXISTING BENCH (TYP)
EXISTING TREE (TYP)
EXISTING PVC IRRIGATION PIPE (ABOVE GRADE)
EXISTING GRAVEL FINES TRAIL
LIMITS OF SITE DRONE SURVEY (SEE NOTE 1)
32'
PERMANENT UTILITY EASEMENT (WIDTH VARIES)
CP 101
CP 102
CP 103
CP 104
CP 105
CP 106

EXISTING CONDITIONS & SURVEY CONTROL PLAN

0 60' 120'
SCALE IN FEET

NORTH

GENERAL NOTES:

1. THE SITE SURVEY WAS COMPLETED BY AERIAL DRONE BY ENCOMPASS ENERGY SERVICES, LLC, IN FEBRUARY 2022 IN US SURVEY FEET.
2. ADDITIONAL TOPOGRAPHIC DATA WAS PROVIDED BY THE CITY AND COUNTY OF BROOMFIELD FROM LIGHT DETECTION AND RANGING (LiDAR) ELEVATION DATA GATHERED BY EAGLEVIEW TECHNOLOGIES INC. IN 2017. THIS ELEVATION DATA HAS NOT BEEN VERIFIED WITH THE SITE DRONE SURVEY CONTROL POINTS AND IS FOR REFERENCE ONLY.
3. HORIZONTAL CONTROL IS BASED ON THE 1983(11) NORTH AMERICAN DATUM (NAD83) COLORADO STATE PLANE COORDINATE SYSTEM, NORTH ZONE (CO83-NF).
4. VERTICAL CONTROL IS BASED ON THE 1988 NORTH AMERICAN VERTICAL DATUM (NAVD88).

COLORADO LICENSED
JOSHUA LEE
45206
05/08/2025
PROFESSIONAL ENGINEER

no.	date	by	ckd	description
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1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

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BROOMFIELD TANKS AND PUMP STATION
EXISTING CONDITIONS & SURVEY CONTROL PLAN

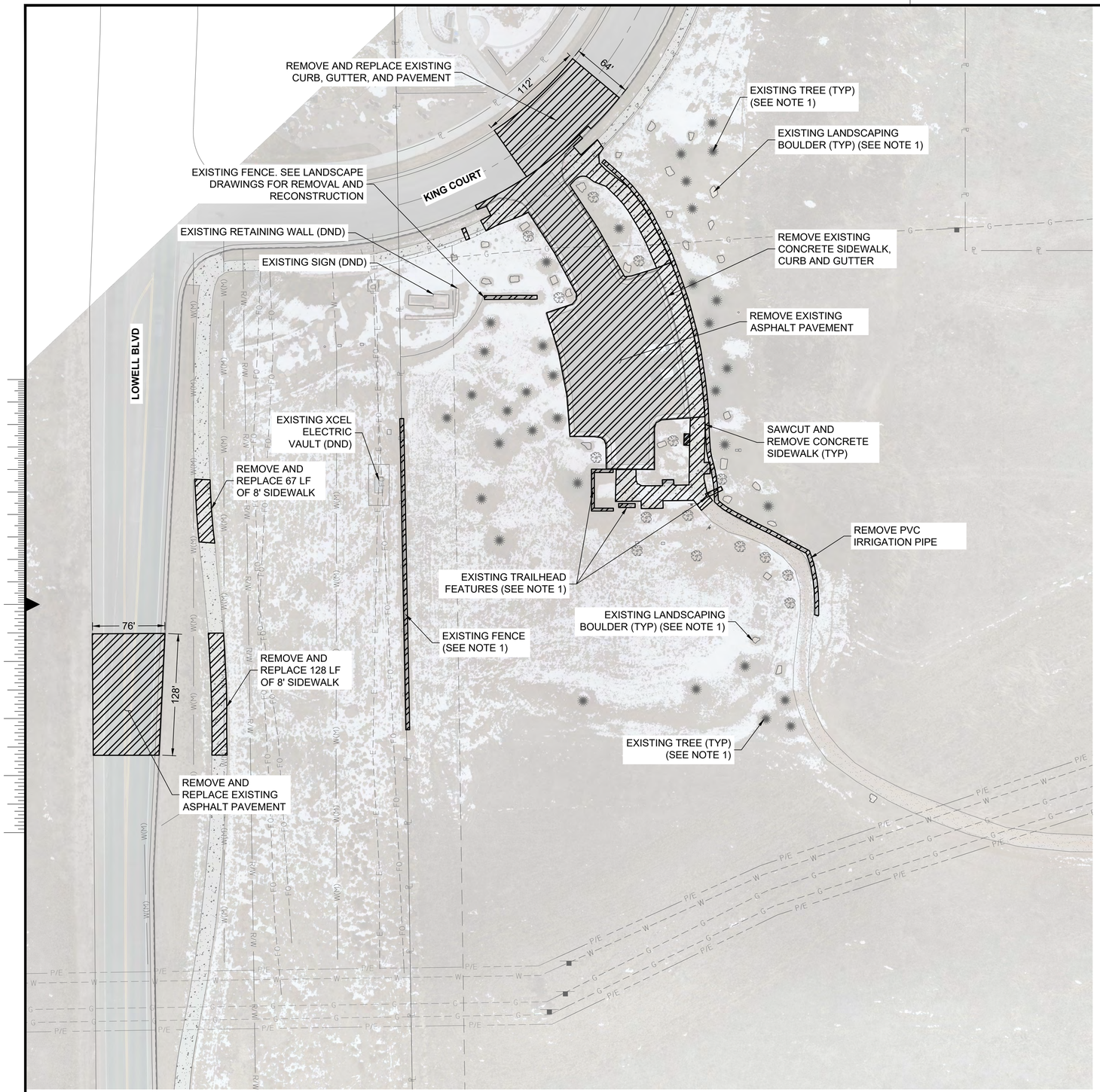
project	contract
135303	

drawing **0CX-101** rev. **1**

sheet of sheets

file 135303_0CX-101.dwg

Millimeters
Inches
Scale For Microfilming

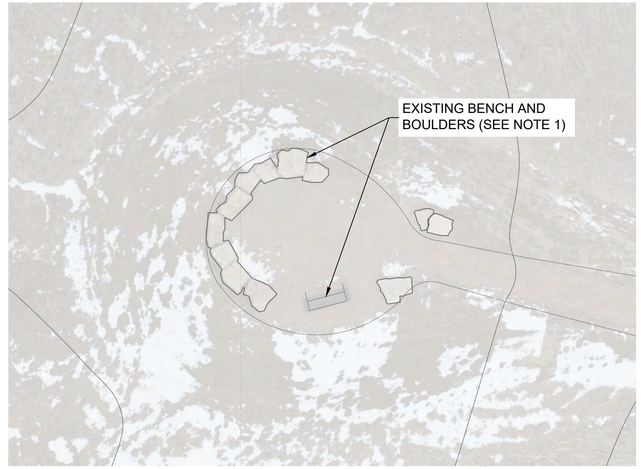


DEMOLITION PLAN - PARKING AREA

0 30' 60'

SCALE IN FEET

NORTH



DEMOLITION PLAN - LOOKOUT AREA

0 10' 20'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. SEE LANDSCAPE DRAWINGS FOR REMOVAL, PROTECTION, AND RELOCATION OF EXISTING LANDSCAPE FEATURES.

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date: MAY 2025	detailed by: C. HARRIS
designed by: C. HARRIS	checked by: J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
DEMOLITION PLAN

project: 135303	contract:
drawing: 0CD-101	rev.: 1
sheet:	of sheets
file: 135303_0CD-101_DEMO.dwg	

Scale For Microfilming
Millimeters
Inches

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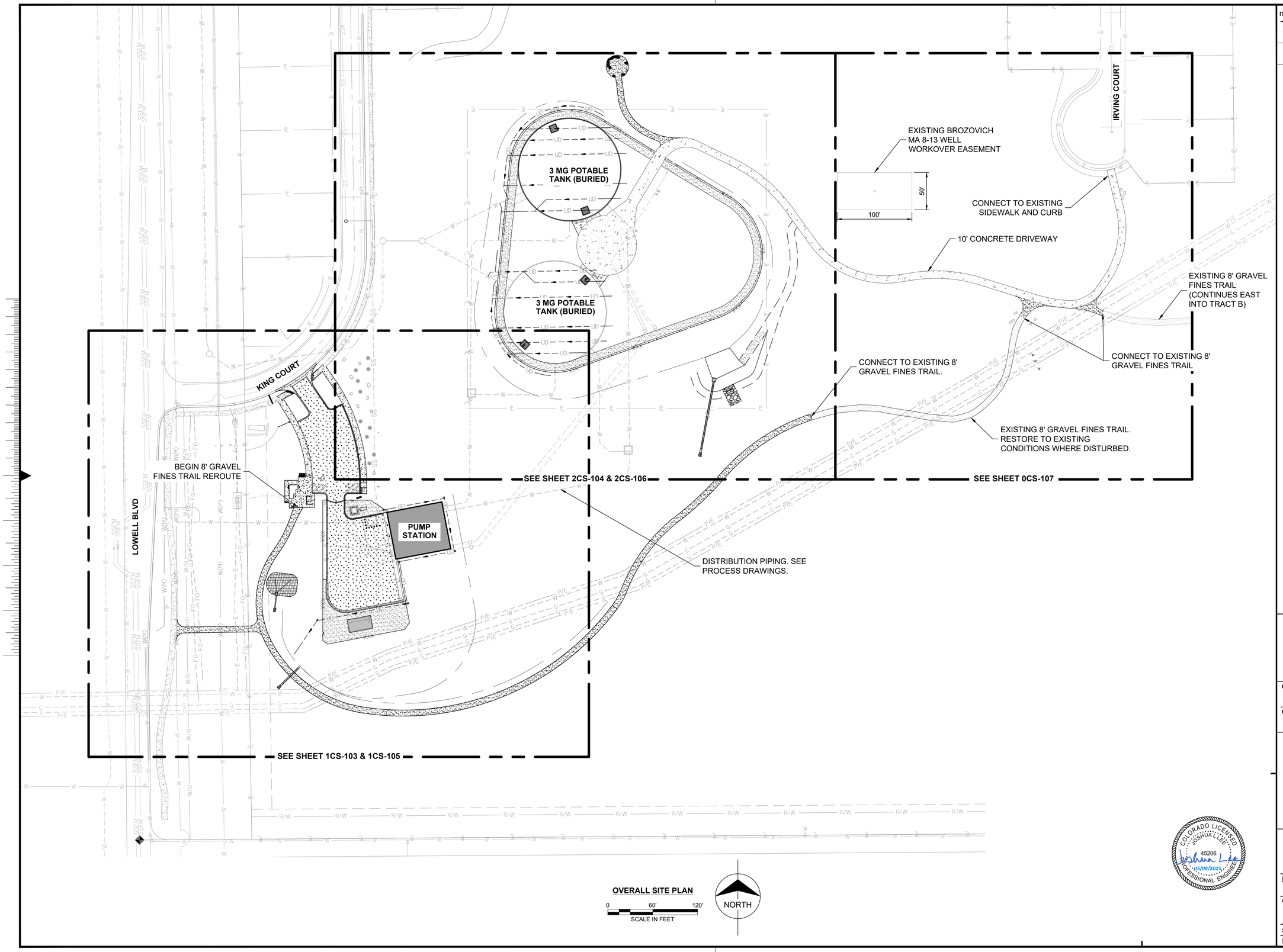

OVERALL SITE PLAN

0 60' 120'

SCALE IN FEET

NORTH

Scale For Microfilming

Millimeters

Inches

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
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MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

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BROOMFIELD, COLORADO

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BROOMFIELD TANKS AND PUMP STATION
OVERALL SITE PLAN

project	contract
135303	

drawing **0CS-102** rev. **1**

sheet of sheets

file 135303_0CS-102.dwg

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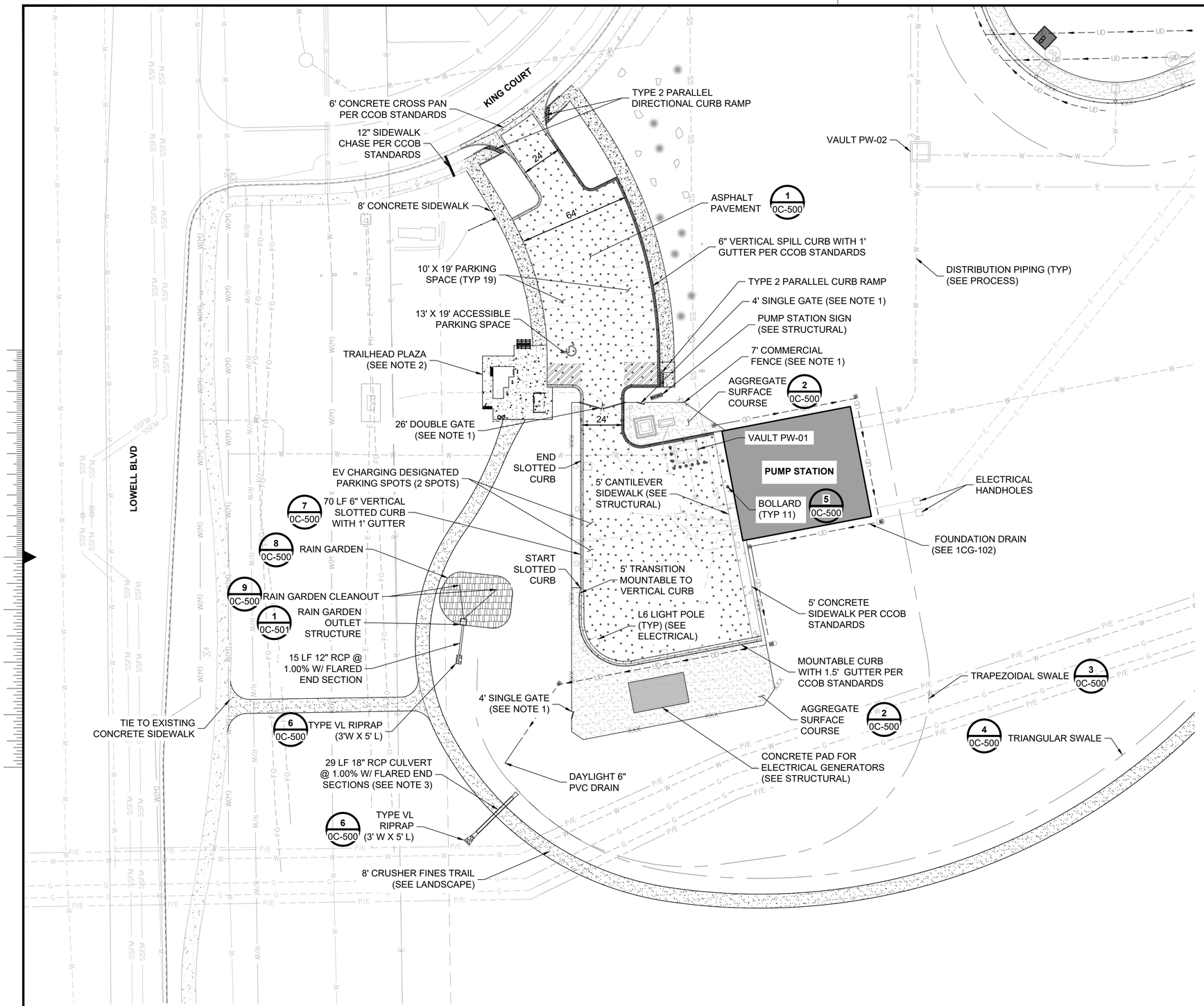

PUMP STATION SITE PLAN

0 30' 60'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. SEE LANDSCAPING DRAWINGS FOR FENCE AND GATE DETAILS.
2. SEE LANDSCAPING DRAWINGS FOR TRAILHEAD PLAZA FEATURES AND DETAILS.
3. RCP CULVERT SHALL BE INSTALLED IN ACCORDANCE WITH CDOT STANDARD PLAN M-603-2. FLARED END SECTION SHALL MEET THE REQUIREMENTS OF CDOT STANDARD PLAN M-603-10.

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
PUMP STATION SITE PLAN

project	contract
135303	

drawing **1CS-103** rev. **1**

sheet of sheets

file 135303_1CS-103.dwg

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Scale For Microfilming: Millimeters / Inches

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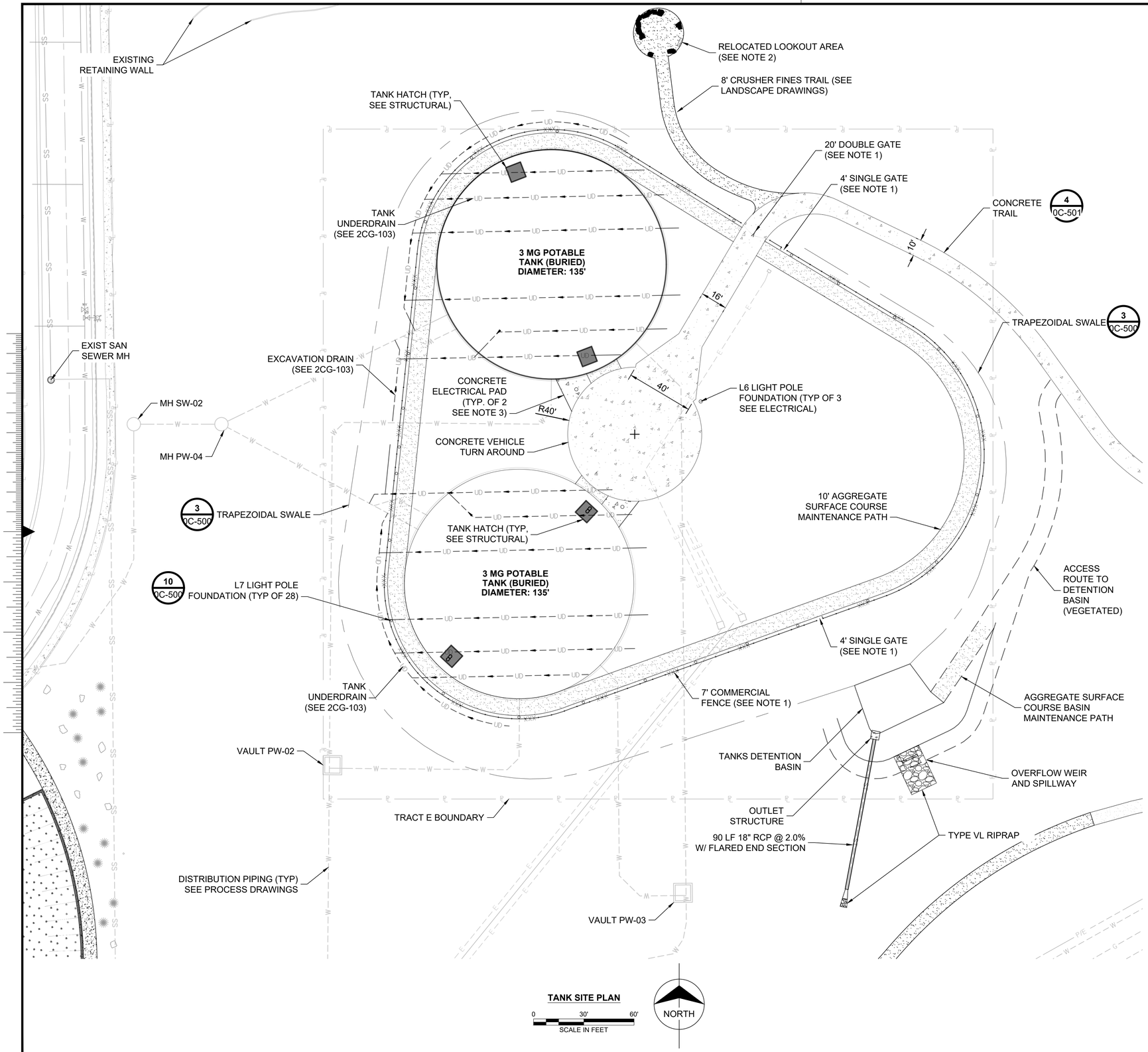

TANK SITE PLAN

0 30' 60'

SCALE IN FEET

Scale For Microfilming: Millimeters / Inches

GENERAL NOTES:

1. SEE LANDSCAPING DRAWINGS FOR FENCE AND GATE DETAILS.
2. SEE LANDSCAPING DRAWINGS FOR LOOKOUT FEATURES AND DETAILS. EXACT LOCATION OF LOOKOUT AREA TO BE COORDINATED WITH CCOB STAFF AND OPEN SPACE AND TRAILS STAFF.
3. CONCRETE ELECTRICAL PAD TO BE HOUSEKEEPING PAD PER STRUCTURAL, CONDUIT AND PENETRATIONS TO BE COORDINATED WITH ELECTRICAL.

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0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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MAY 2025	C. HARRIS
designed by	**checked by**
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COLORADO LICENSED JOSHUA LEE 45206 PROFESSIONAL ENGINEER 05/08/2025

BROOMFIELD TANKS AND PUMP STATION
TANK SITE PLAN

project	contract
135303	

drawing **2CS-104** rev. **1**

sheet of sheets

file 135303_2CS-104.dwg

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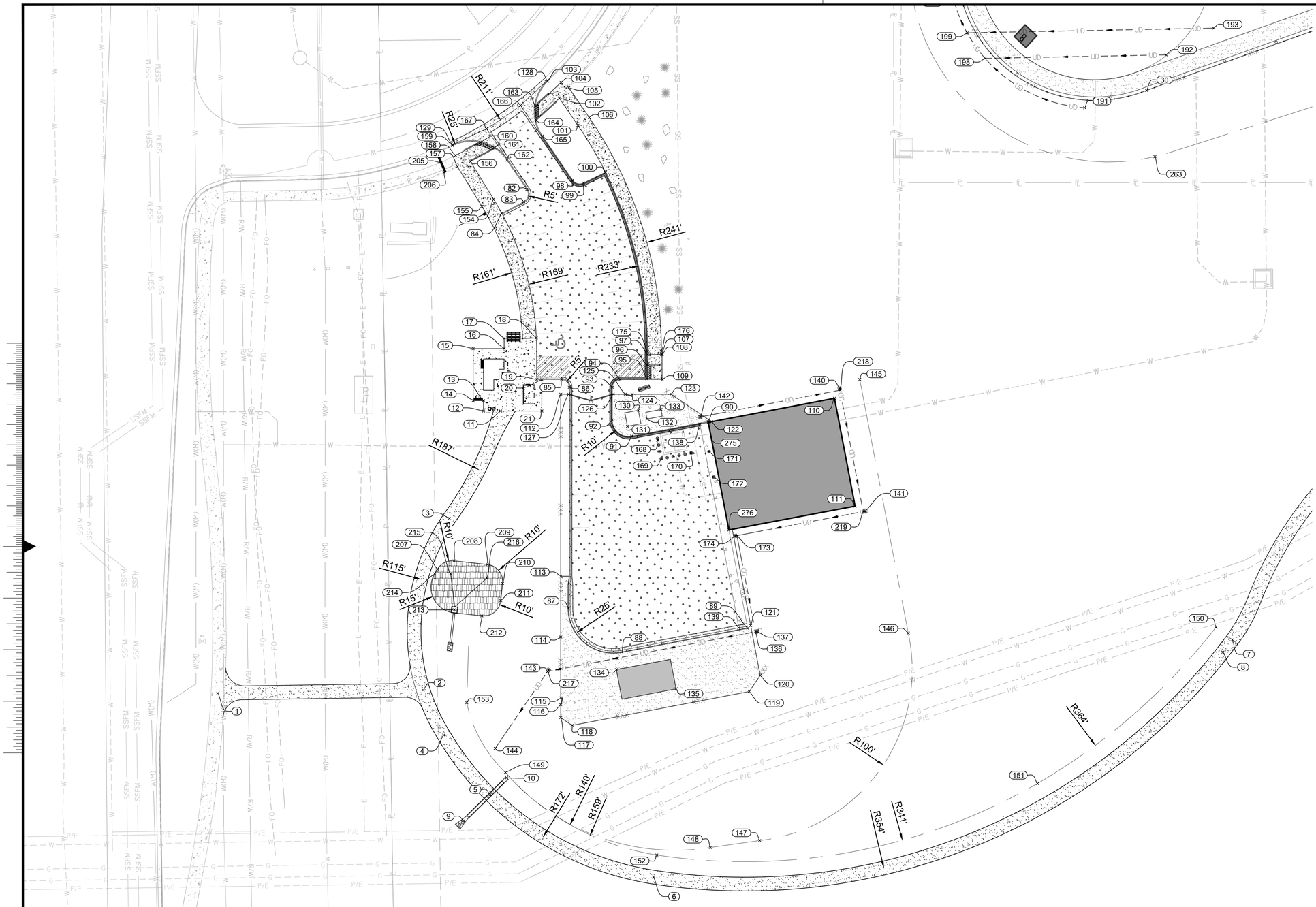

Scale For Microfilming
Millimeters
Inches

PUMP STATION CONTROL POINT PLAN

0 30' 60'
SCALE IN FEET

NORTH

no.	date	by	ckd	description
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CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

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JOSHUA LEE
45206
05/08/2025
PROFESSIONAL ENGINEER

BROOMFIELD TANKS AND PUMP STATION
PUMP STATION CONTROL POINT PLAN

project	contract
135303	

drawing **1CS-105** rev. **1**

sheet of sheets

file 135303_1CS-105.dwg

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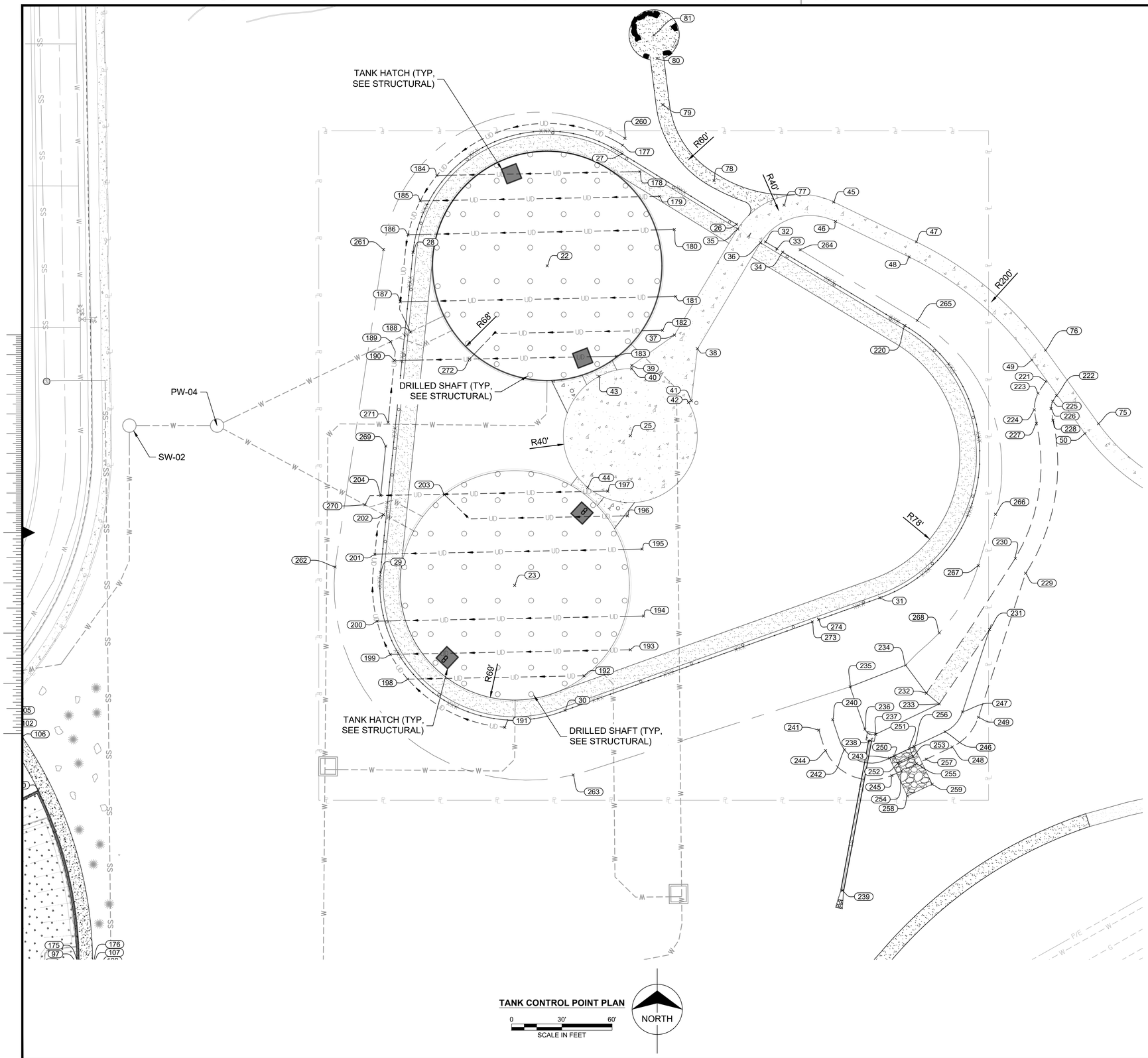

Scale For Microfilming
Millimeters
Inches

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BROOMFIELD TANKS AND PUMP STATION
TANK CONTROL POINT PLAN

project	contract
135303	

drawing **2CS-106** rev. **1**

sheet of sheets

file 135303_2CS-106.dwg

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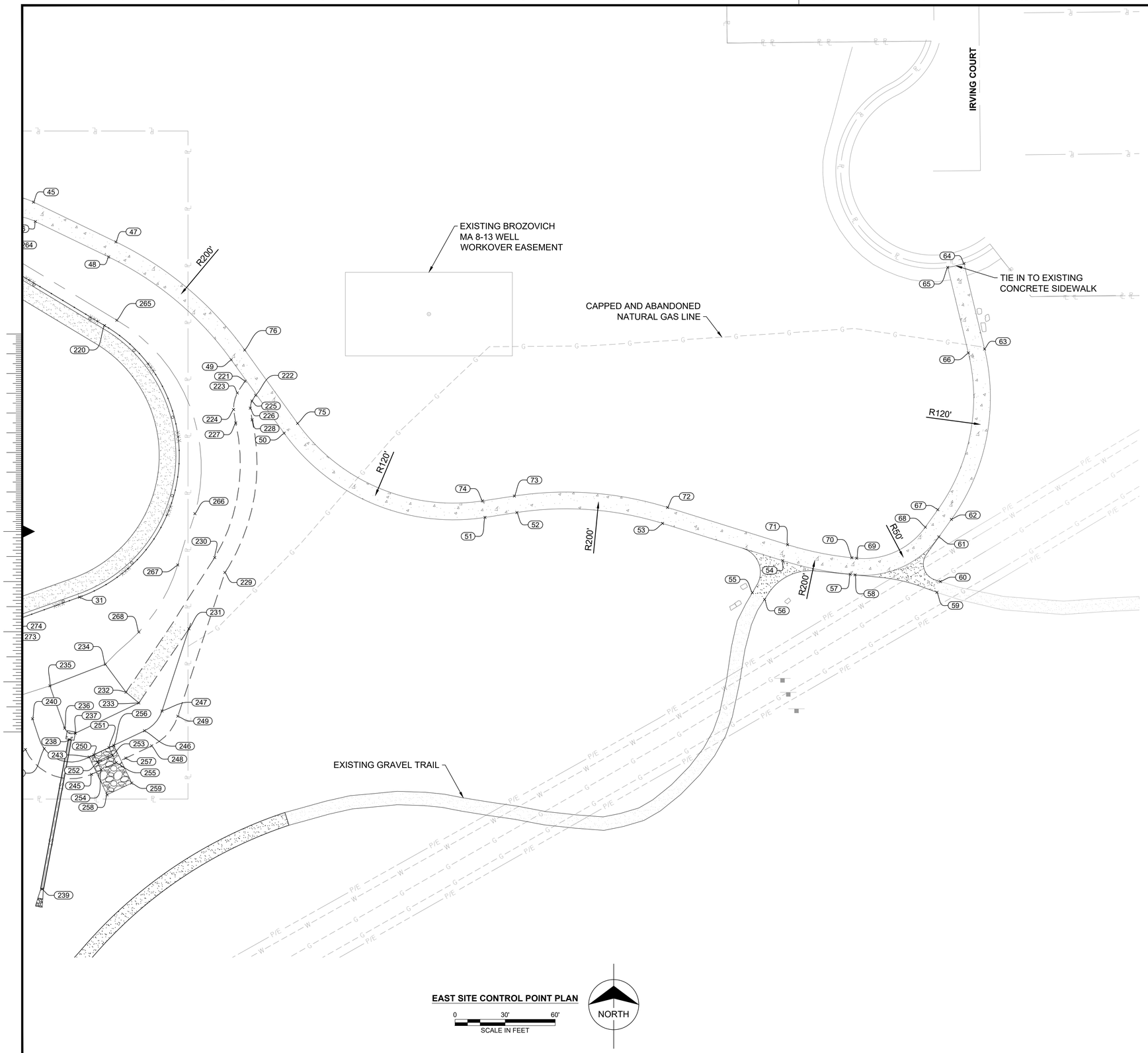

EAST SITE CONTROL POINT PLAN

0 30' 60'

SCALE IN FEET

NORTH

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
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Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

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COLORADO LICENSED JOSHUA LEE 45206 PROFESSIONAL ENGINEER 05/08/2025

BROOMFIELD TANKS AND PUMP STATION
EAST SITE CONTROL POINT PLAN

project	contract
135303	

drawing **0CS-107** rev. **1**

sheet of sheets

file 135303_0CS-107.dwg

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CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	1233332.8250	3130486.6745	5406.77	GRAVEL TRAIL - CONNECT EXISTING
2	1233334.6316	3130606.0082	5412.46	GRAVEL TRAIL CENTERLINE
3	1233434.4817	3130621.1892	5414.45	GRAVEL TRAIL CENTERLINE
4	1233308.4428	3130617.9950	5411.90	GRAVEL TRAIL CENTERLINE
5	1233273.7919	3130644.9518	5412.75	GRAVEL TRAIL CENTERLINE
6	1233225.8875	3130739.8837	5415.13	GRAVEL TRAIL CENTERLINE
7	1233363.8281	3131076.3905	5428.90	GRAVEL TRAIL CENTERLINE
8	1233356.6880	3131070.9220	5428.59	GRAVEL TRAIL CENTERLINE
9	1233258.7029	3130629.6373	5409.58	CULVERT OUTLET FES
10	1233283.6295	3130654.5659	5409.87	CULVERT INLET FES
11	1233496.9112	3130651.0152	5414.69	GRAVEL TRAIL CENTERLINE
12	1233496.9112	3130641.1079	5414.66	CONCRETE PAVEMENT CORNER
13	1233502.9112	3130641.1079	5414.66	CONCRETE PAVEMENT CORNER
14	1233502.9112	3130635.1079	5414.66	CONCRETE PAVEMENT CORNER
15	1233533.1659	3130635.1079	5414.27	CONCRETE PAVEMENT CORNER
16	1233533.1659	3130653.1079	5414.09	CONCRETE PAVEMENT CORNER
17	1233539.1611	3130653.1044	5414.03	CONCRETE PAVEMENT CORNER
18	1233539.3666	3130671.8423	5413.32	CONCRETE PAVEMENT CORNER
19	1233515.1659	3130672.0190	5414.54	CONCRETE PAVEMENT CORNER
20	1233515.1659	3130675.0067	5414.63	CONCRETE PAVEMENT CORNER
21	1233496.9112	3130675.0067	5414.99	CONCRETE PAVEMENT CORNER
22	1233948.8022	3131015.8852	5435.02	TANK FF CENTER - NORTH POTABLE
23	1233757.9958	3130996.4788	5435.11	TANK FF CENTER - SOUTH POTABLE
25	1233847.3985	3131065.5312	5470.75	CONCRETE CENTER (80' DIA)
26	1233973.6032	3131128.9604	5466.01	20 LF VEHICLE SWING GATE
27	1234015.7187	3131060.6338	5463.38	7' COMMERCIAL FENCE
28	1233956.9001	3130935.7936	5463.34	7' COMMERCIAL FENCE
29	1233765.8894	3130916.3667	5463.19	7' COMMERCIAL FENCE
30	1233683.3211	3131026.5444	5461.41	7' COMMERCIAL FENCE
31	1233750.5275	3131214.4268	5459.01	7' COMMERCIAL FENCE
32	1233963.1540	3131146.2188	5466.00	20 LF VEHICLE SWING GATE
33	1233959.0301	3131153.0739	5465.77	4 LF PERSONNEL GATE
34	1233956.9681	3131156.5015	5465.60	4 LF PERSONNEL GATE
35	1233970.8046	3131129.6890	5466.01	CONCRETE PAVEMENT
36	1233962.5823	3131143.2893	5466.10	CONCRETE PAVEMENT
37	1233907.4477	3131091.8798	5468.77	CONCRETE PAVEMENT
38	1233899.2794	3131105.6377	5467.78	CONCRETE PAVEMENT
39	1233889.3896	3131066.3974	5469.57	CONCRETE PAVEMENT
40	1233887.3900	3131066.3561	5469.63	CONCRETE PAVEMENT
41	1233868.2618	3131101.9829	5468.27	CONCRETE PAVEMENT
42	1233867.2683	3131100.2471	5468.31	CONCRETE PAVEMENT
43	1233882.7723	3131046.8579	5469.73	CONCRETE PAVEMENT

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
44	1233816.5718	3131040.0417	5470.00	CONCRETE PAVEMENT
45	1233986.9709	3131186.9409	5463.17	CONCRETE PAVEMENT
46	1233975.3471	3131188.0146	5462.79	CONCRETE PAVEMENT
47	1233963.1397	3131236.2826	5460.55	CONCRETE PAVEMENT
48	1233954.1350	3131231.9335	5460.35	CONCRETE PAVEMENT
49	1233892.5963	3131305.2925	5453.34	CONCRETE PAVEMENT
50	1233848.6811	3131336.9595	5451.88	CONCRETE PAVEMENT
51	1233798.2291	3131457.2471	5445.18	CONCRETE PAVEMENT
52	1233801.1534	3131476.3670	5444.22	CONCRETE PAVEMENT
53	1233794.6412	3131563.6179	5439.18	CONCRETE PAVEMENT
54	1233772.3455	3131635.4986	5435.94	CONCRETE PAVEMENT
55	1233753.1463	3131617.3281	5437.29	CONCRETE PAVEMENT
56	1233749.1557	3131624.6806	5436.97	CONCRETE PAVEMENT
57	1233764.1514	3131675.9214	5434.61	CONCRETE PAVEMENT
58	1233763.8596	3131678.8530	5434.52	CONCRETE PAVEMENT
59	1233753.3902	3131727.8758	5433.30	CONCRETE PAVEMENT
60	1233759.8222	3131730.0420	5432.92	CONCRETE PAVEMENT
61	1233786.5918	3131729.0363	5432.08	CONCRETE PAVEMENT
62	1233797.0700	3131736.5310	5431.61	CONCRETE PAVEMENT
63	1233899.0435	3131756.3905	5430.66	CONCRETE PAVEMENT
64	1233950.2328	3131744.0689	5430.84	CONCRETE PAVEMENT
65	1233947.8926	3131734.3466	5429.60	CONCRETE PAVEMENT
66	1233896.7033	3131746.6682	5430.86	CONCRETE PAVEMENT
67	1233802.8877	3131728.3975	5431.81	CONCRETE PAVEMENT
68	1233792.4095	3131720.9027	5432.28	CONCRETE PAVEMENT
69	1233773.8104	3131679.8437	5434.72	CONCRETE PAVEMENT
70	1233774.1022	3131676.9121	5434.81	CONCRETE PAVEMENT
71	1233781.8966	3131638.4612	5436.14	CONCRETE PAVEMENT
72	1233804.1923	3131566.5804	5439.38	CONCRETE PAVEMENT
73	1233811.0384	3131474.8551	5444.42	CONCRETE PAVEMENT
74	1233808.1141	3131455.7352	5445.38	CONCRETE PAVEMENT
75	1233854.5299	3131345.0706	5452.08	CONCRETE PAVEMENT
76	1233898.4452	3131313.4036	5453.54	CONCRETE PAVEMENT
77	1233985.0826	3131157.3389	5462.16	GRAVEL TRAIL
78	1233999.7836	3131115.5134	5464.93	GRAVEL TRAIL
79	1234044.9518	3131084.9285	5466.75	GRAVEL TRAIL
80	1234072.6979	3131081.4895	5467.10	GRAVEL TRAIL
81	1234086.7326	3131079.7499	5466.90	GRAVEL TRAIL - LOOKOUT AREA
82	1233625.7769	3130666.2982	5411.28	BACK OF CURB
83	1233618.5387	3130664.5065	5411.35	BACK OF CURB
84	1233611.7907	3130651.7516	5411.06	BACK OF CURB
85	1233515.1659	3130686.4991	5414.97	BACK OF CURB

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
86	1233510.6659	3130690.9991	5415.20	BACK OF CURB
87	1233382.3144	3130690.4991	5414.94	BACK OF CURB
88	1233356.7767	3130721.3805	5416.24	BACK OF CURB
89	1233370.4539	3130794.6916	5418.49	BACK OF CURB
90	1233490.7722	3130771.6932	5418.47	BACK OF CURB
91	1233482.2833	3130727.2825	5417.11	BACK OF CURB
92	1233491.6633	3130715.9990	5416.61	BACK OF CURB
93	1233510.6659	3130715.9991	5416.04	BACK OF CURB
94	1233515.1659	3130720.4991	5416.00	BACK OF CURB
95	1233515.6659	3130736.0181	5415.82	BOTTOM OF CURB RAMP
96	1233523.6659	3130736.0181	5416.00	BOTTOM OF CURB RAMP
97	1233529.6659	3130736.5181	5416.62	BACK OF CURB
98	1233631.1224	3130692.9174	5413.17	BACK OF CURB
99	1233629.4528	3130699.2510	5413.37	BACK OF CURB
100	1233635.7127	3130711.9994	5413.80	BACK OF CURB
101	1233663.0162	3130695.9697	5412.99	CONCRETE SIDEWALK
102	1233678.7617	3130685.2236	5412.19	CONCRETE SIDEWALK
103	1233688.6670	3130678.4434	5411.45	CONCRETE SIDEWALK
104	1233687.9554	3130686.2133	5412.03	CONCRETE SIDEWALK
105	1233684.8623	3130690.7457	5412.20	CONCRETE SIDEWALK
106	1233667.5259	3130702.5774	5413.04	CONCRETE SIDEWALK
107	1233529.6659	3130744.5181	5416.78	CONCRETE SIDEWALK
108	1233529.6659	3130745.0181	5416.78	BACK OF CURB
109	1233515.1659	3130745.0419	5416.49	BACK OF CURB
110	1233504.2996	3130845.1260	5437.46	BUILDING CORNER
111	1233441.5811	3130857.1144	5436.22	BUILDING CORNER
112	1233506.6659	3130685.9991	5415.16	7' COMMERCIAL FENCE
113	1233400.8285	3130685.9991	5415.14	7' COMMERCIAL FENCE
114	1233365.4675	3130685.9991	5415.16	7' COMMERCIAL FENCE
115	1233330.1066	3130685.9991	5415.78	4' LF PERSONNEL GATE
116	1233326.1066	3130685.9991	5415.81	4' LF PERSONNEL GATE
117	1233318.6153	3130685.9991	5415.91	7' COMMERCIAL FENCE
118	1233314.1186	3130692.6211	5415.93	7' COMMERCIAL FENCE
119	1233333.8006	3130795.5892	5419.17	7' COMMERCIAL FENCE
120	1233343.1603	3130801.9449	5419.05	7' COMMERCIAL FENCE
121	1233372.1357	3130796.4064	5418.81	7' COMMERCIAL FENCE
122	1233490.6517	3130773.7505	5418.70	7' COMMERCIAL FENCE
123	1233506.6659	3130750.1676	5416.77	7' COMMERCIAL FENCE
124	1233506.6659	3130727.4991	5416.80	4' LF PERSONNEL GATE
125	1233506.6659	3130723.4991	5416.80	4' LF PERSONNEL GATE
126	1233506.6659	3130716.4991	5416.27	20' LF VEHICLE SWING GATE
127	1233506.6659	3130690.4918	5415.30	20' LF VEHICLE SWING GATE

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1. ELEVATIONS SHOWN ARE TO FINISHED GRADE UNLESS OTHERWISE DESIGNATED

no.	date	by	ckd	description
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1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."

City and County Engineer (or Designee) Date

COLORADO LICENSED
JOSHUA LEE
45206
05/08/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	checked by
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
CONTROL POINT TABLE I

project	contract
135303	

drawing **0CS-108** rev. **1**

sheet of sheets
file 135303_0CS-108.dwg

Scale For Microfilming
Millimeters
Inches

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
128	1233689.0223	3130678.0916	5410.95	CONCRETE VALLEY PAN CL
129	1233651.6256	3130622.9575	5409.21	CONCRETE VALLEY PAN CL
130	1233497.3636	3130731.1251	5417.33	ELECTRICAL EQUIPMENT PAD
131	1233488.0039	3130724.7693	5417.16	ELECTRICAL EQUIPMENT PAD
132	1233492.2213	3130736.1804	5417.35	ELECTRICAL EQUIPMENT PAD
133	1233497.8399	3130744.2694	5417.64	ELECTRICAL EQUIPMENT PAD
134	1233346.5211	3130718.3270	5416.20	CONCRETE GENERATOR PAD
135	1233335.3402	3130753.0435	5417.64	CONCRETE GENERATOR PAD
136	1233368.5483	3130799.1283	5411.58	6" FOUNDATION DRAIN INVERT
137	1233368.7361	3130800.1105	5418.48	CLEANOUT
138	1233489.3424	3130766.8760	5417.82	CONCRETE PAVEMENT
139	1233370.8215	3130789.5308	5417.83	CONCRETE PAVEMENT
140	1233509.9850	3130848.1320	5436.85	CLEANOUT
141	1233438.5751	3130862.7999	5435.42	CLEANOUT
142	1233493.4749	3130767.0838	5418.02	CLEANOUT
143	1233346.2934	3130678.8550	5415.57	CLEANOUT
144	1233300.7119	3130647.9027	5410.70	6" PVC DAYLIGHT TO SWALE
145	1233515.2552	3130859.8306	5435.51	GRASS SWALE FLOWLINE
146	1233367.7259	3130888.0303	5429.04	GRASS SWALE FLOWLINE
147	1233247.1573	3130801.6711	5417.27	GRASS SWALE FLOWLINE
148	1233243.1106	3130772.9308	5415.28	GRASS SWALE FLOWLINE
149	1233286.7328	3130653.8551	5409.25	GRASS SWALE FLOWLINE
150	1233371.1196	3131066.8597	5429.77	GRASS SWALE FLOWLINE
151	1233280.2955	3130963.1067	5421.96	GRASS SWALE FLOWLINE
152	1233238.7361	3130741.8622	5413.66	GRASS SWALE FLOWLINE
153	1233327.2556	3130631.3717	5410.29	GRASS SWALE FLOWLINE
154	1233620.0762	3130646.9646	5410.76	CONCRETE SIDEWALK
155	1233615.8818	3130640.1523	5410.60	CONCRETE SIDEWALK
156	1233641.9776	3130633.5185	5409.98	CONCRETE SIDEWALK
157	1233639.0117	3130625.9520	5410.15	CONCRETE SIDEWALK
158	1233645.4510	3130624.8660	5410.10	CONCRETE SIDEWALK
159	1233651.1754	3130623.1752	5409.71	BACK OF CURB
160	1233653.1160	3130639.2831	5409.89	CURB RAMP
161	1233649.8719	3130647.3016	5410.21	CURB RAMP
162	1233642.7610	3130654.7069	5411.12	BACK OF CURB
163	1233674.1836	3130671.2510	5411.41	CURB RAMP
164	1233666.2769	3130671.4667	5411.61	CURB RAMP
165	1233656.8107	3130675.3855	5412.36	BACK OF CURB
166	1233674.5710	3130662.6418	5410.24	CONCRETE VALLEY PAN CL
167	1233661.0589	3130642.8066	5409.67	CONCRETE VALLEY PAN CL
168	1233479.9248	3130742.3751	5416.93	BOLLARD
169	1233469.1205	3130744.4403	5416.95	BOLLARD

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
170	1233472.4373	3130761.7928	5417.49	BOLLARD
171	1233473.2254	3130772.2179	5417.84	BOLLARD
172	1233458.4921	3130775.0341	5417.86	BOLLARD
173	1233424.4528	3130788.4424	5411.86	6" FOUNDATION DRAIN INVERT
174	1233424.2651	3130787.4601	5418.55	CLEANOUT
175	1233531.6716	3130736.5181	5416.57	CONCRETE SIDEWALK
176	1233531.6716	3130744.5181	5416.73	CONCRETE SIDEWALK
177	1234020.9174	3131060.9211	5432.74	6" PVC EXCAVATION DRAIN INVERT
178	1234005.1027	3131071.2746	5433.73	6" PVC UNDERDRAIN INVERT
179	1233990.3252	3131083.0381	5433.82	6" PVC UNDERDRAIN INVERT
180	1233970.4888	3131091.7748	5433.92	6" PVC UNDERDRAIN INVERT
181	1233930.4978	3131092.6269	5434.09	6" PVC UNDERDRAIN INVERT
182	1233910.3436	3131084.7634	5434.10	6" PVC UNDERDRAIN INVERT
183	1233894.8109	3131057.0887	5434.01	6" PVC UNDERDRAIN INVERT
184	1234002.7817	3130950.0556	5432.51	6" X 6" TEE
185	1233987.5884	3130940.1028	5432.42	6" X 6" TEE
186	1233967.4454	3130932.8262	5432.31	6" X 6" TEE
187	1233927.3491	3130928.1789	5432.62	6" X 6" TEE
188	1233909.3198	3130934.3192	5432.00	6" X 6" TEE
189	1233903.5509	3130922.4013	5430.77	6" X 6" TEE
190	1233892.2751	3130924.6496	5432.82	6" X 6" TEE TO OVERFLOW MANHOLE
191	1233673.2312	3130990.5864	5433.13	6" PVC EXCAVATION DRAIN INVERT
192	1233703.9814	3131037.8725	5433.82	6" PVC UNDERDRAIN INVERT
193	1233719.5140	3131065.5472	5433.99	6" PVC UNDERDRAIN INVERT
194	1233739.6683	3131073.4107	5434.07	6" PVC UNDERDRAIN INVERT
195	1233779.6593	3131072.5586	5434.13	6" PVC UNDERDRAIN INVERT
196	1233799.4957	3131063.8219	5434.09	6" PVC UNDERDRAIN INVERT
197	1233814.2732	3131052.0584	5434.06	6" PVC UNDERDRAIN INVERT
198	1233701.9669	3130932.6641	5432.81	6" X 6" TEE
199	1233716.7701	3130922.2418	5431.15	6" X 6" TEE
200	1233736.6217	3130914.2970	5431.05	6" X 6" TEE
201	1233776.6041	3130912.9954	5432.60	6" X 6" TEE
202	1233800.2745	3130918.0634	5432.00	6" X 6" TEE
203	1233812.1628	3130954.5481	5433.12	6" X 6" TEE
204	1233811.6782	3130916.5300	5432.56	6" X 6" TEE
205	1233641.3061	3130615.8228	5409.67	12" SIDEWALK CHASE
206	1233635.4694	3130618.1857	5409.77	12" SIDEWALK CHASE
207	1233404.9793	3130614.3638	5414.25	RAIN GARDEN PERIMETER
208	1233409.7558	3130624.0149	5414.25	RAIN GARDEN PERIMETER
209	1233407.6395	3130643.3554	5414.25	RAIN GARDEN PERIMETER
210	1233396.6111	3130652.2083	5414.25	RAIN GARDEN PERIMETER
211	1233386.6340	3130651.1166	5414.25	RAIN GARDEN PERIMETER

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
212	1233377.7811	3130640.0882	5414.25	RAIN GARDEN PERIMETER
213	1233381.2797	3130624.2039	5413.76	RAIN GARDEN OUTLET STRUCTURE
214	1233402.2091	3130612.6932	5414.25	RAIN GARDEN PERIMETER
215	1233402.2128	3130621.9680	5413.25	RAIN GARDEN UNDERDRAIN
216	1233399.7957	3130643.1080	5413.25	RAIN GARDEN UNDERDRAIN
217	1233345.4661	3130678.2932	5410.97	6" PVC INVERT
218	1233509.0028	3130848.3198	5412.59	6" FOUNDATION DRAIN INVERT
219	1233438.3873	3130861.8177	5412.23	6" FOUNDATION DRAIN INVERT
220	1233913.0893	3131229.4405	5461.79	7' COMMERCIAL FENCE
221	1233879.8003	3131313.6162	5452.90	POND ACCESS ROAD
222	1233871.3687	3131319.9545	5452.64	POND ACCESS ROAD
223	1233872.7365	3131308.9523	5452.71	POND ACCESS ROAD
224	1233862.8234	3131306.7169	5452.48	POND ACCESS ROAD
225	1233867.9168	3131317.7243	5452.55	POND ACCESS ROAD
226	1233863.6506	3131316.7112	5452.46	POND ACCESS ROAD
227	1233854.7569	3131308.0016	5452.30	POND ACCESS ROAD
228	1233856.6527	3131317.8257	5452.30	POND ACCESS ROAD
229	1233765.2510	3131301.5452	5451.09	POND ACCESS ROAD
230	1233774.2011	3131295.4257	5451.75	POND ACCESS ROAD
231	1233731.6010	3131279.9931	5451.05	POND ACCESS ROAD
232	1233693.6120	3131242.2846	5446.00	POND ACCESS ROAD
233	1233687.1819	3131250.0033	5445.94	POND ACCESS ROAD
234	1233710.3249	3131229.8941	5445.91	POND CORNER
235	1233697.4453	3131196.7777	5445.59	POND CORNER
236	1233672.1106	3131205.5978	5445.50	POND CORNER
237	1233669.0608	3131211.9773	5445.60	POND CORNER
238	1233665.2710	3131208.7072	5443.75	POND OUTLET PIPE INVERT
239	1233575.7687	3131192.0608	5442.00	POND OUTLET PIPE INVERT
240	1233677.7449	3131186.3573	5450.96	POND BERM
241	1233671.5626	3131178.0210	5450.90	POND BERM
242	1233659.7579	3131193.3797	5450.84	POND BERM
243	1233654.8145	3131220.2441	5400.00	EDGE OF RIPRAP
244	1233659.3196	3131182.0721	5450.84	POND BERM
245	1233644.4176	3131221.6522	5450.81	POND SPILLWAY
246	1233670.5357	3131253.4198	5450.90	POND BERM
247	1233682.3805	3131263.8612	5450.94	POND BERM
248	1233661.4989	3131257.7017	5450.90	POND BERM
249	1233679.2660	3131273.3638	5450.94	POND BERM
250	1233656.1766	3131223.1172	5449.25	POND SPILLWAY
251	1233660.4605	3131232.1531	5449.25	POND SPILLWAY
252	1233651.6590	3131225.2590	5449.25	POND OVERFLOW WEIR
253	1233655.9429	3131234.2949	5449.25	POND OVERFLOW WEIR

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no.	date	by	ckd	description
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City and County Engineer (or Designee) Date

COLORADO LICENSED
JOSHUA L. LEE
45206
05/08/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	checked by
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
CONTROL POINT TABLE II

project	contract
135303	

drawing **0CS-109** rev. **1**

sheet of sheets

file 135303_0CS-108.dwg

Scale For Microfilming
Millimeters
Inches

CONTROL POINT TABLE				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
254	1233647.1414	3131227.4008	5449.25	POND SPILLWAY
255	1233651.4253	3131236.4367	5449.25	POND SPILLWAY
256	1233661.8214	3131235.0285	5400.00	EDGE OF RIPRAP
257	1233654.1467	3131242.1852	5450.70	POND SPILLWAY
258	1233632.2243	3131230.9532	5400.00	EDGE OF RIPRAP
259	1233639.2328	3131245.7360	5400.00	EDGE OF RIPRAP
260	1234024.9608	3131062.3381	5461.77	SWALE CENTERLINE
261	1233958.5580	3130918.2018	5458.04	SWALE CENTERLINE
262	1233768.9411	3130889.2398	5453.98	SWALE CENTERLINE
263	1233644.7670	3131031.4072	5449.59	SWALE CENTERLINE
264	1233958.3853	3131166.9300	5462.80	SWALE CENTERLINE
265	1233916.2632	3131236.8284	5458.92	SWALE CENTERLINE
266	1233800.4666	3131283.5763	5454.41	SWALE CENTERLINE
267	1233769.7707	3131273.2735	5453.23	SWALE CENTERLINE
268	1233729.6172	3131250.0056	5449.02	SWALE CENTERLINE
269	1233841.2113	3130919.4964	5432.84	6" PVC EXCAVATION DRAIN INVERT
270	1233806.1314	3130907.1190	5429.72	6" X 6" TEE
271	1233855.3299	3130920.9320	5432.92	6" PVC EXCAVATION DRAIN INVERT
272	1233893.1344	3130969.5288	5433.22	6" X 6" TEE
273	1233736.1275	3131174.1701	5459.30	4 LF PERSONNEL GATE
274	1233737.4594	3131177.9418	5459.24	4 LF PERSONNEL GATE
275	1233490.2811	3130771.7871	5418.00	BUILDING CORNER
276	1233427.7466	3130783.7403	5418.00	BUILDING CORNER

GENERAL NOTES:

1. ELEVATIONS SHOWN ARE TO FINISHED GRADE UNLESS OTHERWISE DESIGNATED

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

COLORADO LICENSED JOSHUA L. LEE 45206 05/08/2025 PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
CONTROL POINT TABLE III

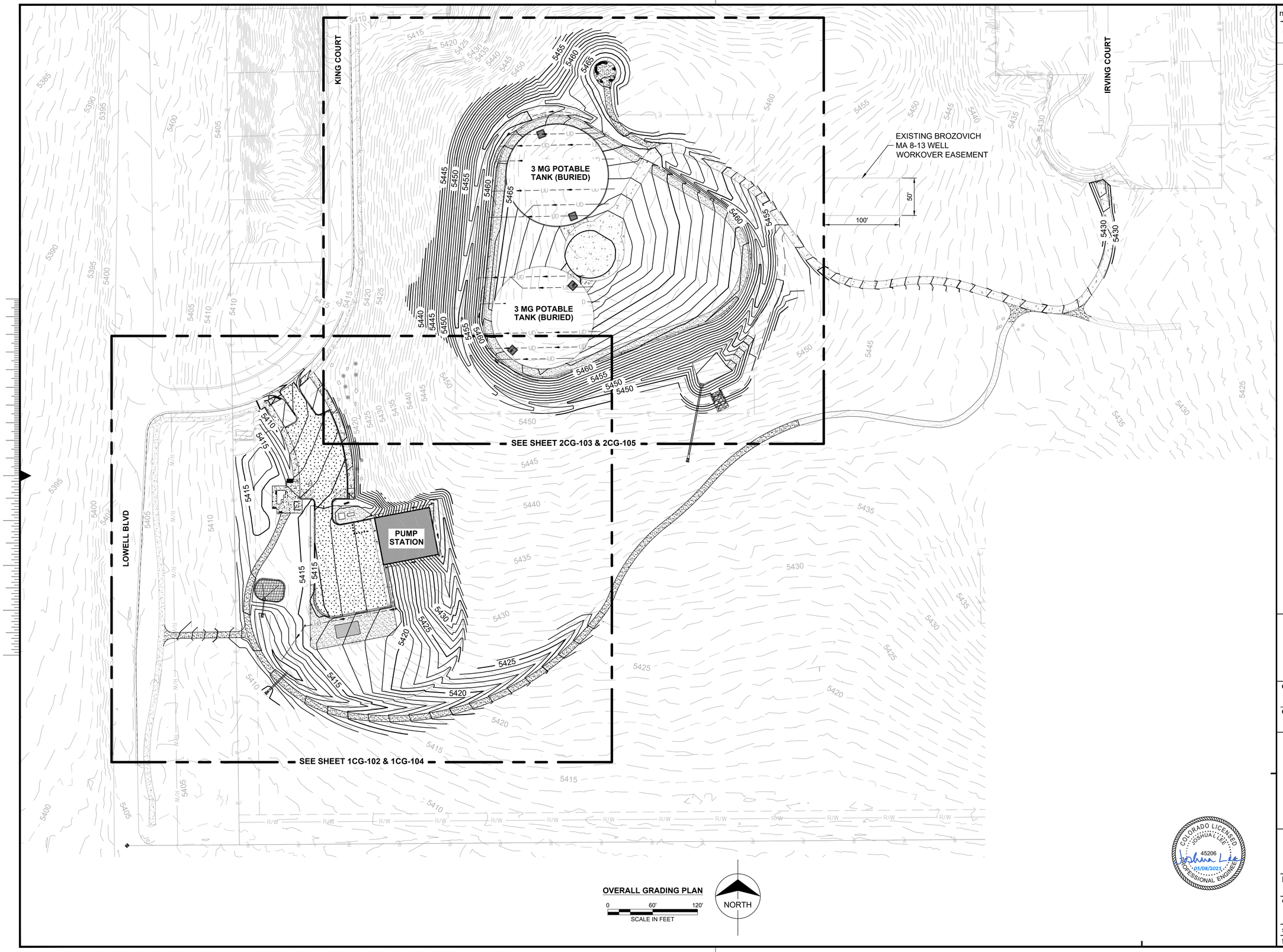
project	contract
135303	

drawing **0CS-110** rev. **1**

sheet of sheets

file 135303_0CS-108.dwg

Scale For Microfilming: Millimeters / Inches



Scale For Microfilming
Millimeters
Inches

OVERALL GRADING PLAN
0 60' 120'
SCALE IN FEET

NORTH

no.	date	by	ckd	description
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MAY 2025	C. HARRIS
designed by	**checked by**
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CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

COLORADO LICENSED
JOSHUA LEE
45206
PROFESSIONAL ENGINEER
05/08/2025

BROOMFIELD TANKS AND PUMP STATION
OVERALL GRADING PLAN

project	contract
135303	

drawing **0CG-101** rev. **1**

sheet of sheets

file 135303_0CG-101.dwg

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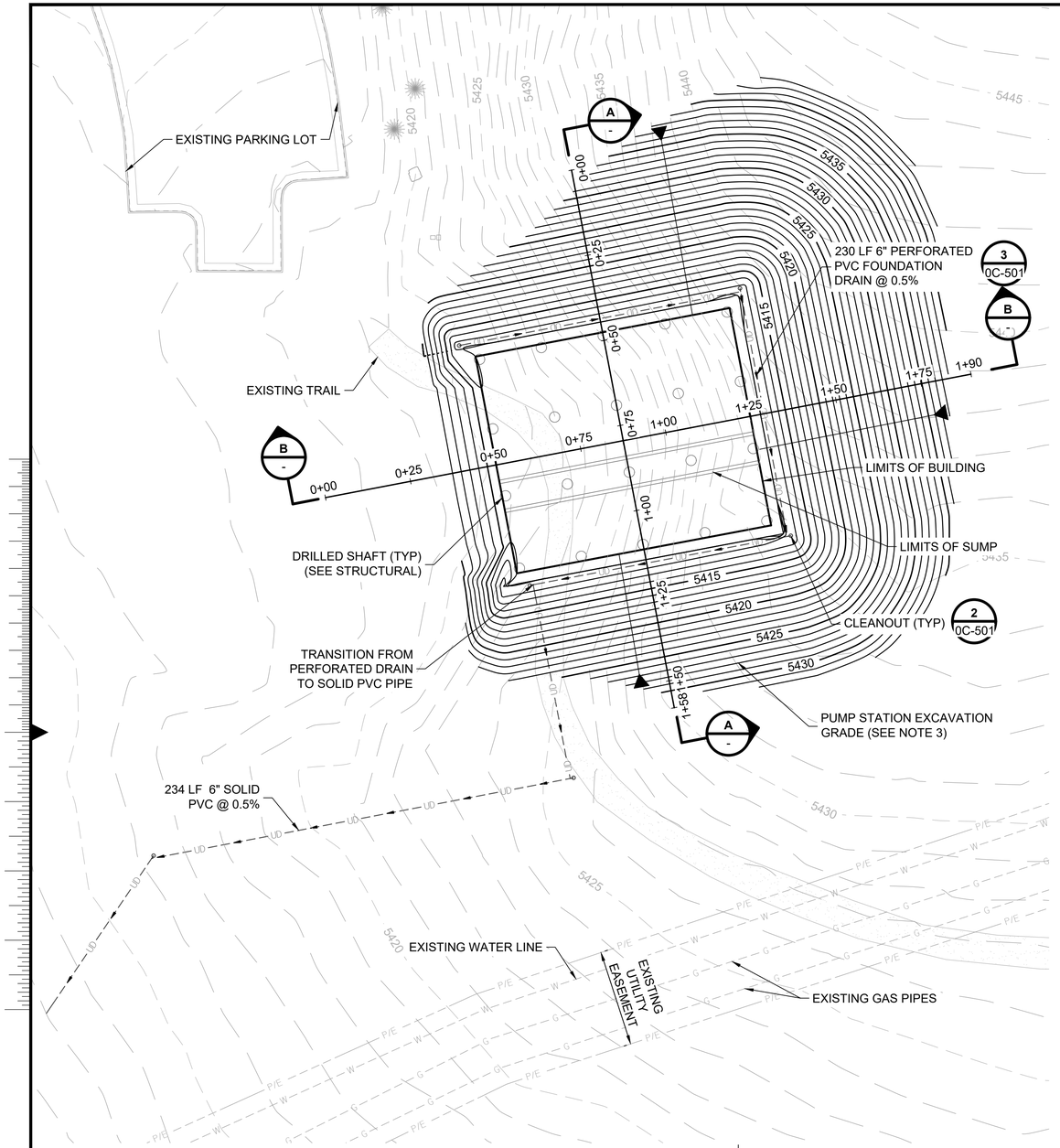

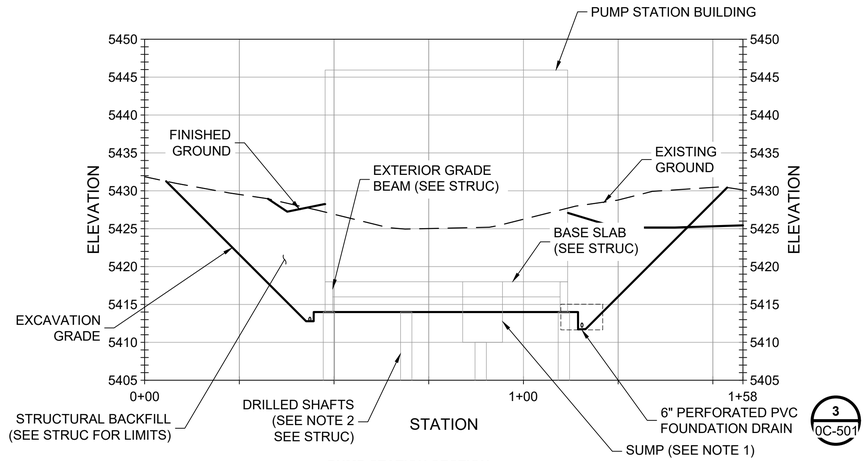

PUMP STATION SECTION NORTH TO SOUTH A -

HORIZONTAL 0 10' 20' 40' SCALE IN FEET

VERTICAL 0 5' 10' SCALE IN FEET

PUMP STATION SECTION WEST TO EAST B -

HORIZONTAL 0 10' 20' 40' SCALE IN FEET

VERTICAL 0 5' 10' SCALE IN FEET

PUMP STATION SECTIONS - PLAN VIEW

0 10' 20' 40' SCALE IN FEET

NORTH

GENERAL NOTES:

1. EXCAVATION INSIDE GRADE BEAMS OF PUMP STATION NOT SHOWN. CONTRACTOR TO EXCAVATE MATERIAL TO THE EXTENT NECESSARY TO CONSTRUCT SUMP AND ACHIEVE FLOOR SLAB THICKNESS BELOW FINISHED FLOOR ELEVATION 5418.00.
2. DEPTH OF DRILLED SHAFTS NOT SHOWN ON THIS SHEET, SEE STRUCTURAL FOR DETAILS.
3. CONTRACTOR IS RESPONSIBLE FOR DETERMINING EXCAVATION SLOPE BASED ON SOIL CONDITIONS IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE, AND FEDERAL REGULATIONS.

no.	date	by	ckd	description
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1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	checked by
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
PUMP STATION EXCAVATION PLAN

project	contract
135303	

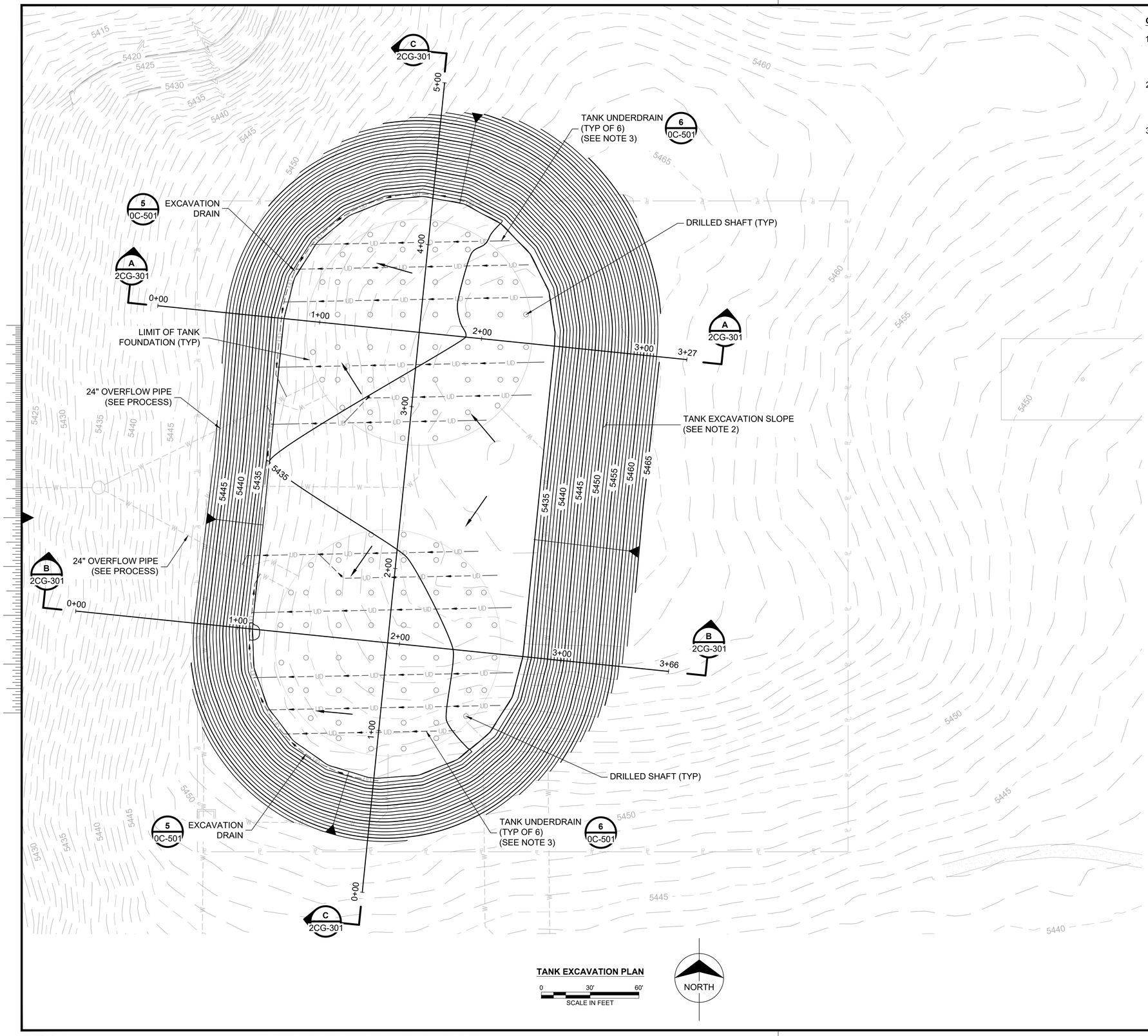
drawing **1CG-102** rev. **1**

sheet of sheets

file 135303_1CG-102.dwg

Scale For Microfilming
Millimeters
Inches

\\BMCD\DFS\CLIENTS\WTR\BROOMFIELDCO\135303_TANKSPROJECT\DESIGN\CADD\CIVIL\PROD_DWGS\135303_1CG-102.DWG 5/8/2025 8:06 AM HHARRIS3



TANK EXCAVATION PLAN

0 30' 60'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. REFER TO DRAWING 2CS-106 FOR TANK UNDERDRAIN AND EXCAVATION DRAIN ELEVATIONS. ALL UNDERDRAINS AND EXCAVATION DRAINS SHALL HAVE A MINIMUM SLOPE OF 0.5%.
2. CONTRACTOR IS RESPONSIBLE FOR DETERMINING EXCAVATION SLOPE BASED ON SOIL CONDITIONS IN ACCORDANCE WITH ALL APPLICABLE LOCAL, STATE, AND FEDERAL REGULATIONS.
3. DRILLED SHAFTS ARE SHOWN AS A SCHEMATIC ONLY. CONTRACTOR TO COORDINATE UNDERDRAINS WITH DRILLED SHAFT LOCATIONS.

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1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
TANK EXCAVATION PLAN

project	contract
135303	

drawing **2CG-103** — rev. **1**

sheet of sheets

file 135303_2CG-103.dwg

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Scale For Microfilming: Millimeters / Inches

\\BMCD\DFS\CLIENTS\WTR\BROOMFIELDCO\135303_TANKSPROJECT\DESIGN\CADD\CIVIL\PROD_DWGS\135303_2CG-103.DWG 5/8/2025 8:06 AM HHARRIS3

PUMP STATION FINAL GRADING PLAN

0 30' 60'

SCALE IN FEET

NORTH

Scale For Microfilming

Millimeters

Inches

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION FINAL GRADING PLAN

project	contract
135303	

drawing **1CG-104** rev. **1**

sheet of sheets

file 135303_1CG-104.dwg

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45206
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05/08/2025

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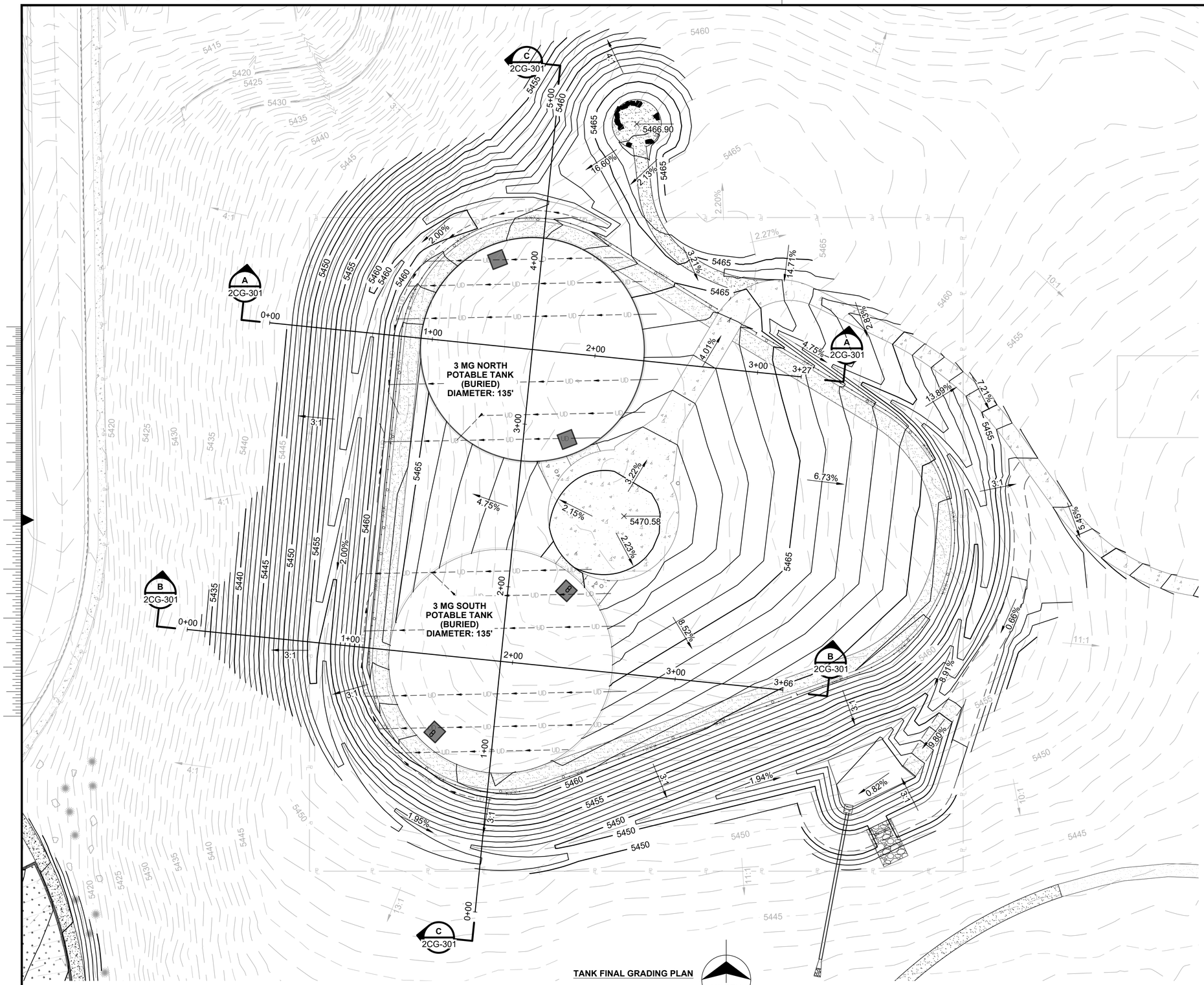

TANK FINAL GRADING PLAN

0 30' 60'

SCALE IN FEET

NORTH

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
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BROOMFIELD TANKS AND PUMP STATION
TANK FINAL GRADING PLAN

project	contract
135303	

drawing **2CG-105** rev. **1**

sheet of sheets

file 135303_2CG-105.dwg

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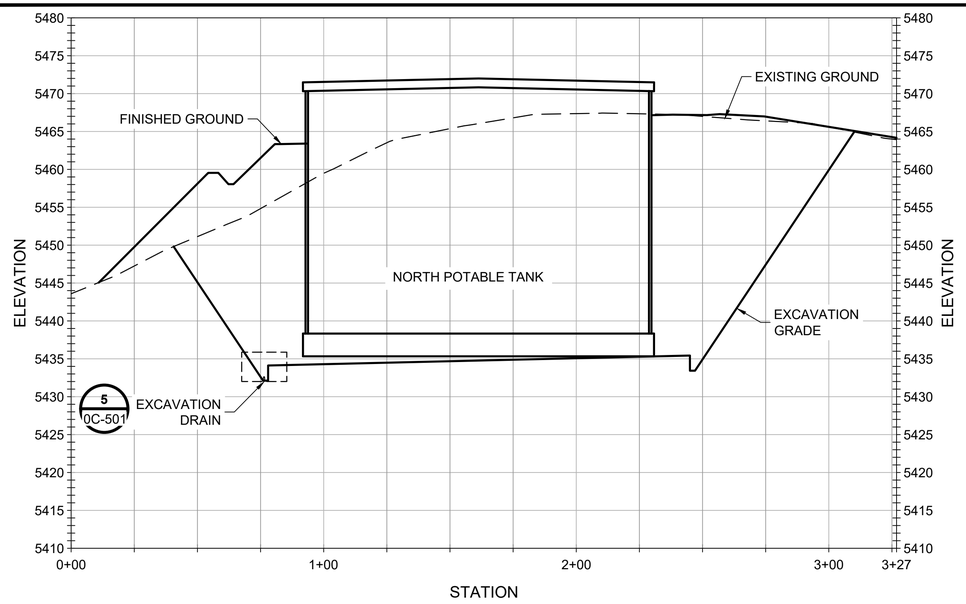
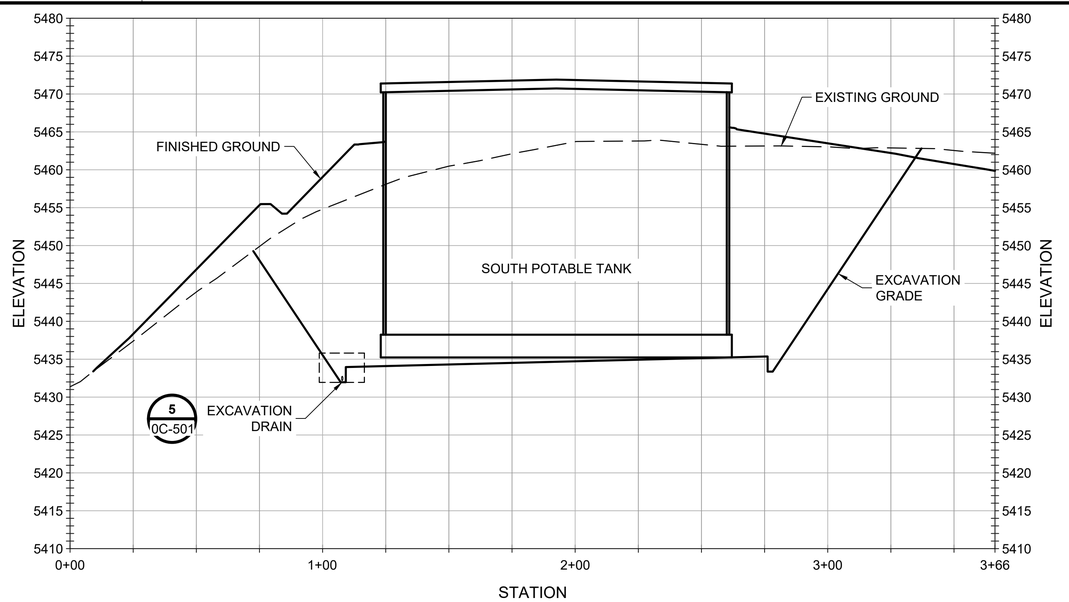


NORTH POTABLE SECTION A 2CG-103

HORIZONTAL 0 30' 60' SCALE IN FEET

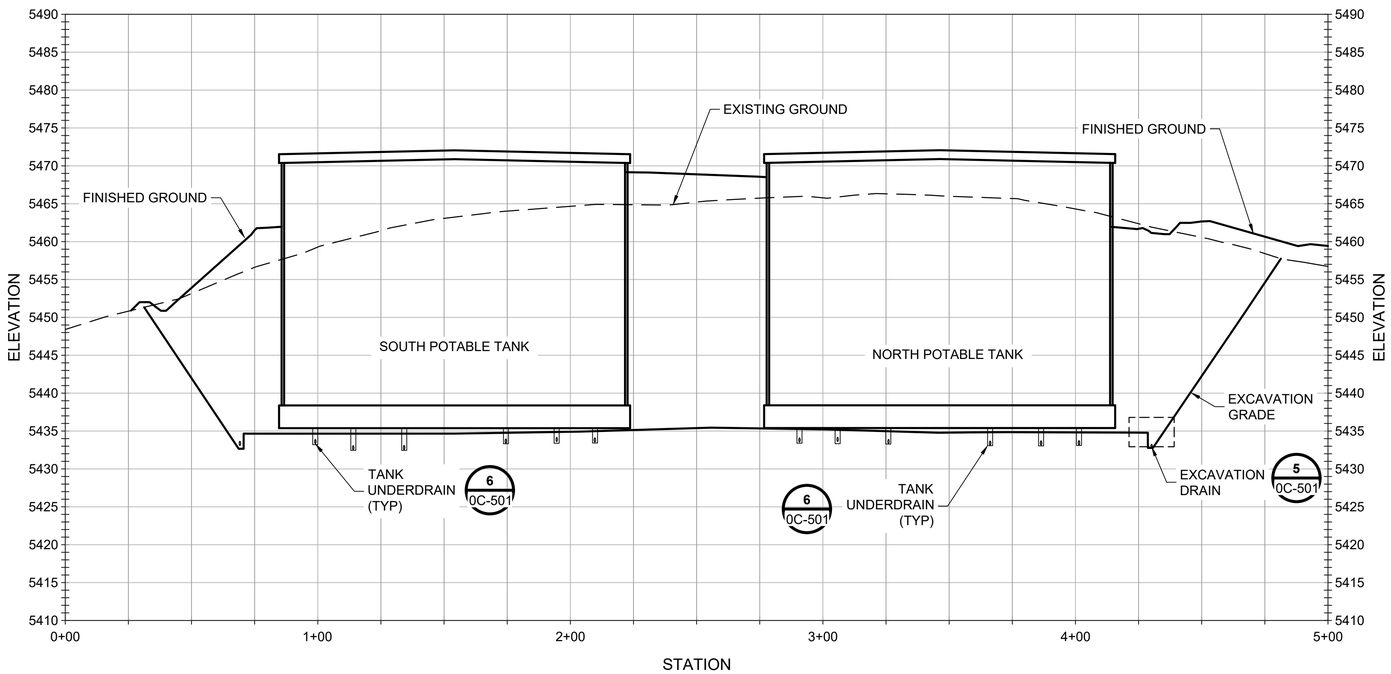
VERTICAL 0 10' 20' SCALE IN FEET



SOUTH POTABLE SECTION B 2CG-103

HORIZONTAL 0 30' 60' SCALE IN FEET

VERTICAL 0 10' 20' SCALE IN FEET



SOUTH AND NORTH POTABLE SECTION C 2CG-103

HORIZONTAL 0 30' 60' SCALE IN FEET

VERTICAL 0 10' 20' SCALE IN FEET

GENERAL NOTES:

1. ALL TANKS INCLUDE 6 UNDERDRAINS, NOT ALL ARE SHOWN BASED ON LOCATION OF SECTION CUT. SEE PLAN VIEW FOR LOCATIONS OF UNDERDRAINS.

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
TANK SECTIONS

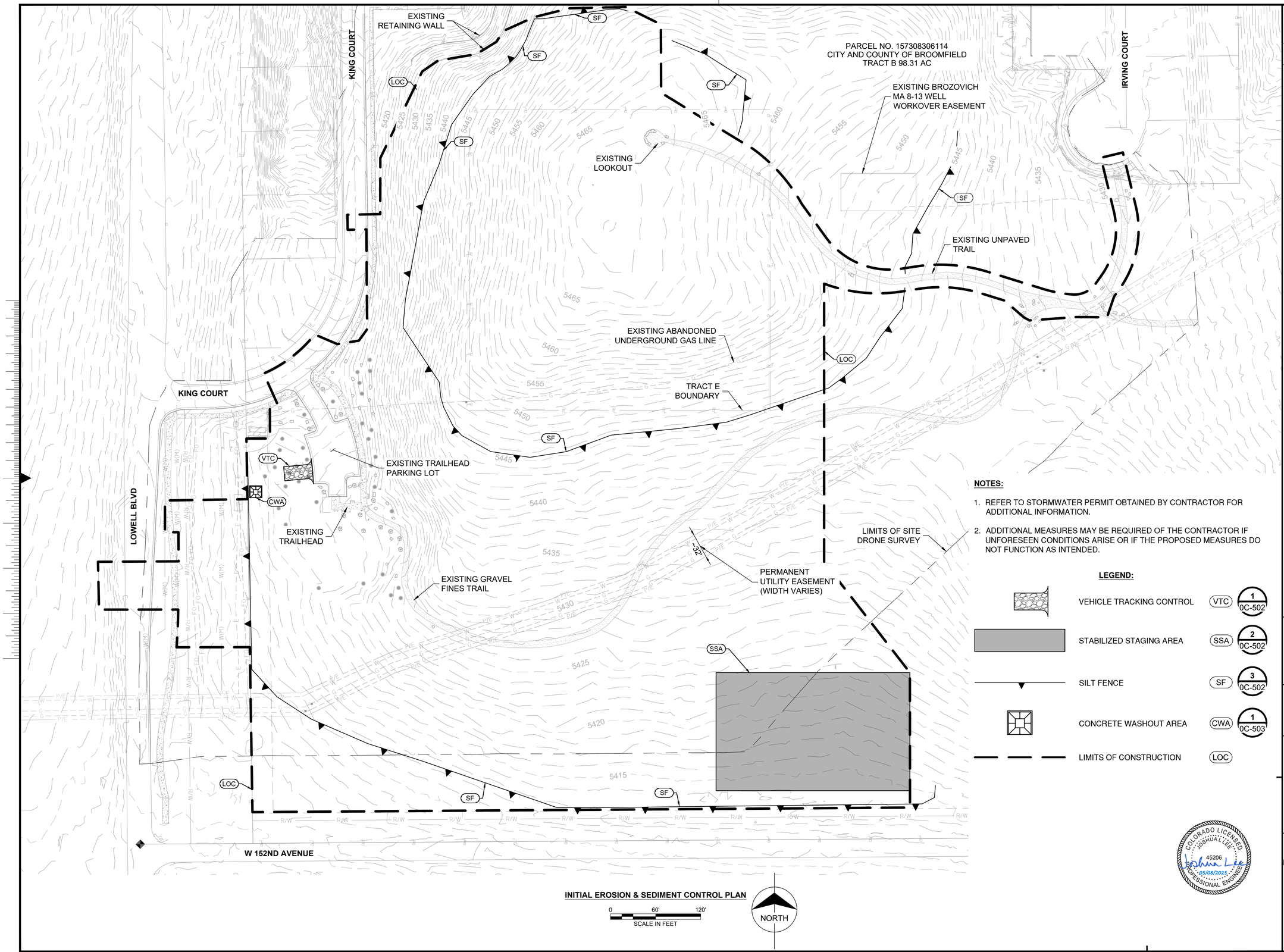
project	contract
135303	

drawing **2CG-301** rev. **1**

sheet of sheets

file 135303_2CG-103.dwg

Scale For Microfilming
Millimeters
Inches



NOTES:

1. REFER TO STORMWATER PERMIT OBTAINED BY CONTRACTOR FOR ADDITIONAL INFORMATION.
2. ADDITIONAL MEASURES MAY BE REQUIRED OF THE CONTRACTOR IF UNFORESEEN CONDITIONS ARISE OR IF THE PROPOSED MEASURES DO NOT FUNCTION AS INTENDED.

LEGEND:

VEHICLE TRACKING CONTROL	VTC	1 / 0C-502
STABILIZED STAGING AREA	SSA	2 / 0C-502
SILT FENCE	SF	3 / 0C-502
CONCRETE WASHOUT AREA	CWA	1 / 0C-503
LIMITS OF CONSTRUCTION	LOC	

COLORADO LICENSED JOSHUA LEE 45206 05/08/2025 PROFESSIONAL ENGINEER

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designed by	checked by
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
INITIAL EROSION & SEDIMENT CONTROL PLAN

project	contract
135303	

drawing **0CE-101** rev. **1**

sheet of sheets

file 135303_0CE-101.dwg

Scale For Microfilming: Millimeters / Inches

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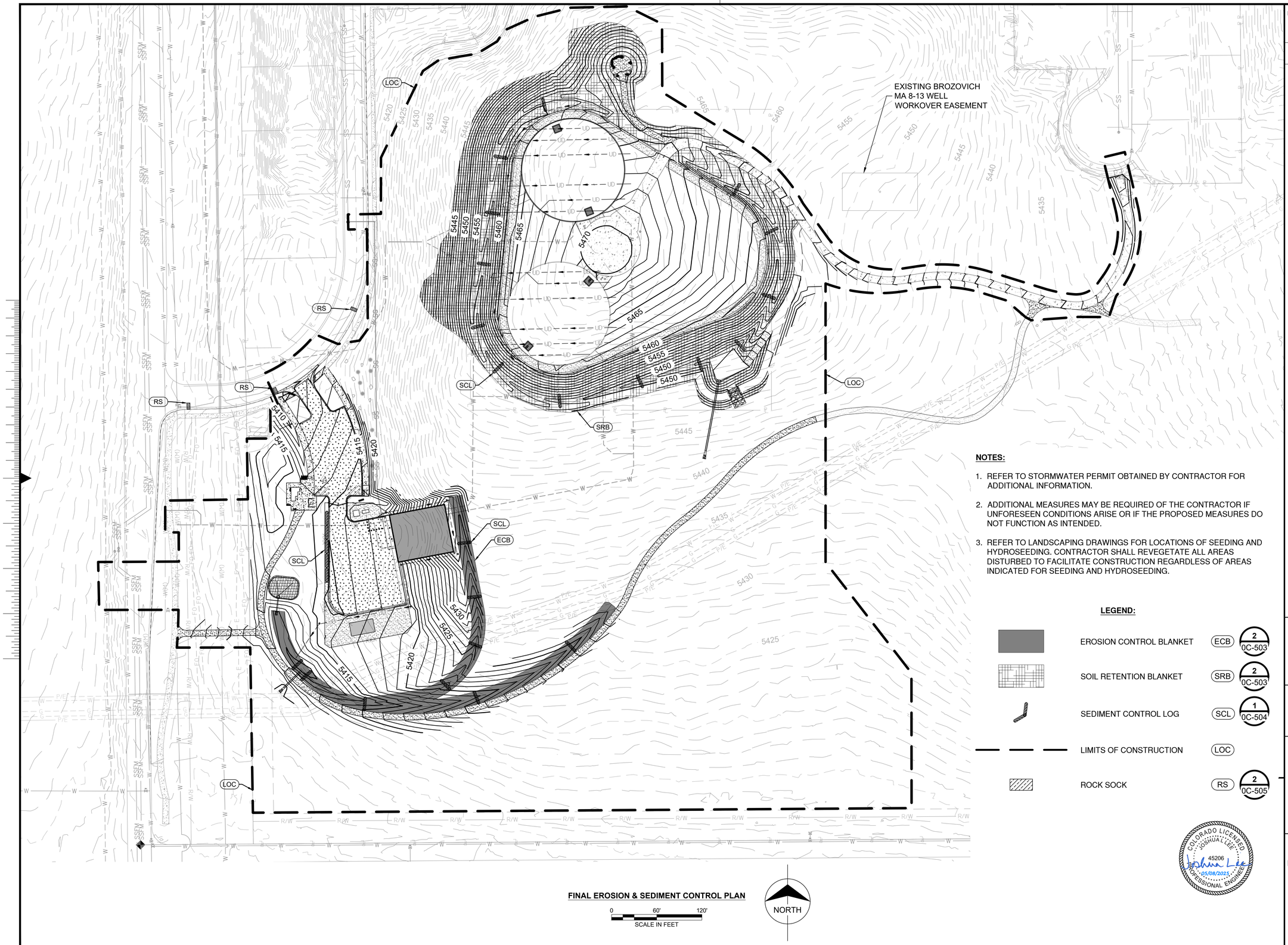

Scale For Microfilming
Millimeters
Inches

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3. REFER TO LANDSCAPING DRAWINGS FOR LOCATIONS OF SEEDING AND HYDROSEEDING. CONTRACTOR SHALL REVEGETATE ALL AREAS DISTURBED TO FACILITATE CONSTRUCTION REGARDLESS OF AREAS INDICATED FOR SEEDING AND HYDROSEEDING.

LEGEND:

EROSION CONTROL BLANKET	ECB	2 / 0C-503
SOIL RETENTION BLANKET	SRB	2 / 0C-503
SEDIMENT CONTROL LOG	SCL	1 / 0C-504
LIMITS OF CONSTRUCTION	LOC	
ROCK SOCK	RS	2 / 0C-505

FINAL EROSION & SEDIMENT CONTROL PLAN

0 60' 120'
SCALE IN FEET

NORTH

no.	date	by	ckd	description
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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date: MAY 2025	detailed by: C. HARRIS
designed by: C. HARRIS	checked by: J. LEE

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
FINAL EROSION & SEDIMENT CONTROL PLAN

project: 135303	contract:
drawing: 0CE-102	rev.: 1
sheet:	of sheets:

file 135303_0CE-102.dwg

COLORADO LICENSED · JOSHUA LEE · 45206 · PROFESSIONAL ENGINEER · 05/08/2025

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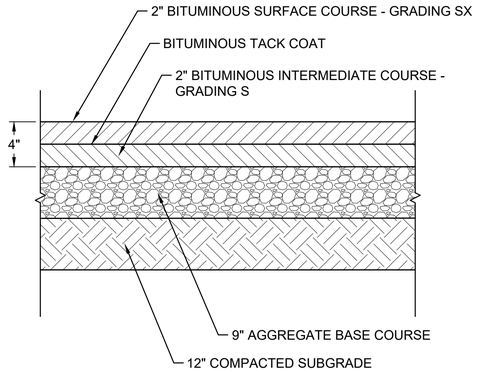

ASPHALT PAVEMENT SECTION — 1 / 0C-500
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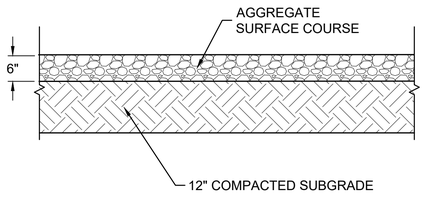

AGGREGATE SURFACE SECTION — 2 / 0C-500
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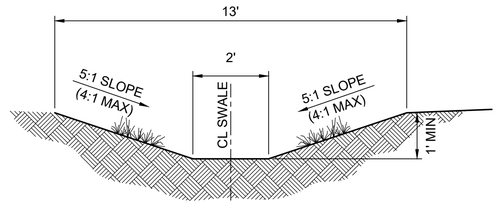
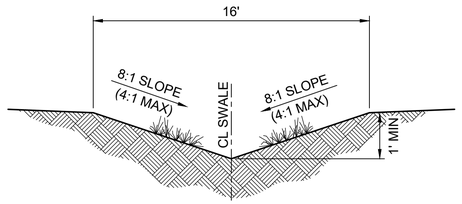
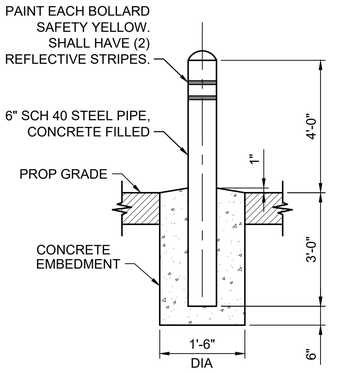


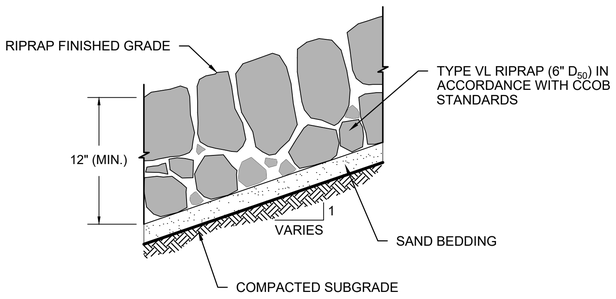
GRASS-LINED SWALE - TRAPEZOIDAL SECTION — 3 / 0C-500
NOT TO SCALE



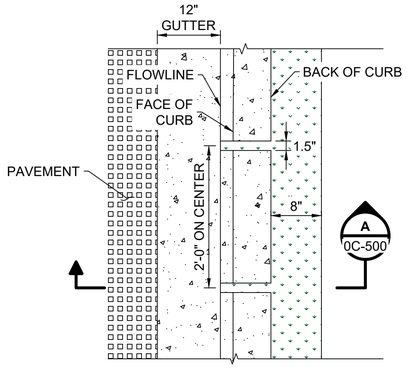
GRASS-LINED SWALE - TRIANGULAR SECTION — 4 / 0C-500
NOT TO SCALE



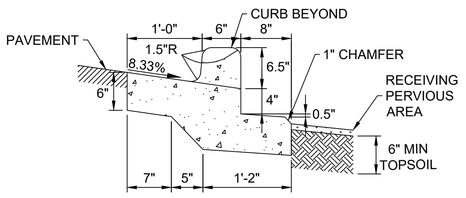
BOLLARD — 5 / 0C-500
NOT TO SCALE



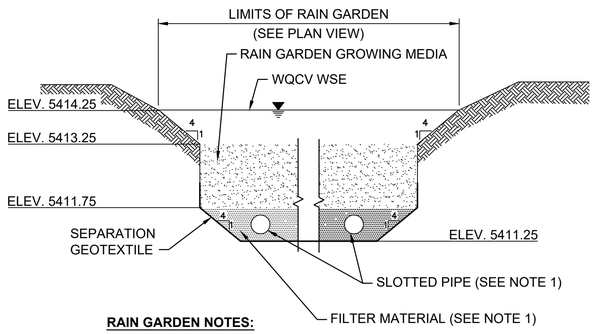
RIPRAP — 6 / 0C-500
NOT TO SCALE



SLOTTED CURB — 7 / 0C-500
NOT TO SCALE



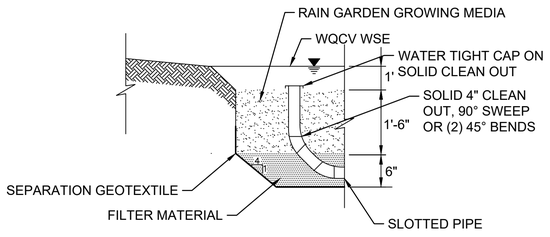
SECTION — A / 0C-500
NOT TO SCALE



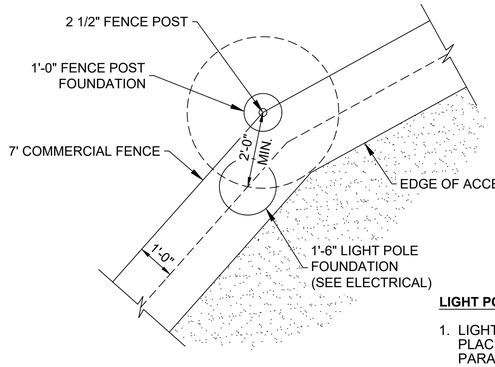
RAIN GARDEN NOTES:

1. SEE MHFD BIORETENTION PAGE T-3 FOR INFORMATION AND TABLES RELATING TO RAIN GARDEN

RAIN GARDEN — 8 / 0C-500
NOT TO SCALE



RAIN GARDEN CLEANOUT — 9 / 0C-500
NOT TO SCALE



LIGHT POLE FOUNDATION NOTES:

1. LIGHT POLE FOUNDATIONS TO BE PLACED 40'-0" CENTER TO CENTER PARALLEL TO FENCE LINE.

L7 LIGHT POLE FOUNDATION PLACEMENT — 10 / 0C-500
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD · COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
CIVIL DETAILS I

project	contract
135303	

drawing **0C-500** — rev. **1**

sheet of sheets

file 135303_0C-504_DETAILS.dwg

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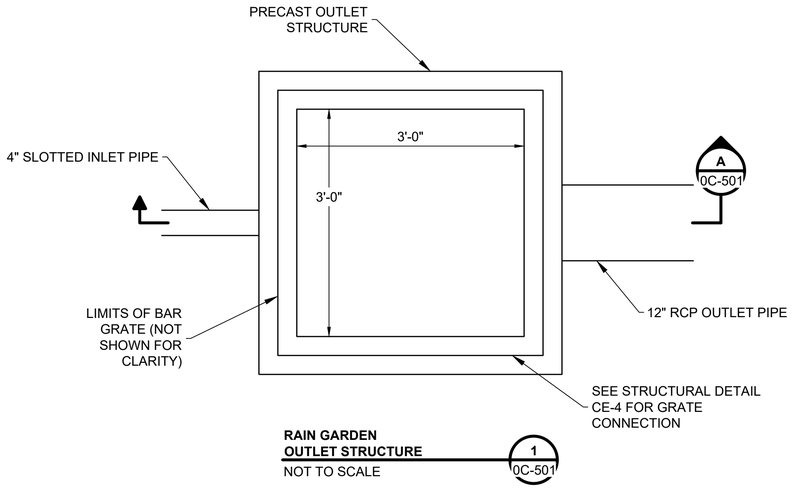
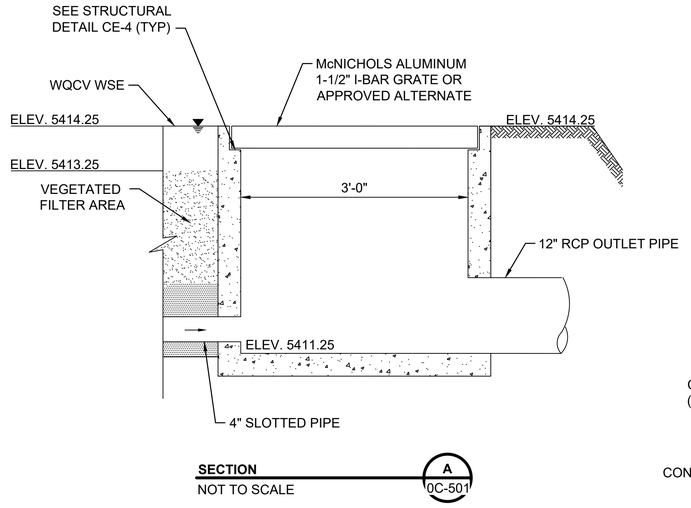


RAIN GARDEN OUTLET STRUCTURE — 1 / 0C-501
NOT TO SCALE



SECTION — A / 0C-501
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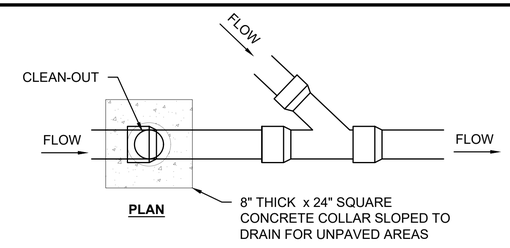
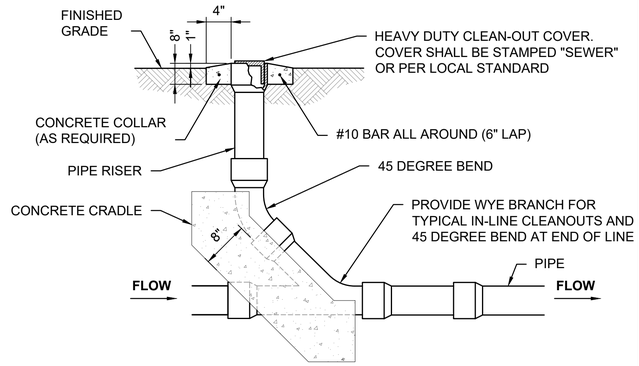
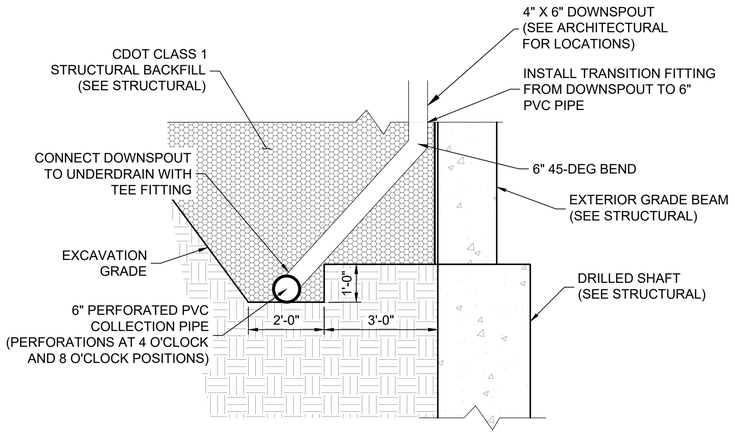


PLAN

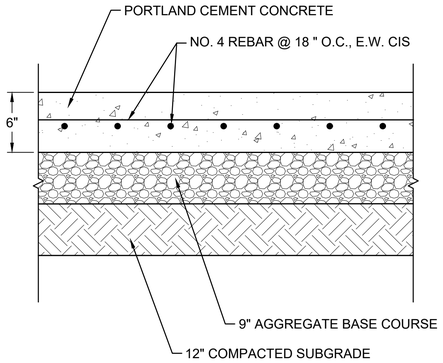


ELEVATION

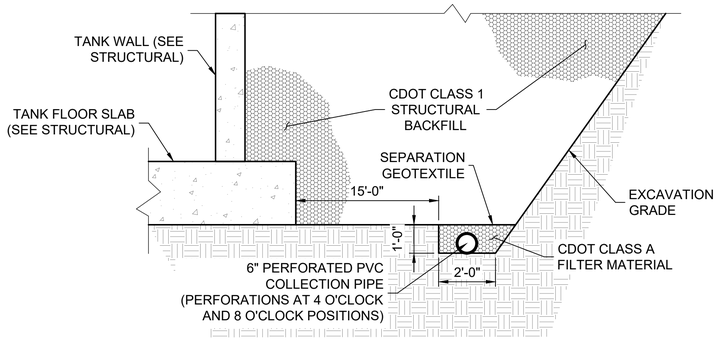
CLEANOUT — 2 / 0C-501
NOT TO SCALE



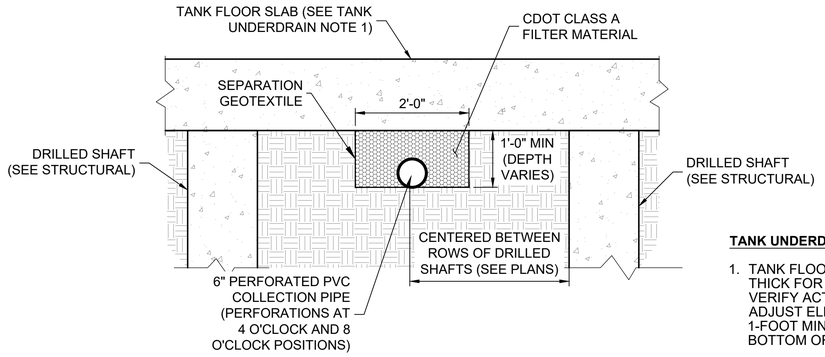
6" PERFORATED PVC FOUNDATION DRAIN — 3 / 0C-501
NOT TO SCALE



CONCRETE PAVEMENT SECTION — 4 / 0C-501
NOT TO SCALE



TANK EXCAVATION DRAIN — 5 / 0C-501
NOT TO SCALE



TANK UNDERDRAIN — 6 / 0C-501
NOT TO SCALE

TANK UNDERDRAIN NOTES:

1. TANK FLOOR SLAB ASSUMED TO BE 2-FEET THICK FOR DESIGN. CONTRACTOR TO VERIFY ACTUAL SLAB THICKNESS AND ADJUST ELEVATIONS OF PIPES BASED ON 1-FOOT MINIMUM DIMENSION BELOW BOTTOM OF SLAB.

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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date	detailed by
MAY 2025	C. HARRIS
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CITY AND COUNTY OF BROOMFIELD · COLORADO
BROOMFIELD, COLORADO

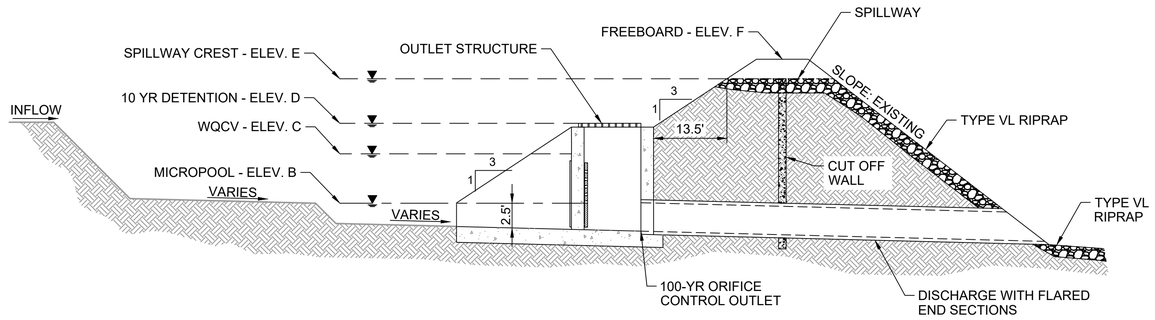
BROOMFIELD TANKS AND PUMP STATION
CIVIL DETAILS II

project	contract
135303	

drawing **0C-501** — rev. **1**
sheet of sheets
file 135303_0C-504_DETAILS.dwg

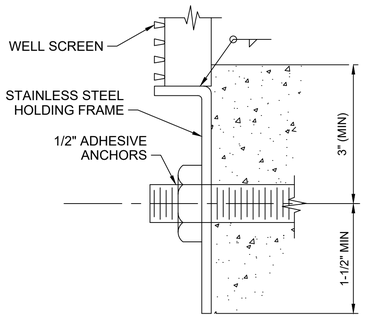
COLORADO LICENSED JOSHUA LEE 45206 PROFESSIONAL ENGINEER 05/08/2025

Scale For Microfilming: Millimeters / Inches

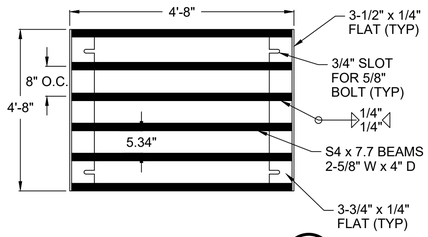


EXTENDED DETENTION BASIN — 1 / 0C-502
NOT TO SCALE

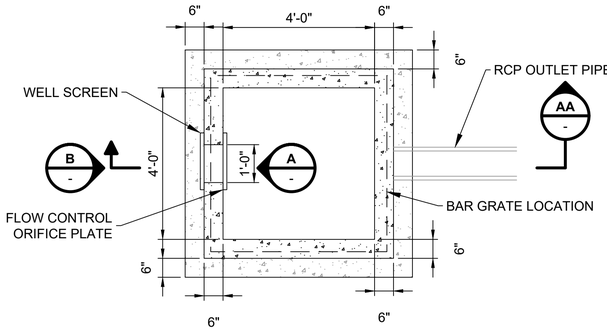
OUTLET STRUCTURE									
OUTLET STRUCTURE ID	ELEVATIONS (FT)						DIAMETERS (IN)		
	A	B	C	D	E	F	D1	D2	D3
TANKS	5443.75	5444.50	5446.87	5447.89	5449.25	5450.81	7/16	6	8



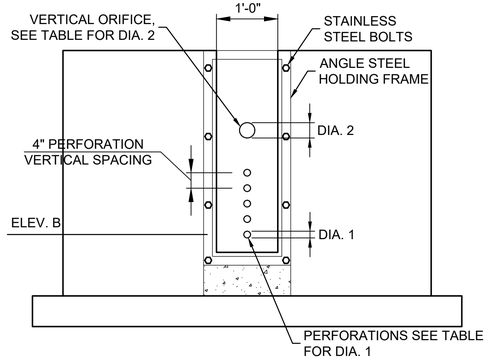
WELL SCREEN BOLT DETAIL — 3 / 0C-502
NOT TO SCALE



BAR TRASH RACK — 4 / 0C-502
NOT TO SCALE



OUTLET STRUCTURE — 2 / 0C-502
NOT TO SCALE



ELEVATION — A / --
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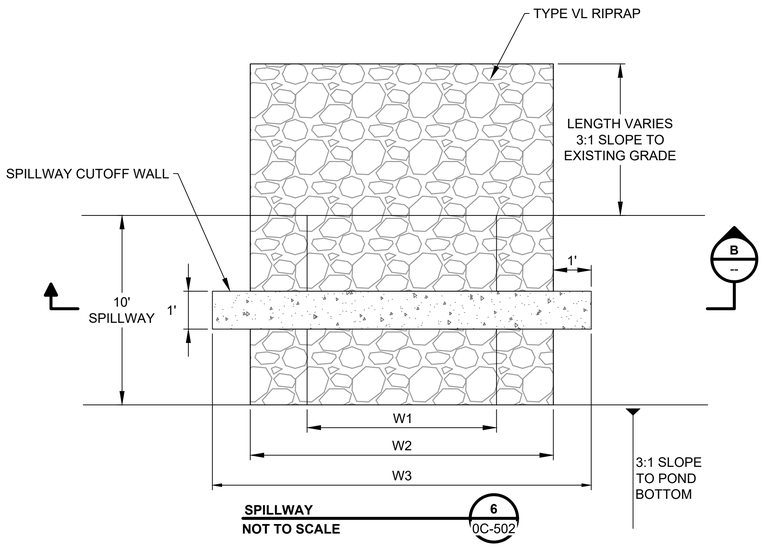
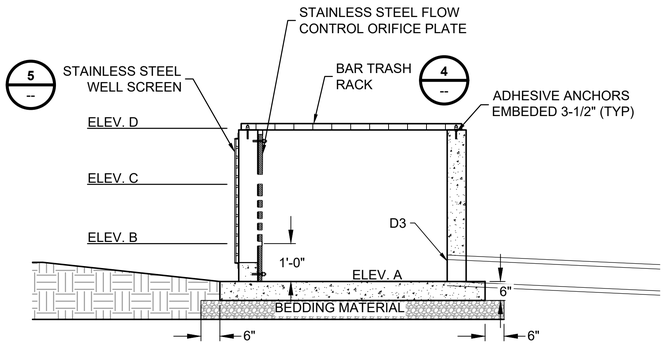


SPILLWAY — 6 / 0C-502
NOT TO SCALE

SPILLWAY DETAILS				
POND ID	WIDTH OF BOTTOM FLOW (W1)	WIDTH OF SPILLWAY (W2)	WIDTH OF CUTOFF WALL (W3)	HEIGHT OF CUTOFF WALL (H)
TANKS	10'	16'	18'	6'



SECTION — AA / --
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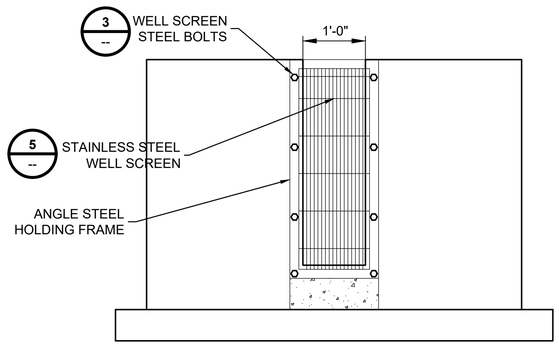
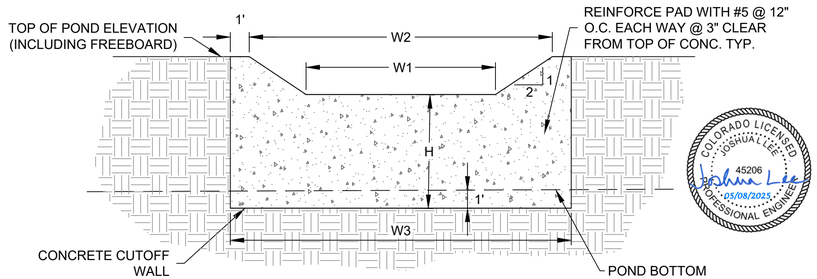


ELEVATION — B / --
NOT TO SCALE



SECTION — B / --
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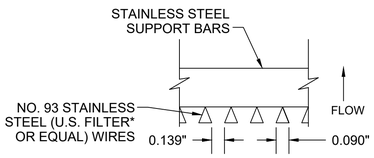

WELL SCREEN — 5 / 0C-502
NOT TO SCALE

no.	date	by	ckd	description
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Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
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BROOMFIELD TANKS AND PUMP STATION
CIVIL DETAILS III

project	contract
135303	

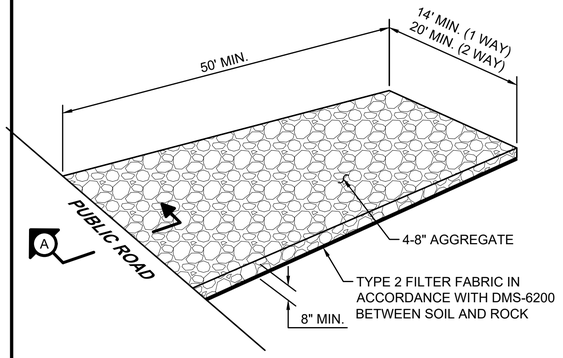
drawing **0C-502** — rev. **1**

sheet of sheets

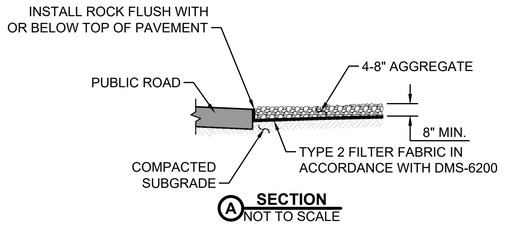
file 135303_0C-504_DETAILS.dwg

COLORADO LICENSED JOSHUA LEE 45206 PROFESSIONAL ENGINEER 05/08/2025

Scale For Microfilming
Millimeters
Inches

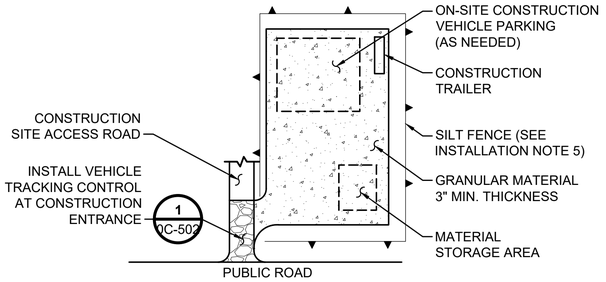


PLAN
NOT TO SCALE



SECTION
NOT TO SCALE

VEHICLE TRACKING CONTROL PAD (VTC) 1 0C-503
NOT TO SCALE



PLAN
NOT TO SCALE

INSTALLATION NOTES:

1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR GENERAL LOCATION OF STAGING AREA. CONTRACTOR MAY MODIFY LOCATION AND SIZE OF STABILIZED STAGING AREA WITH APPROVAL FROM ENGINEER AND/OR OWNER.
2. STABILIZED STAGING AREA SHALL BE SIZED APPROPRIATELY TO FULLY CONTAIN PARKING, STORAGE, AND UNLOADING AND LOADING OPERATIONS.
3. STAGING AREA SHALL BE STABILIZED PRIOR TO ANY OTHER OPERATIONS ON THE SITE.
4. THE STABILIZED STAGING AREA SHALL CONSIST OF 2-4" AGGREGATE A MINIMUM OF 8 INCHES THICK.
5. STAGING AREA SHALL BE CONTAINED WITHIN THE SITE'S PERIMETER BMPS, OR HAVE ADDITIONAL PERIMETER BMPS (SILT FENCE) INSTALLED AROUND STAGING AREA.

MAINTENANCE NOTES:

1. THE CONTRACTOR SHALL INSPECT THE STABILIZED STAGING AREA WEEKLY AND MAINTAIN IT IN AN EFFECTIVE CONDITION. IT SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS OR CLEAN OUT OF UPSTREAM SEDIMENT SHOULD BE COMPLETED AS NEEDED.
2. THE CONTRACTOR SHALL PROVIDE ADDITIONAL THICKNESS OF AGGREGATE MATERIAL IF ANY RUTTING OCCURS OR UNDERLYING SUBGRADE BECOMES EXPOSED.
3. STABILIZED STAGING AREA SHALL BE ENLARGED IF NECESSARY TO CONTAIN PARKING, STORAGE, AND UNLOADING AND LOADING OPERATIONS.
4. ANY ACCUMULATED DIRT OR MUD SHALL BE REMOVED FROM THE SURFACE OF THE STABILIZED STAGING AREA.
5. THE STABILIZED STAGING AREA SHALL BE REMOVED AT THE END OF CONSTRUCTION. THE GRANULAR MATERIAL SHALL BE REMOVED AND THE AREA TOPSOILED, SEEDED AND MULCHED.

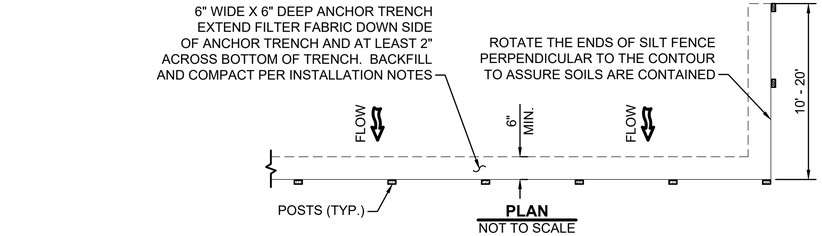
STABILIZED STAGING AREA (SSA) 2 0C-503
NOT TO SCALE

INSTALLATION NOTES:

1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR GENERAL LOCATION OF CONSTRUCTION ENTRANCE. CONTRACTOR MAY MODIFY LOCATIONS AND QUANTITIES AS NECESSARY TO MEET SITE CONDITIONS.
2. THE VEHICLE TRACKING PAD SHALL BE SIZED APPROPRIATELY TO ALLOW PROPER TRAFFIC FLOW AND TO PREVENT TRACKING OF SEDIMENT OFF-SITE. IF TRACKING PAD IS NOT EFFECTIVE AT CONTAINING SEDIMENT THE CONTRACTOR SHALL STOP OPERATIONS AND MAKE MODIFICATIONS TO THE TRACKING PAD TO PREVENT OFF-SITE TRACKING OF SEDIMENT.
3. VEHICLE TRACKING PAD SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES.
4. THE TRACKING PAD SHALL CONSIST OF 4-8" AGGREGATE A MINIMUM OF 8 INCHES THICK. A NON-WOVEN GEOTEXTILE FABRIC SHALL BE PLACED UNDER THE TRACKING PAD PRIOR TO THE PLACEMENT OF AGGREGATE.
5. A STABILIZED ENTRANCE/EXIT IS REQUIRED AT ALL ACCESS POINTS WHERE VEHICLES CAN ACCESS THE CONSTRUCTION SITE FROM PUBLIC ROADS. ANY OTHER ACCESS POINTS NOT SHOWN ON THE PLANS THAT THE CONTRACTOR ELECTS TO USE SHALL HAVE A VEHICLE TRACKING PAD INSTALLED AND THE ENTRANCE/EXIT LOCATION.

MAINTENANCE NOTES:

1. THE CONTRACTOR SHALL INSPECT THE VEHICLE TRACKING PAD WEEKLY AND MAINTAIN IT IN AN EFFECTIVE CONDITION. IT SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS SHOULD BE COMPLETED AS NEEDED.
2. THE CONTRACTOR SHALL PROVIDE ADDITIONAL THICKNESS OF AGGREGATE MATERIAL IF ANY RUTTING OCCURS OR UNDERLYING SUBGRADE BECOMES EXPOSED. ROCK SHALL BE RE-APPLIED OR RE-GRADED AS NECESSARY TO MAINTAIN A CONSTANT DEPTH OF THE AGGREGATE.
3. SEDIMENT TRACKED ONTO PAVED ROADS SHALL BE REMOVED THROUGHOUT THE DAY AND AT THE END OF THE DAY BY SHOVELING OR SWEEPING. SEDIMENT SHALL NOT BE WASHED INTO DRAINAGE SWALES, DITCHES OR STORM SEWERS.
4. ALL AGGREGATE USED FOR THE VEHICLE TRACKING PAD SHALL BE REMOVED AT THE END OF CONSTRUCTION. THE AGGREGATE MATERIAL SHALL BE REMOVED AND EITHER SURFACED WITH GRAVEL OR TOPSOILED, SEEDED AND MULCHED PER THE PLANS.



PLAN
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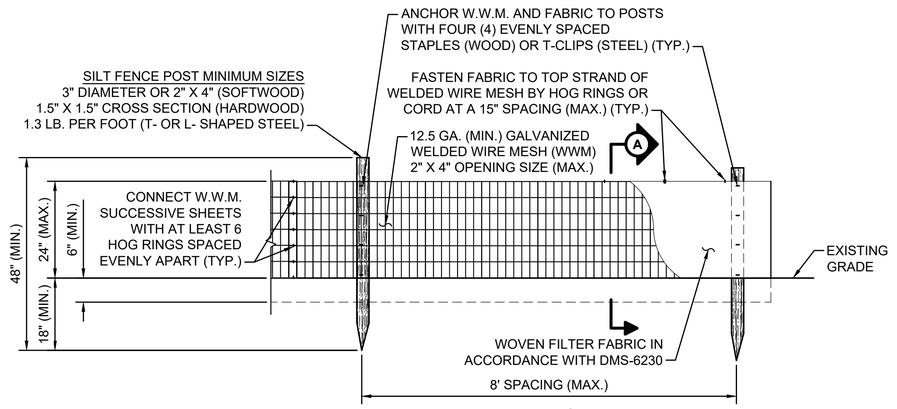
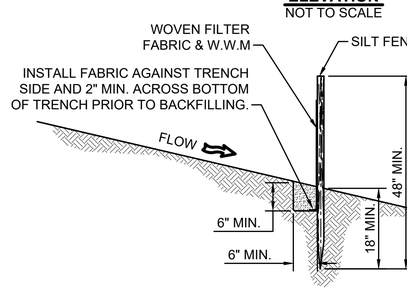


ELEVATION
NOT TO SCALE



SECTION
NOT TO SCALE

INSTALLATION NOTES:

1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR GENERAL LOCATION OF SILT FENCE. CONTRACTOR MAY MODIFY LOCATIONS AND QUANTITIES WITH APPROVAL FROM ENGINEER AND/OR OWNER.
2. SILT FENCE SHALL BE INSTALLED PRIOR TO BEGINNING ANY LAND DISTURBING ACTIVITIES.
3. SILT FENCE SHALL BE PLACED AWAY FROM THE TOE OF A SLOPE TO ALLOW FOR WATER PONDING. IT SHALL BE INSTALLED AT LEAST 5 FEET BEYOND THE LIMITS OF GRADING.
4. ANCHOR TRENCH SHALL BE EXCAVATED USING A TRENCHER OR SILT FENCE INSTALLATION DEVICE. GRADERS, BACKHOES OR OTHER SIMILAR EQUIPMENT SHALL NOT BE USED FOR INSTALLATION.
5. COMPACTION OF THE ANCHOR TRENCH BACKFILL SHALL BE COMPLETED BY HAND WITH A "JUMPING JACK" OR BY WHEEL ROLLING. THE COMPACTION EFFORT SHALL BE SUFFICIENT TO PREVENT THE SILT FENCE FROM BEING PULLED OUT BY HAND.
6. WIRE MESH AND FABRIC SHALL BE PULLED TIGHT AS IT IS ANCHORED TO THE POSTS, THERE SHALL BE NO NOTICEABLE SAG BETWEEN POSTS AFTER INSTALLATION.
7. STAPLES USED TO ANCHOR MESH AND FABRIC TO POSTS SHALL BE 3/4" HEAVY DUTY STAPLES WITH 1/2" LEGS MINIMUM.
8. SILT FENCE SHALL BE INSTALLED AS CLOSE TO ON THE CONTOUR AS POSSIBLE. AT THE END OF A RUN OF SILT FENCE IT SHALL BE TURNED PERPENDICULAR TO THE CONTOUR TO CREATE A J-HOOK. THE EXTENSION OF THE PERPENDICULAR SECTION SHOULD BE A SUFFICIENT LENGTH TO PREVENT RUNOFF FROM FLOWING AROUND THE END OF THE SILT FENCE.

MAINTENANCE NOTES:

1. THE CONTRACTOR SHALL INSPECT SILT FENCE WEEKLY AND MAINTAIN IT IN AN EFFECTIVE CONDITION. IT SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS SHOULD BE COMPLETED AS NEEDED.
2. SEDIMENT ACCUMULATED UPSTREAM OF SILT FENCE SHALL BE REMOVED WHEN THE UPSTREAM SEDIMENT DEPTH IS GREATER THAN 6 INCHES.
3. REPAIR OR REPLACE SILT FENCE WHEN THERE ARE SIGNS OF WEAR, SUCH AS SAGGING, TEARING OR COLLAPSE.
4. SILT FENCE SHALL REMAIN IN PLACE UNTIL UPSTREAM DISTURBED AREA HAS BEEN STABILIZED OR IT IS REPLACED BY ANOTHER EQUIVALENT PERIMETER SEDIMENT CONTROL BMP.
5. SILT FENCE SHALL BE REMOVED AT THE END OF CONSTRUCTION. AFTER REMOVAL OF THE THE FABRIC, WIRE MESH AND POSTS THE DISTURBED AREAS SHALL BE TOP-SOILED, SEEDED AND MULCHED.

SILT FENCE (SF) 3 0C-503
NOT TO SCALE

COLORADO LICENSED JOSHUA LEE 45206 PROFESSIONAL ENGINEER
05/08/2025

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements.
THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."

City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	**checked by**
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

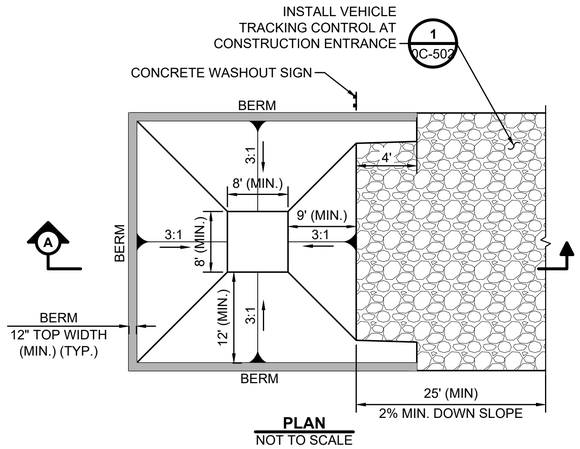
BROOMFIELD TANKS AND PUMP STATION
EROSION AND SEDIMENT CONTROL DETAILS I

project	contract
135303	

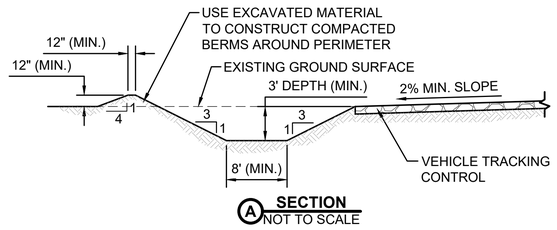
drawing **0C-503** rev. **1**

sheet of sheets
file 135303_0C-504_DETAILS.dwg

Scale For Microfilming
Millimeters
Inches



PLAN
NOT TO SCALE



A **SECTION**
NOT TO SCALE

INSTALLATION NOTES:

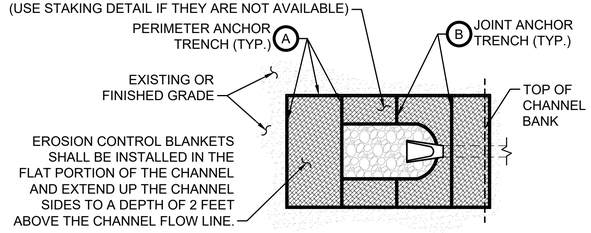
1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR LOCATION OF CONCRETE WASHOUT AREA.
2. THE CONCRETE WASHOUT AREA SHALL BE INSTALLED PRIOR TO ANY CONCRETE PLACEMENT ON SITE.
3. VEHICLE TRACKING CONTROL IS REQUIRED AT THE ACCESS POINT.
4. SIGNS SHALL BE PLACED AT THE CONSTRUCTION ENTRANCE, AT THE WASHOUT AREA, AND ELSEWHERE AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CONCRETE WASHOUT AREA TO OPERATORS OF CONCRETE TRUCKS AND PUMP RIGS.
5. EXCAVATION MATERIAL SHALL BE UTILIZED IN PERIMETER BERM CONSTRUCTION.

MAINTENANCE NOTES:

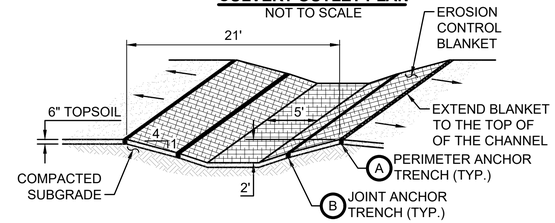
1. THE CONCRETE WASHOUT AREA SHALL BE REPAIRED, ENLARGED OR CLEANED OUT AS NECESSARY TO MAINTAIN CAPACITY FOR WASTED CONCRETE. CONCRETE WASTE MATERIALS SHALL BE REMOVED ONCE THE MATERIALS HAVE REACHED A DEPTH OF 2'.
2. THE CONTRACTOR SHALL INSPECT THE CONCRETE WASHOUT AREA WEEKLY AND MAINTAIN IT IN AN EFFECTIVE CONDITION. IT SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS OR CLEAN OUT OF SEDIMENT SHOULD BE COMPLETED AS NEEDED.
3. THE CONCRETE WASHOUT AREA SHALL REMAIN IN PLACE UNTIL ALL CONCRETE FOR THE PROJECT IS PLACED.
4. THE CONCRETE WASHOUT AREA SHALL BE REMOVED AT THE END OF CONSTRUCTION. THE CONCRETE WASTE SHALL BE REMOVED AND DISPOSED OF IN ACCORDANCE WITH ALL LOCAL, STATE AND FEDERAL REGULATIONS. AFTER REMOVAL OF THE WASTE MATERIAL THE AREA SHALL BE GRADED SMOOTH, TOPSOILED, SEEDED AND MULCHED.

CONCRETE WASHOUT AREA (CWA) — 1 / 0C-504
NOT TO SCALE

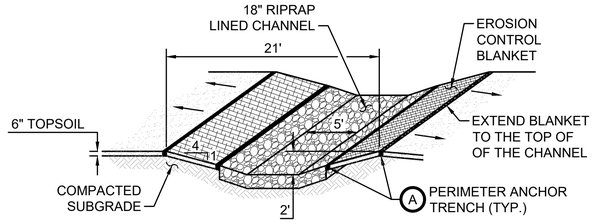
BLANKETS SHOULD BE INSTALLED PARALLEL TO THE FLOW DIRECTION. STAKING SHALL BE COMPLETED PER MANUFACTURERS RECOMMENDATIONS (USE STAKING DETAIL IF THEY ARE NOT AVAILABLE)



CULVERT OUTLET PLAN
NOT TO SCALE



NON-RIPRAPPED DITCH DETAIL
NOT TO SCALE



RIPRAPPED LINED DITCH DETAIL
NOT TO SCALE

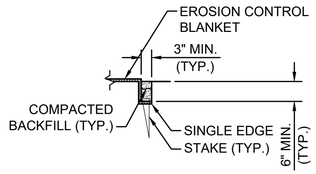
INSTALLATION NOTES:

1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR LOCATION OF EROSION CONTROL BLANKETS.
2. 100 PERCENT NATURAL AND BIODEGRADABLE MATERIALS ARE REQUIRED FOR EROSION CONTROL BLANKETS.
3. PRIOR TO INSTALLING THE EROSION CONTROL BLANKETS THE CONTRACTOR SHALL PLACE TOPSOIL AND FINISH GRADE THE AREA, FOLLOWED BY SEEDING AND MULCHING OF THE AREA. THE SOIL SHALL BE SMOOTH AND MOIST PRIOR TO THE INSTALLATION OF THE EROSION CONTROL BLANKET AND THE BLANKET SHALL BE IN FULL CONTACT WITH THE SUBGRADE. AN GAPS OR VOIDS SHALL EXIST UNDER THE EROSION CONTROL BLANKET.
4. A PERIMETER ANCHOR TRENCH SHALL BE USED ALONG THE OUTSIDE PERIMETER OF ALL EROSION CONTROL BLANKET AREAS.
5. JOINT ANCHOR TRENCHES SHALL BE USED TO JOIN ROLLS OF EROSION CONTROL BLANKETS TOGETHER BOTH LONGITUDINALLY AND TRANSVERSELY, EXCEPT FOR STRAW ONLY BLANKETS WHICH MAY BE JOINED WITH AN OVERLAPPING JOINT.
6. OVERLAPPING JOINTS SHALL BE USED TO JOIN ROLLS OF EROSION CONTROL BLANKETS ON SLOPES.
7. AREAS THAT HAVE BEEN SEEDED AND MULCHED THAT ARE DISTURBED DURING THE EROSION CONTROL BLANKET INSTALLATION SHALL BE RE-SEEDED AND RE-MULCHED PRIOR TO INSTALLATION OF THE EROSION CONTROL BLANKETS.
8. EROSION CONTROL BLANKETS SHALL CONSIST OF STRAW, COCONUT OR EXCELSIOR WITH DOUBLE NETTING. EROSION CONTROL BLANKETS SHALL MEET THE THE REQUIREMENTS OF CDOT.

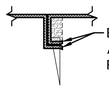
MAINTENANCE NOTES:

1. THE CONTRACTOR SHALL INSPECT THE CONCRETE EROSION CONTROL BLANKETS WEEKLY AND MAINTAIN THEM IN AN EFFECTIVE CONDITION. THEY SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS SHOULD BE COMPLETED AS NEEDED.
2. THE EROSION CONTROL BLANKETS SHALL BE LEFT IN PLACE TO BIODEGRADE UNLESS REQUESTED TO BE REMOVED BY THE ENGINEER OR OWNER IF THEY ARE NO LONGER NECESSARY.
3. ANY EROSION CONTROL BLANKETS THAT ARE PULLED OUT, TORN, OR OTHERWISE DAMAGED SHALL BE RE-INSTALLED. ANY SUBGRADE AREAS BELOW THE BLANKET THAT HAVE ERODED TO CREATE A VOID UNDER THE BLANKET, OR THAT REMAIN DEVOID OF GRASS SHALL BE REPAIRED, RESEEDED AND MULCHED AND THE EROSION CONTROL BLANKET REINSTALLED.

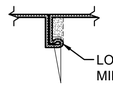
EROSION CONTROL BLANKET (ECB) — 2 / 0C-504
NOT TO SCALE



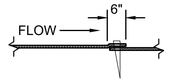
A **PERIMETER ANCHOR TRENCH**



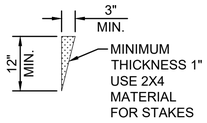
B **JOINT ANCHOR TRENCH**



C **INTERMEDIATE ANCHOR TRENCH**

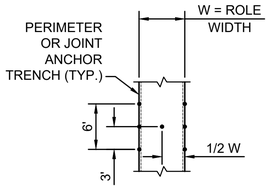


D **OVERLAPPING JOINT**

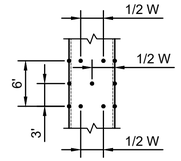


E **WOOD STAKE DETAIL**

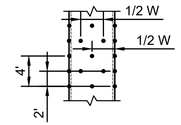
ANCHOR DETAILS
NOT TO SCALE



STRAW BLANKET
NOT TO SCALE



STRAW-COCONUT BLANKET
NOT TO SCALE



COCONUT OR EXCELSIOR BLANKET
NOT TO SCALE

SHALL BE IN ACCORDANCE WITH MANUFACTURER'S SPECIFICATION. IF NO MANUFACTURER'S SPECIFICATION IS AVAILABLE USE THE ACCEPTABLE STAKING PATTERN (AS SHOWN ABOVE)

STAKING PATTERNS
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
1	05/06/25	HCH	JLL	ISSUED FOR CONSTRUCTION

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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	checked by
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
EROSION AND SEDIMENT CONTROL DETAILS II

project	contract
135303	

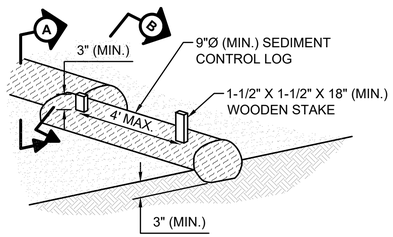
drawing **0C-504** rev. **1**

sheet of sheets

file 135303_0C-504_DETAILS.dwg

COLORADO LICENSED
JOSHUA LEE
45206
PROFESSIONAL ENGINEER
05/08/2025

Scale For Microfilming
Millimeters
Inches



PERSPECTIVE VIEW
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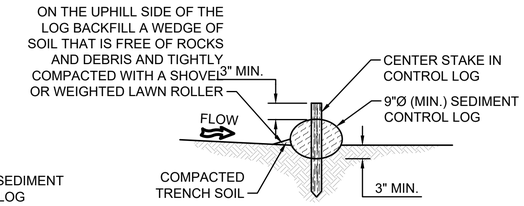
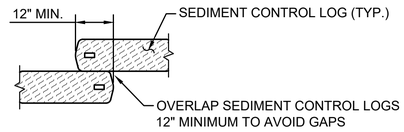


A SECTION
NOT TO SCALE



B OVERLAP JOINT DETAIL
NOT TO SCALE

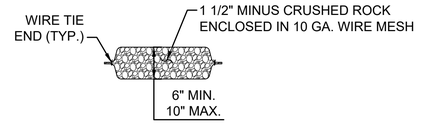
INSTALLATION NOTES:

1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR GENERAL LOCATION OF SEDIMENT CONTROL LOGS. CONTRACTOR MAY MODIFY LOCATIONS AND QUANTITIES WITH APPROVAL FROM ENGINEER AND/OR OWNER.
2. SEDIMENT CONTROL LOGS SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES IN THE LOCATIONS THAT WILL NOT BE DISTURBED. LOGS LOCATED IN AREAS THAT WILL BE GRADED SHALL BE INSTALLED AS SOON AS POSSIBLE AFTER GRADING HAS BEEN COMPLETED.
3. SEDIMENT CONTROL LOGS SHOULD BE AVOIDED IN CONCENTRATED HIGH FLOW AREAS.
4. SEDIMENT CONTROL LOGS SHALL BE TRENCHED INTO THE GROUND A MINIMUM OF 3 INCHES.

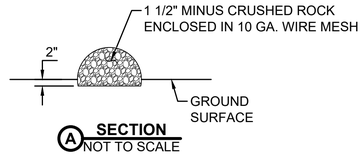
MAINTENANCE NOTES:

1. THE CONTRACTOR SHALL INSPECT THE SEDIMENT CONTROL LOGS WEEKLY AND MAINTAIN THEM IN AN EFFECTIVE CONDITION. THEY SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS SHOULD BE COMPLETED AS NEEDED.
2. SEDIMENT ACCUMULATED UPSTREAM OF SEDIMENT CONTROL LOGS SHALL BE REMOVED WHEN THE UPSTREAM SEDIMENT DEPTH IS WITHIN 1/2 THE HEIGHT OF THE CREST OF THE LOG.
3. SEDIMENT CONTROL LOGS THAT ARE SHOWN IN RIPRAP LINED DRAINAGE CHANNELS DO NOT NEED TO BE INSTALLED IF RIPRAP IS INSTALLED DURING CHANNEL CONSTRUCTION. IF RIPRAP IS NOT INSTALLED DURING CHANNEL CONSTRUCTION, THE SEDIMENT CONTROL LOGS SHALL BE TEMPORARILY INSTALLED UNTIL COMMENCING THE RIPRAP INSTALLATION.
4. SEDIMENT CONTROL LOGS SHALL BE REMOVED AT THE END OF CONSTRUCTION. AFTER REMOVAL OF THE LOGS THE DISTURBED AREAS SHALL BE TOPSOILED, SEEDED AND MULCHED.

SEDIMENT CONTROL LOG (SCL) — 1 / 0C-505
NOT TO SCALE



PLAN
NOT TO SCALE



A SECTION
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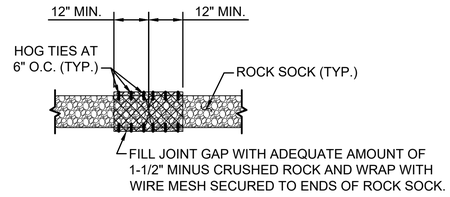
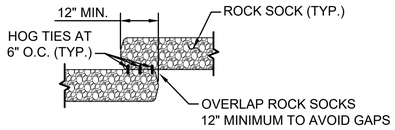


B LAPPED JOINT DETAIL
NOT TO SCALE



C OVERLAP JOINT DETAIL
NOT TO SCALE

INSTALLATION NOTES:

1. SEE SEDIMENT AND EROSION CONTROL PLAN FOR GENERAL LOCATION OF ROCK SOCKS. CONTRACTOR MAY MODIFY LOCATIONS WITH APPROVAL FROM ENGINEER AND/OR OWNER.
2. CRUSHED ROCK SHALL BE 1-1/2" MINUS IN SIZE WITH A FRACTURED FACE ON ALL SIDES AND SHALL CONFORM TO THE GRADION IN TABLE A.
3. WIRE MESH SHALL BE FABRICATED OF 10 GAGE POULTRY MESH, OR EQUIVALENT, WITH A MAXIMUM OPENING OF 1/2".
4. WIRE MESH SHALL BE SECURED USING "HOG RINGS" OR WIRE TIES AT 6" CENTERS ALONG ALL JOINTS AND AT 2" CENTERS AT ENDS OF SOCKS.

MAINTENANCE NOTES:

1. THE CONTRACTOR SHALL INSPECT THE ROCK SOCKS WEEKLY AND MAINTAIN THEM IN AN EFFECTIVE CONDITION. THEY SHALL ALSO BE INSPECTED WITHIN 24 HOURS AFTER A STORM EVENT AND REPAIRS SHOULD BE COMPLETED AS NEEDED.
2. SEDIMENT ACCUMULATED UPSTREAM OF ROCK SOCK SHALL BE REMOVED WHEN THE UPSTREAM SEDIMENT DEPTH IS WITHIN 1/2 THE HEIGHT OF THE ROCK SOCK.
3. ROCK SOCKS SHALL REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED.
4. ONCE CONSTRUCTION AND FINAL STABILIZATION IS COMPLETE THE ROCK SOCKS SHALL BE REMOVED. AFTER REMOVAL THE DISTURBED AREAS SHALL BE TOP-SOILED, SEEDED AND MULCHED.

GRADATION TABLE A	
SIEVE SIZE	PERCENT PASSING
2"	100
1-1/2"	90 - 100
1"	20 - 55
3/4"	0 - 15
3/8"	0 - 5

ROCK SOCK DETAIL (RS) — 2 / 0C-505
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	HCH	JLL	ISSUED FOR CONSTRUCTION
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City and County Engineer (or Designee) Date

COLORADO LICENSED JOSHUA LEE 45206 05/08/2025 PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	C. HARRIS
designed by	checked by
C. HARRIS	J. LEE

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
EROSION AND SEDIMENT CONTROL DETAILS III

project	contract
135303	

drawing 0C-505 — rev. 1
sheet of sheets
file 135303_0C-504_DETAILS.dwg

Millimeters
Scale For Microfilming
Inches

STRUCTURAL LEGEND

MATERIAL HATCH PATTERNS

- UNDISTURBED EARTH OR NATIVE SOIL
- BRICK (COMMON/FACE)
- COMPACTED FILL
- STEEL
- ROCK
- ALUMINUM
- GRANULAR FILL
- GRATING
- CONCRETE
- CHECKERED PLATE
- GROUT
- VOID FORM
- CONCRETE MASONRY UNITS (PLAN/SECTION)
- EPS (GEOFOAM)
- CONCRETE MASONRY UNIT (ELEVATION)
- DEMOLITION

COMMON SYMBOLS

GENERAL

- (?) KEYNOTES
- (?) GRID - COLUMN CENTERLINE
- (?) GRID - WALL FACE

WATERSTOPS (SEE SPECIFICATION SECTION 03 30 00)

- PLASTIC, EXPANSIVE
- MASTIC, NON-EXPANSIVE
- PVC, DUMBBELL TYPE
- PVC, SPLIT FLANGE TYPE
- PVC, BASE SEAL TYPE

PLAN VIEW SYMBOLS

- SPAN — FLOOR SPAN
- SLAB STEP OR SLOPE TRANSITION
- (?) SCHEDULED BEAM TAG (SEE SCHEDULE)
- ? (?) [?] / TOS EL ? — BEAM TAG (STEEL IF NO MATERIAL INDICATED)
- (?) SCHEDULED COLUMN TAG (SEE SCHEDULE)
- ? [?] — COLUMN TAG (STEEL IF NO MATERIAL INDICATED)

SECTION/ELEVATION/DETAIL VIEW SYMBOLS

- POST-INSTALLED EPOXY EMBED ANCHOR
- POST-INSTALLED EXPANSION ANCHOR
- STRUCTURAL SHAPES (STEEL, ALUMINUM, FRP)
- (?)* TYPICAL WALL TYPE
  - DESIGNATES REINFORCING & JOINT DETAILS FOR SIMILAR NUMBERED WALLS

STANDARD STRUCTURAL ABBREVIATIONS

#	NUMBER OR POUND(S)
%	PERCENT
&	AND
@	AT
AA	ALUMINUM ASSOCIATION
AB	ANCHOR BOLT
ACI	AMERICAN CONCRETE INSTITUTE
ADDL	ADDITIONAL
ADH	ADHESIVE
ADJ	ADJACENT
AFF	ABOVE FINISH FLOOR
AGGR	AGGREGATE
AHJ	AUTHORITY HAVING JURISDICTION
AHR	ANCHOR
AISC	AMERICAN INSTITUTE OF STEEL CONSTRUCTION
AISI	AMERICAN IRON AND STEEL INSTITUTE
ALT	ALTERNATE
ALUM	ALUMINUM
ANSI	AMERICAN NATIONAL STANDARDS INSTITUTE
APPD	APPROVED
APPROX	APPROXIMATE
ARCH	ARCHITECT(URAL)
ASCE	AMERICAN SOCIETY OF CIVIL ENGINEERS
ASTM	ASTM INTERNATIONAL
AWS	AMERICAN WELDING SOCIETY
B/B	BACK TO BACK
BC	BOLT CIRCLE
BFF	BELOW FINISH FLOOR
BLDG	BUILDING
BLW	BELOW
BM	BEAM
BOS	BOTTOM OF STEEL
BOT	BOTTOM
BRCG	BRACING
BRDG	BRIDGING
BRG	BEARING
BTWN	BETWEEN
C	CHANNEL SHAPE
C/C	CENTER TO CENTER
CAP	CAPACITY
CFS	COLD-FORMED STEEL
CHFR	CHAMFER
CIP	CAST-IN-PLACE
CIR	CIRCLE
CJ	CONSTRUCTION JOINT
CJP	COMPLETE JOINT PENETRATION
CL	CENTER LINE
CLJ	CONTROL JOINT
CLL	COLUMN LINE
CLR	CLEAR
CMPST	COMPOSITE
CMU	CONCRETE MASONRY UNIT
CNR	CORNER
COL	COLUMN
CONC	CONCRETE
CONN	CONNECTION
CONSTR	CONSTRUCTION
CONT	CONTINUOUS
CONTR	CONTRACTOR
COORD	COORDINATE
COTR	CONTRACTING OFFICER'S TECHNICAL REPRESENTATIVE
CPRS	COMPRESSIBLE
CRSI	CONCRETE REINFORCING STEEL INSTITUTE
CTJ	CONTRACTION JOINT
CTR	CENTER(ED)
CY	CUBIC YARD(S)
D	DEEP (DEPTH)
DBL	DOUBLE
DEG	DEGREE(S)
DEMO	DEMOLISH (DEMOLITION)
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DIR	DIRECTION
DIV	DIVISION
DK	DECK
DL	DEAD LOAD
DWG	DRAWING
DWL	DOWEL
E	EAST
EA	EACH
EF	EACH FACE
EJ	EXPANSION JOINT
EL	ELEVATION
EL	EARTHQUAKE LOAD
ELEC	ELECTRICAL
ELEV	ELEVATOR
EMBED	EMBEDMENT
ENGR	ENGINEER
EOD	EDGE OF DECK
EOS	EDGE OF SLAB
EQ	EQUAL
EQUIP	EQUIPMENT
EQUIV	EQUIVALENT
ETC	AND SO FORTH
EW	EACH WAY
EXP	EXPANSION
EXST	EXISTING
EXT	EXTERIOR OR EXTERNAL
EXTN	EXTENSION
FAB	FABRICATE
FD	FLOOR DRAIN
FDTN	FOUNDATION
FF	FAR FACE
FIN	FINISH
FLG	FLANGE
FLR	FLOOR
FR	FRAME
FRMG	FRAMING
FRP	FIBER-REINFORCED POLYMER
FS	FAR SIDE
FT	FOOT (FEET)
FTG	FOOTING
FUT	FUTURE
GA	GAGE
GALV	GALVANIZE(D)
GB	GRADE BEAM
GC	GENERAL CONTRACTOR
GDR	GUARDRAIL
GEN	GENERAL
GOVT	GOVERNMENT
GR	GRADE
GRTG	GRATING
GT	GROUT
H	HIGH (HEIGHT)
HC	HOLLOW CORE
HGR	HANGER
HORIZ	HORIZONTAL
HP	BEARING PILE SHAPE
HPT	HIGH POINT
HS	HIGH STRENGTH
HSS	HOLLOW STRUCTURAL SECTION
I	MOMENT OF INERTIA
IBC	INTERNATIONAL BUILDING CODE
ID	INSIDE DIAMETER
IF	INSIDE FACE
IJ	ISOLATION JOINT
IN	INCH(ES)
INFO	INFORMATION
INT	INTERIOR
INV	INVERT
IR	INSIDE RADIUS
JST	JOIST
JT	JOINT
KB	KNEE BRACE
KIP	THOUSAND POUNDS
KLF	KIP(S) PER LINEAR FOOT
KPL	KICK PLATE
KSF	KIP(S) PER SQUARE FOOT
KSI	KIP(S) PER SQUARE INCH
L	ANGLE SHAPE OR LENGTH
LAD	LADDER
LBS	POUND(S)
LD	DEVELOPMENT LENGTH
LG	LONG
LL	LIVE LOAD
LLH	LONG LEG HORIZONTAL
LLO	LONG LEG OUTSTANDING
LLV	LONG LEG VERTICAL
LONG	LONGITUDINAL
LPT	LOW POINT
LSL	LONG-SLOT HOLE(S)
LTWT	LIGHTWEIGHT
MATL	MATERIAL
MAX	MAXIMUM
MBMA	METAL BUILDING MANUFACTURERS ASSOCIATION
MBS	METAL BUILDING SYSTEM
MC	MISCELLANEOUS CHANNEL SHAPE OR MOMENT CONNECTION
MECH	MECHANICAL
MEZZ	MEZZANINE
MFR	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MSL	MEAN SEA LEVEL
MTL	METAL
N	NORTH
NA	NOT APPLICABLE
NAAMM	NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS
NAVD	NORTH AMERICAN VERTICAL DATUM
NCMA	NATIONAL CONCRETE MASONRY ASSOCIATION
NE	NORTHEAST
NF	NEAR FACE
NIC	NOT IN CONTRACT
NO	NUMBER
NOM	NOMINAL
NS	NEAR SIDE
NTS	NOT TO SCALE
NW	NORTHWEST
OC	ON CENTER
OD	OUTSIDE DIAMETER
OF	OUTSIDE FACE
OPH	OPPOSITE HAND
OPNG	OPENING
OPP	OPPOSITE
OR	OUTSIDE RADIUS
OSHA	OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
OVS	OVERSIZE HOLE(S)
PAR	PARALLEL
PCA	PORTLAND CEMENT ASSOCIATION
PCC	PRECAST CONCRETE
PCF	POUND(S) PER CUBIC FOOT
PCI	POUND(S) PER CUBIC INCH OR PRECAST/PRESTRESSED CONCRETE INSTITUTE
PED	PEDESTAL
PERP	PERPENDICULAR
PH	PHASE
PL	PLATE
PLBG	PLUMBING
PLC	PLACE(S)
PLF	POUND(S) PER LINEAR FOOT
PREFAB	PREFABRICATE(D)
PREP	PREPARATION
PS	PIPE SUPPORT
PSF	POUND(S) PER SQUARE FOOT
PSI	POUND(S) PER SQUARE INCH
PT	PRETENSIONED JOINT
PUR	PURLIN
PVC	POLYVINYL CHLORIDE
QA	QUALITY ASSURANCE
QC	QUALITY CONTROL
R	RADIUS OR RISER(S)
RD	ROOF DRAIN
REBAR	REINFORCING STEEL BAR(S)
REF	REFERENCE
REINF	REINFORCE(D)
REQD	REQUIRED
REV	REVISION
RF	ROOF
RM	ROOM
RST	REINFORCING STEEL
S	SECTION MODULUS OR SOUTH OR AMERICAN STANDARD BEAM SHAPE
SB	SHEAR BAR
SC	SLIP-CRITICAL JOINT
SCHED	SCHEDULE
SDI	STEEL DECK INSTITUTE
SE	SOUTHEAST
SECT	SECTION
SEI	STRUCTURAL ENGINEERING INSTITUTE
SF	SWAY FRAME
SHT	SHEET
SIM	SIMILAR
SJI	STEEL JOIST INSTITUTE
SLNT	SEALANT
SLO	SHORT LEG OUTSTANDING
SLV	SLEEVE
SP	SPACE(S)
SPEC	SPECIFICATION(S)
SQ	SQUARE
SSL	SHORT-SLOT HOLE(S)
SST	STAINLESS STEEL
ST	SNUG-TIGHT JOINT
STD	STANDARD
STIF	STIFFENER
STIR	STIRRUP
STL	STEEL
STR	STRAIGHT
STRUCT	STRUCTURAL
SUB	SUBSTITUTE
SUPT	SUPPORT
SW	SOUTHWEST
SYMM	SYMMETRICAL
T	TON(S) OR TREAD(S)
T&B	TOP AND BOTTOM
TB	THROUGH BOLT
TD	TRENCH DRAIN
TEMP	TEMPORARY
THD	THREAD(ED)
THK	THICK(NESS)
THRU	THROUGH
TMS	THE MASONRY SOCIETY
TOC	TOP OF CONCRETE
TOM	TOP OF MASONRY
TOS	TOP OF STEEL
TOW	TOP OF WALL
TYP	TYPICAL
UNO	UNLESS NOTED OTHERWISE
VAR	VARIES
VB	VAPOR BARRIER
VERT	VERTICAL
VNR	VENEER
VR	VAPOR RETARDER
W	WEST OR WIDE (WIDTH) OR WIDE FLANGE SHAPE
W/	WITH
W/O	WITHOUT
WH	WEEP HOLE
WL	WIND LOAD
WLD	WELD(ED)
WP	WORKING POINT
WS	WATERSTOP
WT	WEIGHT OR WIDE FLANGE TEE SHAPE
WWR	WELDED WIRE REINFORCEMENT
X	EXTRA STRONG
XX	DOUBLE EXTRA STRONG

no.	date	by	ckd	description
0	01/28/25	STD	JJZ	ISSUED FOR CONSTRUCTION
1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	B. MIMIAGA
designed	checked
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ABBREVIATIONS & LEGEND

project	contract
135303	

drawing **0S-001** — rev. **1**

sheet of sheets

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 PE 05/08/2025 PROFESSIONAL ENGINEER

Millimeters / Inches / Scale For Microfilming

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NOTES:

1. STATEMENT OF SPECIAL INSPECTIONS AND TESTING REQUIREMENTS
   A. THIS "STATEMENT OF SPECIAL INSPECTIONS" HAS BEEN PREPARED IN ACCORDANCE WITH IBC 2021, SECTION 1704.
   B. OWNER SHALL RETAIN PRE-COORDINATED AND GOVERNMENT-APPROVED THIRD-PARTY QUALITY ASSURANCE AGENCIES TO PROVIDE SPECIAL INSPECTIONS DURING CONSTRUCTION IN ACCORDANCE WITH IBC REQUIREMENTS.
   C. EACH SPECIAL INSPECTOR SHALL BE A QUALIFIED PERSON WHO SHALL DEMONSTRATE COMPETENCE, TO THE SATISFACTION OF THE CONTRACTING OFFICER'S REPRESENTATIVE, FOR INSPECTION OF THE PARTICULAR TYPE OF CONSTRUCTION OR OPERATION REQUIRING SPECIAL INSPECTION.
   D. SPECIAL INSPECTION AGENCY SHALL SUBMIT INSPECTION REPORTS DURING CONSTRUCTION FOR VERIFICATION, INCLUDING FINAL REPORTS IN ACCORDANCE WITH IBC SECTION 1704.2.4.
   E. SPECIAL INSPECTOR SHALL USE THE LATEST ISSUE OF THE STRUCTURAL DRAWINGS FOR ALL INSPECTIONS. SHOP FABRICATION DRAWINGS SHALL NOT BE USED FOR SUCH PURPOSES.
   F. THE TABLE ON THIS SHEET IDENTIFIES THE MATERIALS, SYSTEMS, AND COMPONENTS FOR WHICH SPECIAL INSPECTION IS REQUIRED.
   G. CONTRACTOR SHALL RETAIN PRE-COORDINATED AND GOVERNMENT-APPROVED THIRD-PARTY TESTING AGENCIES TO PROVIDE STRUCTURAL TESTING DURING CONSTRUCTION IN ACCORDANCE WITH IBC REQUIREMENTS.
   H. TESTING AGENCY SHALL SUBMIT TEST RESULTS DURING CONSTRUCTION FOR VERIFICATION INCLUDING A FINAL REPORT IN ACCORDANCE WITH IBC SECTION 1704.2.4.
   I. THE TABLE ON THIS SHEET IDENTIFIES THE STRUCTURAL TESTS REQUIRED FOR THIS PROJECT.
2. STRUCTURAL OBSERVATIONS
   A. A REGISTERED DESIGN PROFESSIONAL SHALL PROVIDE STRUCTURAL OBSERVATIONS DURING CONSTRUCTION IN ACCORDANCE WITH IBC REQUIREMENTS.
   B. EACH STRUCTURAL OBSERVER SHALL SUBMIT WRITTEN STATEMENTS IDENTIFYING FREQUENCY AND EXTENT OF STRUCTURAL OBSERVATIONS AND ANY REPORTED DEFICIENCIES WHICH, TO THE BEST OF THE STRUCTURAL OBSERVER'S KNOWLEDGE, HAVE NOT BEEN RESOLVED.
3. DELEGATED DESIGN
   A. DESIGN ENGINEER FOR DELEGATED DESIGN ELEMENTS SHALL SUBMIT SUPPLEMENTAL STATEMENT OF SPECIAL INSPECTIONS IN ACCORDANCE WITH IBC 2021, SECTION 1704.

SPECIAL INSPECTION REQUIREMENTS

MATERIAL/SYSTEM	TYPE & EXTENT OF SPECIAL INSPECTION	CONT/PERIODIC INSPECTION	TYPE & EXTENT OF TESTING	CODE REFERENCE
SUBGRADE PREPARATION	VERIFY DEPTH, MATERIALS AND COMPACTION	P	DENSITY TEST ON COMPACTED FILL, PROOFROLL UNDISTRUBED NATIVE MATERIAL	
MATERIAL VERIFICATION OF STRUCTURAL STEEL	IDENTIFICATION OF ASTM MARKINGS, MILL TEST REPORTS			ASTM A6 OR ASTM A568
MATERIAL VERIFICATION OF WELD FILLER MAT'LS	IDENTIFICATION OF AWS MARKINGS, MFR'S CERTIFICATE OF COMPLIANCE			AISC 360, SECTION A3.5
SINGLE PASS FILLET WELDS<= 5/16"	VISUAL INSPECTION	P		AWS D1.1
CONCRETE FORM WORK	SHAPE, LOCATION, AND DIMENSIONS OF CONCRETE MEMBER	P		
REINFORCEMENT	SIZE AND PLACEMENT	P		ACI 318
CONCRETE MIX DESIGN	VERIFICATON OF PROPERTIES	P		ACI 318
CAST-IN-PLACE CONCRETE	PLACEMENT OF CONCRETE	C	TEMPERATURE, STRENGTH, SLUMP, AIR ENTRAINMENT	ACI 318
CONCRETE CURING	MAINTENANCE OF CURING TEMPERATURE AND TECHNIQUES	P		ACI 318
ANCHORS CAST IN CONCRETE	SIZE AND PLACEMENT	P		ACI 318
ANCHORS POST INSTALLED IN HARDENED CONCRETE	SIZE, PLACEMENT, AND CONFORMANCE TO MFR'S INSTALLATION PROCEDURES	C		ACI 318
MASONRY CONSTRUCTION	COMPLIANCE WITH CONSTRUCTION DOCUMENTS AND APPROVED SUBMITTALS	P	MORTAR JOINTS, HOT AND COLD WEATHER PLACEMENT	ACI 530
MASONRY STRENGTH	VERIFICATION OF f'm	P	PRIOR TO CONSTRUCTION AND EVERY 5000 SQ FT	ACI 530
PREMIXED MORTAR AND GROUT	VERIFICATION OF PROPERTIES	P		ACI 530
SITE PREPARED MORTAR AND GROUT	VERIFICATION OF PROPERTIES	P		ACI 530
MASONRY CONSTRUCTION	SIZE, PLACEMENT AND CONDITIONS	P	MORTAR JOINTS, HOT AND COLD WEATHER PLACEMENT	ACI 530
GROUT	GROUT SPACE PRIOR TO GROUT, PLACEMENT OF GROUT	C		ACI 530
DRILLED SHAFT FOUNDATIONS	DRILLING OPERATIONS LOGGING FOR EACH ELEMENT. VERIFY LOCATIONS, PLUMBNESS, ELEMENT DIAMETERS, LENGTHS, BEDROCK EMBEDMENT AND ADEQUATE END-BEARING STRATA CAPACITY	P		SJI 100
AWWA D115 CONCRETE TANK INSPECTIONS	AS REQUIRED BY TANK DESIGN ENGINEER, SEE NOTE 3			AWWA D115, IBC

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COLORADO LICENSED SHAWN T. DALGLISH 58555 05/08/2025 PROFESSIONAL ENGINEER

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CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

STATEMENT OF SPECIAL INSPECTIONS

project	contract
135303	

drawing **0S-002** — **rev.** **1**

sheet **of** **sheets**

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Millimeters Scale For Microfilming Inches

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STRUCTURAL DESIGN LOADING/CRITERIA

SITE STRUCTURAL DESIGN CRITERIA PROVIDED BELOW. WHERE INDICATED AS "VARIES", SEE STRUCTURE-SPECIFIC LOADS / CRITERIA WITHIN INDIVIDUAL STRUCTURE DRAWING SUBSETS. REFER TO "DRAWING IDENTIFICATION SYSTEM," IN THE INDEX, FOR BUILDING/STRUCTURE IDENTIFIERS.

1. RISK CATEGORY: IV (TYPICAL FOR ALL STRUCTURES WITHIN PROJECT SCOPE.)
2. DEAD LOADS
   A. SELF WEIGHT OF MATERIALS OF CONSTRUCTION
   B. SUPERIMPOSED DEAD LOAD.....VARIES
3. SNOW LOADS.....VARIES
   A. STAIRS, WALKWAYS, PLATFORMS.....100 PSF, UNIFORM
4. ROOF LIVE LOADS.....20 PSF
   A. SNOW LOAD IMPORTANCE FACTOR (I_s)..... 1.35
   B. GROUND SNOW LOAD (P_g)..... 40 PSF
   C. FLAT-ROOF SNOW LOAD.....38 PSF
   D. SNOW EXPOSURE FACTOR (C_e)..... 1.0
   E. THERMAL FACTOR (C_t).....VARIES
   F. SLOPE FACTOR (C_s)..... VARIES
   G. DRIFT SURCHARGE LOADS.....VARIES
5. WIND DESIGN DATA:
   A. BASIC WIND SPEED (V_{ult}).....140 MPH
   B. NOMINAL DESIGN WIND SPEED (V_{asd}).....109 MPH
   C. EXPOSURE CATEGORY..... C
   D. INTERNAL PRESSURE COEFFICIENT..... VARIES
   E. COMPONENTS AND CLADDING LOADS..... VARIES
6. SEISMIC DESIGN DATA:
   A. SEISMIC IMPORTANCE FACTOR (I_e)..... 1.5
   B. MAPPED SPECTRAL RESPONSE PARAMETERS:
      a. S_S.....0.204
      b. S_1.....0.057
   C. SOIL SITE CLASS.....C
   D. DESIGN SPECTRAL RESPONSE PARAMETERS:
      a. S_{DS}.....0.176
      b. S_{D1}.....0.057
   E. SEISMIC DESIGN CATEGORY..... C
   F. BASIC SEISMIC FORCE RESISTING SYSTEM(S).....VARIES
   G. DESIGN BASE SHEARS(S)..... VARIES
   H. SEISMIC RESPONSE COEFFICIENT(S) (C_S)..... VARIES
   I. RESPONSE MODIFICATION COEFFICIENT(S) (R).... VARIES
7. ROOF RAIN LOAD DATA
   A. RAIN INTENSITY, PRIMARY DRAINAGE (i).....2.6 (IN/HR)
   B. RAIN INTENSITY, SECONDARY DRAINAGE (i).....1.53 (IN/15 MIN)
8. GEOTECHNICAL DATA
   A. DESIGN LOAD BEARING VALUE.....N/A
9. FLOOD DESIGN DATA:
   A. FLOOD DESIGN CLASS..... N/A

STRUCTURAL GENERAL NOTES

1. THESE NOTES, AND OTHER DRAWING NOTES CONTAINED WITHIN, ARE PROVIDED TO MEET SPECIFIC REQUIREMENTS AND TO SUPPLEMENT THE CONTRACT SPECIFICATIONS. THESE NOTES NEITHER REPLACE NOR OVERRIDE THE PROVISIONS AND REQUIREMENTS OF THE CONTRACT SPECIFICATIONS.
2. COORDINATE ALL STRUCTURAL WORK WITH WORK SHOWN ON ALL OTHER DRAWINGS.
3. VERIFY ALL DIMENSIONS OF EXISTING CONSTRUCTION AND REPORT ANY DISCREPANCIES FROM THE CONTRACT DRAWINGS TO THE ENGINEER PRIOR TO COMMENCING WITH WORK. IN NO CASE SHALL WORKING DIMENSIONS BE SCALED FROM THE STRUCTURAL DRAWINGS.
4. THE CONTRACT DRAWINGS AND SPECIFICATIONS REPRESENT THE FINISHED STRUCTURE. CONTRACTOR SHALL BE RESPONSIBLE FOR MEANS AND METHODS OF CONSTRUCTION INCLUDING, BUT NOT LIMITED TO, SHORING AND TEMPORARY BRACING TO PROVIDE STRUCTURAL STABILITY DURING CONSTRUCTION.
5. IF CERTAIN FEATURES ARE NOT FULLY SHOWN OR CALLED FOR ON THE CONTRACT DRAWINGS OR SPECIFICATIONS, THEIR CONSTRUCTION SHALL BE OF THE SAME CHARACTER AS FOR SIMILAR CONDITIONS THAT ARE SHOWN OR CALLED FOR, WITH THE APPROVAL OF THE ENGINEER. WHERE SECTIONS VARY, CONTRACTOR SHALL PROVIDE FOR SMOOTH TRANSITIONS BETWEEN THEM, UNLESS NOTED OTHERWISE.
6. ALL PRODUCTS SHALL BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS WRITTEN INSTRUCTIONS AND RECOMMENDATIONS, UNLESS NOTED OTHERWISE.
7. DIMENSIONS ARE TO FACE OF WALL UNLESS NOTED OTHERWISE.

REINFORCED CAST-IN-PLACE CONCRETE

1. ALL CONCRETE SHALL BE PREPARED AND PLACED IN ACCORDANCE WITH ACI MANUAL OF CONCRETE PRACTICE, ACI 318 & ACI 350 AS MODIFIED BY CONTRACT DOCUMENTS.
2. ALL CONCRETE SHALL MEET THE FOLLOWING REQUIREMENTS (UNO):
   - MINIMUM 28-DAY COMPRESSIVE STRENGTH (f'_c): 4500 PSI
   - NORMALWEIGHT CONCRETE SHALL BE USED, UNO
3. DO NOT AIR-ENTRAIN CONCRETE USED FOR INTERIOR SLABS WITH A TROWEL FINISH.
4. BEFORE CONCRETE WORK BEGINS, THE PROPOSED CONCRETE MIX DESIGN, ALONG WITH COLLABORATING DATA SHOWING COMPLIANCE WITH PROJECT REQUIREMENTS, SHALL BE SUBMITTED TO ENGINEER FOR APPROVAL.

CONCRETE AND REINFORCING

1. SEE DRAWING 0S-500 SERIES FOR CONCRETE DETAILS, CONCRETE REINFORCING DETAILS AND ADDITIONAL DESIGN NOTES.

CONCRETE FORMWORK

1. CONTRACTOR IS RESPONSIBLE FOR DESIGN, ENGINEERING, STRUCTURAL ADEQUACY AND CONSTRUCTION OF CONCRETE FORMWORK IN ACCORDANCE WITH CONTRACT SPECIFICATIONS.
2. COORDINATE CONCRETE WORK WITH PLACEMENT OF PIPING, INSERTS, FLOOR DRAINS AND OTHER EMBEDDED ITEMS INDICATED ON CONTRACT DRAWINGS OR IN CONTRACT SPECIFICATIONS.
3. SLEEVE NEW OR EXISTING PIPING OR UTILITIES PASSING THROUGH NEW CONCRETE, UNLESS NOTED OTHERWISE. SEE OTHER DISCIPLINE DRAWINGS FOR SLEEVE DETAILS. ENSURE SLEEVES REMAIN FREE OF DEBRIS AND WATER DURING CONSTRUCTION.
4. ALL EXPOSED CORNERS SHALL BE CHAMFERED 3/4", UNO.

REINFORCING STEEL

1. ALL REINFORCING BARS SHALL BE ASTM A615, GRADE 60.
2. REINFORCE ALL CONCRETE UNLESS SPECIFICALLY MARKED "NOT REINFORCED" OR "UNREINFORCED".
3. DETAIL AND PLACE REINFORCEMENT IN ACCORDANCE WITH ACI SP-66, ACI 301, ACI 318 AND CRSI MANUAL OF STANDARD PRACTICE.
4. DO NOT INSERT REINFORCEMENT INTO FRESH OR PARTIALLY HARDENED CONCRETE.
5. THE FOLLOWING CONCRETE COVER SHALL BE PROVIDED FOR REINFORCEMENT (UNLESS OTHERWISE NOTED). SEE ACI 117 FOR CONSTRUCTION TOLERANCES:
   A. CONCRETE CAST AGAINST AND PERMANENTLY EXPOSED TO EARTH..... 3"
   B. CONCRETE EXPOSED TO EARTH, LIQUID, WEATHER OR CAST AGAINST A CONCRETE WORK MAT:
      a. SLABS, WALLS & FOOTINGS.....2"
      b. BEAMS & COLUMNS:
         • STIRRUPS, SPIRALS & TIES.....2"
         • PRIMARY REINFORCEMENT..... 2 1/2"
   C. CONDITIONS NOT COVERED IN "A" OR "B":
      a. SLABS AND WALLS..... 1 1/2"
      b. BEAMS AND COLUMNS:
         • STIRRUPS, SPIRALS & TIES..... 1 1/2"
         • PRIMARY REINFORCEMENT..... 2"
6. THE MINIMUM LENGTH OF LAP SPLICES AND EMBEDMENT SHALL BE AS NOTED IN THE TABLES AND DETAILS ON THE CONTRACT DRAWINGS.
7. HEATING OF REINFORCING BARS SHALL NOT BE ALLOWED.
8. PROVIDE ADDITIONAL REINFORCEMENT AT OPENINGS AND CORNER BARS AT WALLS GRADE BEAMS AND CURBS IN ACCORDANCE WITH DETAILS PROVIDED ON THE CONTRACT DOCUMENTS.
9. REPOSITIONING OF REINFORCING TO AVOID INTERFERENCE WITH EMBEDDED ITEMS SHALL BE APPROVED BY THE ENGINEER PRIOR TO WORK.

CONCRETE JOINTS

1. LOCATE JOINTS AS INDICATED IN STANDARD DETAILS, AS SPECIFIED ON THE DRAWINGS OR AS APPROVED BY THE ENGINEER PRIOR TO PLACEMENT OF CONCRETE.
2. PRIOR TO PLACING NEW CONCRETE CLEAN CONSTRUCTION JOINT SURFACES OF LAITANCE. IMMEDIATELY BEFORE PLACING NEW CONCRETE WET SURFACE AND REMOVE ANY STANDING WATER.
3. INTENTIONALLY ROUGHEN SURFACE OF JOINTS AS SPECIFIED ON THE CONTRACT DOCUMENTS.
4. PROVIDE WATERSTOPS AT CONCRETE JOINTS WHERE INDICATED.

POST-INSTALLED ANCHORS

1. POST INSTALLED CONCRETE ANCHOR MANUFACTURERS AND ADHESIVES FOR POST INSTALLED REINFORCING BARS SHALL BE PROVIDED AND INSTALLED PER SPECIFICATION 05 05 19.
2. ANCHOR CAPACITY IS DEPENDENT UPON SPACING BETWEEN ADJACENT ANCHORS AND PROXIMITY OF ANCHORS TO EDGE OF CONCRETE. INSTALL ANCHORS IN ACCORDANCE WITH SPACING AND EDGE CLEARANCES INDICATED ON THE DRAWINGS.
3. EXISTING REINFORCING BARS IN THE CONCRETE STRUCTURE MAY CONFLICT WITH SPECIFIC ANCHOR LOCATIONS. REINFORCING BARS SHALL NOT BE CUT UNLESS NOTED ON THE DRAWINGS THAT THE BARS CAN BE CUT. CONTRACTOR SHALL CONTACT THE ENGINEER OF RECORD WHEN INTERFERENCES OCCUR.
4. ADHESIVE ANCHORS SHALL BE INSTALLED IN CONCRETE HAVING A MINIMUM AGE OF 21 DAYS AT TIME OF ANCHOR INSTALLATION. APPROVAL OF THE ENGINEER OF RECORD IS REQUIRED FOR INSTALLATIONS IN CONCRETE LESS THAN 21 DAYS OF AGE.

STRUCTURAL ALUMINUM

1. ALL DESIGN, FABRICATION, AND ERECTION SHALL BE DONE IN ACCORDANCE WITH THE LATEST EDITION OF THE ALUMINUM ASSOCIATION ALUMINUM DESIGN MANUAL SPECIFICATIONS, THE AWS CODE, AND THE OSHA STANDARDS.
2. STRUCTURAL SHAPES: ASTM B308, ALLOY 6061 T6
   SHEET AND PLATE: ASTM B209, ALLOY 6061 T6
3. UNLESS NOTED OTHERWISE, PRIMARY BOLTED CONNECTIONS SHALL BE BEARING TYPE USING 316 STAINLESS STEEL BOLTS CONFORMING TO ASTM F593 WITH NUTS CONFORMING TO ASTM F594. SIZE OF BOLTS SHALL BE 3/4"Ø UNLESS OTHERWISE NOTED ON THE DRAWINGS AND SHALL HAVE ONE PLAIN HARDENED WASHER.. BOLT AND NUT THREADS SHALL BE LUBRICATED.
4. WELDS SHALL COMPLY WITH AWS D1.2 WITH FILLER ALLOY TYPE 4043
5. MINIMUM BOLT HOLE EDGE DISTANCE SHALL BE MAINTAINED PER AA ADM.
6. SUBSTITUTIONS OF SPECIFIED MEMBER SIZE OR CHANGE IN DETAILS OR DIMENSIONS OF ANY KIND SHALL NOT BE PERMITTED WITHOUT PRIOR WRITTEN APPROVAL OF THE ENGINEER.
7. FIELD CUTTING IS NOT PERMITTED EXCEPT BY THE SPECIFIC APPROVAL OF THE FIELD ENGINEER.
8. ALL ALUMINUM SURFACES IN CONTACT WITH CONCRETE SHALL HAVE A BITUMASTIC COATING.

BUILDING CODES AND DESIGN STANDARDS

1. STRUCTURAL DESIGN WAS PREPARED USING THE FOLLOWING CODES AND DATA:
   A. INTERNATIONAL BUILDING CODE, 2021 EDITION AS MODIFIED BY THE FOLLOWING:
      A. CITY AND COUNTY OF BROOMFIELD BUILDING DEPARTMENT AMENDMENTS
   B. ASCE 7 MINIMUM DESIGN LOADS FOR BUILDINGS AND OTHER STRUCTURES, 2016 EDITION
   C. ACI 318, BUILDING CODE REQUIREMENTS FOR STRUCTURAL CONCRETE
   D. ACI 350 BUILDING CODE REQUIREMENTS FOR ENVIRONMENTAL ENGINEERING CONCRETE STRUCTURES
   E. AISC MANUAL FOR STEEL CONSTRUCTION
   F. AA ALUMINUM DESIGN MANUAL PART 1
   G. TMS 402, BUILDING CODE REQUIREMENTS FOR MASONRY STRUCTURES.

GEOTECHNICAL INFORMATION

1. GEOTECHNICAL INFORMATION PROVIDED ON THESE DRAWINGS IS A SUMMARY OF THE INFORMATION PROVIDED IN THE PROJECT GEOTECHNICAL REPORT AND IS USED AS THE BASIS OF FOUNDATION DESIGN.
2. THE FOUNDATION DESIGN ASSUMES THAT THE SITE AND SUBGRADE HAVE BEEN PREPARED AND TESTED IN ACCORDANCE WITH THE RECOMMENDATIONS PROVIDED ON THE CONTRACT DRAWINGS AND IN THE CONTRACT SPECIFICATIONS. IN ADDITION, THE PROJECT GEOTECHNICAL REPORT WILL BE PROVIDED UPON REQUEST.
3. PROJECT GEOTECHNICAL REPORT:
   A. REPORT TITLE: "GEOTECHNICAL ENGINEERING STUDY AND PAVEMENT THICKNESS DESIGN PROPOSED BROOMFIELD WATER TANKS AND PUMP STATION NEAR THE INTERSECTION OF LOWELL BOULEVARD AND KING COURT, BROOMFIELD COLORADO"
   B. PROJECT NO.: 23-2-171
   C. ISSUED DATE: AUGUST 15, 2023
   D. REVISION DATE: MARCH 12, 2024
   E. PREPARED BY: JACOB HANSON
4. SITE & SUBGRADE PREPARATION
   A. PROVIDE EXCAVATION, FILL AND BACKFILL IN ACCORDANCE WITH CONTRACT DRAWINGS AND SPECIFICATIONS, DIVISION 31.
   B. EXCAVATIONS FOR STRUCTURES SHALL BE TO THE REQUIRED DEPTH TO PLACE VOID FORM BELOW BOTTOM OF SLAB.
   C. NOTIFY ENGINEER WHEN LOOSE OR SOFT SOILS ARE EXPOSED WHERE SLABS, MATS, OR FOOTINGS ARE TO BE PLACED SO THAT A DETERMINATION MAY BE MADE REGARDING IMPROVEMENT OF THIS POTENTIALLY UNDESIRABLE CONDITION.
5. SOIL CHARACTERISTICS
   A. UNIT WEIGHT.....112 PCF (UNSATURATED)
   B. FROST DEPTH..... 36 INCHES
   C. WATER TABLE DEPTH..... NOT ENCOUNTERED
6. LATERAL EARTH PRESSURES CLASS 1 CDOT STRUCTURAL FILL AT PUMP STATION (AS EQUIVALENT FLUID PRESSURES)
   A. AT-REST CONDITION, K_o.....55 PCF
   B. ACTIVE CONDITION, K_a..... 40 PCF
7. LATERAL EARTH PRESSURES ON-SITE BACKFILL (AS EQUIVALENT FLUID PRESSURES)
   A. AT-REST CONDITION, K_o.....70 PCF
   B. ACTIVE CONDITION, K_a.....55 PCF
8. DEEP FOUNDATIONS - DESIGN PARAMETERS
   A. PROVIDE IN ACCORDANCE WITH CONTRACT DRAWINGS AND SPECIFICATION SECTION 31 63 29.
   B. DRILLED SHAFT FOUNDATION SHALL CONFORM TO ACI 336.1 AND 336.3, UNLESS NOTED OTHERWISE.
   C. DESIGN PARAMETERS:
      a. ALLOWABLE END BEARING PRESSURE..... 25,000 PSF
      b. ALLOWABLE SKIN FRICTION.....2,500 PSF FOR PORTION BELOW THE DEPTH OF WETTING
      c. ALLOWABLE UPLIFT SKIN FRICTION.....1,875 PSF FOR PORTION BELOW THE DEPTH OF WETTING
      d. MINIMUM DEAD LOAD PRESSURE.....18,000 PSF

STRUCTURAL STEEL

1. SEE DRAWING 1S-503 FOR STRUCTURAL STEEL DETAILS AND DESIGN NOTES.

GRATING

1. METAL GRATING AND STAIR TREADS SHALL CONFORM TO THE "METAL BAR GRATING MANUAL" OF THE NATIONAL ASSOCIATION OF ARCHITECTURAL METAL MANUFACTURERS. GRATING AND STAIR TREADS SHALL BE ALUMINUM I-BAR SHAPE WITH SWAGE LOCKED CROSS BARS SPACED AT 4" OC. GRATING SHALL BE 1 1/2" DEEP UNLESS NOTED OTHERWISE ON THE DRAWINGS. STAIR TREADS UP TO 3'-6" WIDE SHALL BE 1 1/2" DEEP WITH CAST NOSING. TOP SURFACE OF GRATING AND TREADS SHALL BE GROOVED FOR SLIP RESISTANCE.

MISCELLANEOUS MATERIALS

1. GROUT FOR EQUIPMENT BASE PLATES SHALL BE NON-SHRINK NON-METALLIC HIGH STRENGTH GROUT. GROUT SHALL BE FIVE STAR GROUT BY U.S. GROUT CORPORATION OR APPROVED EQUAL. ALL GROUTING REQUIRES CURING THE EXPOSED SURFACE WITH CURING AND SEALING COMPOUND IMMEDIATELY AFTER INSTALLATION.
2. BONDING AGENT SHALL BE SIKADUR 32, HI-MOD BY SIKA CORPORATION OR APPROVED EQUAL.

DEFERRED DESIGN SUBMITTALS:

PRECAST CONCRETE

1. PRECAST CONCRETE DOUBLE TEES, COLUMNS, BEAMS ARE A DEFERRED DESIGN. REFER TO PROJECT SPECIFICATIONS FOR ADDTIONAL REQUIREMENTS.
2. DESIGN, DETAIL, FABRICATE, AND ERECT PRECAST CONCRETE MEMBERS, CONNECTIONS, AND ACCESSORIES IN ACCORDANCE WITH ACI 318 AND PCI HANDBOOKS AND MANUALS AS MODIFIED BY CONTRACT DOCUMENTS.
3. PROVIDE INSERTS, BRACES, STRONGBACKS, AND OTHER REQUIRED LIFTING ACCESSORIES IN APPROPRIATE LOCATIONS TO PREVENT CRACKING DUE TO ERECTION STRESSES WITH 50% FORCE INCREASE FOR IMPACT. ALTERNATIVELY, PROVIDE SPECIAL REINFORCEMENT TO PREVENT FLEXURAL CRACKS DURING LIFTING AND HANDLING OPERATIONS.
4. DESIGN AND DETAIL PRECAST CONCRETE UNITS FOR LOADS BASED ON CRITERIA GIVEN ABOVE, INCLUDING TRIBUTARY LOADING AND ANCHORAGE FOR GLAZING SYSTEMS AND OTHER ADJACENT CONSTRUCTION, AS WELL AS ERECTION LOADS.
5. DESIGN AND DETAIL PRECAST CONCRETE UNITS AND CONNECTIONS TO TRANSFER ALL VERTICAL LOADS, INCLUDING SELF-WEIGHT, DIRECTLY TO FOUNDATIONS TO THE MAXIMUM EXTENT PRACTICABLE. DO NOT TRANSFER ANY SUCH LOADS TO STRUCTURAL FRAMING EXCEPT WHERE SPECIFICALLY INDICATED ON CONTRACT DRAWINGS.
6. CONCRETE
   A. MEMBERS: MINIMUM 28-DAY COMPRESSIVE STRENGTH f'c = 5,000 PSI, NORMALWEIGHT
   B. TOPPING: MINIMUM 28-DAY COMPRESSIVE STRENGTH f'c = 4,000 PSI, NORMALWEIGHT
7. PRESTRESSING STEEL:
   A. STRAND: ASTM A416 GRADE 270. LOW-RELAXATION STRESS-RELIEVED.
8. NON-PRESTRESSED REINFORCING STEEL: COMPLY WITH REQUIREMENTS FOR REINFORCED CONCRETE.
9. SUBMIT SHOP DRAWINGS AND STRUCTURAL DESIGN ANALYSIS OF PRECAST CONCRETE ELEMENTS PREPARED AND SEALED BY QUALIFIED PROFESSIONAL ENGINEER LICENSED IN THE STATE OF COLORADO.
   A. INCLUDE APPLICATION OF DESIGN LOADS, DESCRIPTION OF INDIVIDUAL AND COMBINED LOAD CASES, DESCRIPTION OF MATERIALS, COMPARISON OF PERMITTED STRESSES VERSUS COMPUTED STRESSES, CALCULATION OF DEFLECTIONS, AND ANCHOR ROD LAYOUT.
10. PROVIDE OPENINGS IN PRECAST ELEMENTS WHICH ARE >12" IN ANY DIMENSION AS SHOWN ON PLANS. COORDINATE LOCATIONS WITH ARCHITECTURAL, MECHANICAL, ELECTRICAL, PROCESS AND PLUMBING DRAWINGS.
11. DESIGN LOADS FOR PRECAST CONCRETE ELEMENTS ARE PROVIDED ON DRAWING 1S-103.

COLD FORMED STEEL FRAMING:

1. DESIGN, FABRICATE, AND ERECT COLD-FORMED METAL FRAMING IN ACCORDANCE WITH AISI COLD-FORMED STEEL DESIGN MANUAL AND APPLICABLE SSMA PUBLICATIONS AS MODIFIED BY CONTRACT DOCUMENTS.
2. SHAPE DESIGNATIONS FOR STUDS, JOISTS, TRACK, CHANNELS, AND FURRING CHANNELS: PER SSMA PRODUCT TECHNICAL INFORMATION, INDICATING MEMBER DEPTH, STYLE, FLANGE WIDTH, AND MATERIAL THICKNESS.
3. FRAMING MEMBERS
   A. ASTM A653 GRADE 33, Fy = 33 KSI, UNLESS NOTED OTHERWISE.
   B. ASTM A653 GRADE 50, Fy = 50 KSI, FOR MATERIAL THICKNESS 54 MILS OR GREATER AND WHERE INDICATED AS "(50)".
4. FINISH: HOT-DIP GALVANIZE TO PROVIDE COATING CLASS G60.
5. MECHANICAL FASTENERS: CORROSION-RESISTANT-COATED, SELF-DRILLING, SELF-THREADING STEEL DRILL SCREWS WITH LOW PROFILE HEADS BENEATH SHEATHING AND MANUFACTURER'S STANDARD HEADS ELSEWHERE.
6. BOLTS: ASTM F3125, GRADE A325.
7. WELDING: IN ACCORDANCE WITH AWS D1.1 OR D1.3, AS APPLICABLE.
8. POWER-ACTUATED FASTENERS: TESTED AND ASSESSED IN ACCORDANCE WITH LATEST EDITION OF ICC-ES AC70. SUBMIT CORRESPONDING ICC EVALUATION SERVICE REPORT.

FIBER REINFORCED POLYMER (FRP) GRATING AND FRAMING

1. THE FRP GRATING, FRAMING AND STAIRS ARE A DEFERRED DESIGN. DESIGN SHALL BE PERFORMED IN ACCORDANCE WITH THE CODES SPECIFIED ON THE CONTRACT DOCUMENTS AND SEALED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF COLORADO.
2. TOP SURFACE OF ALL GRATING SHALL HAVE A MECHANICALLY ADHERED NON-SKID GRIT SURFACE.
3. STAIR TREADS SHALL HAVE A SKID RESISTANT NOSING.
4. ALL FIELD CUT EDGES OF FRP PRODUCTS SHALL BE SMOOTH AND SEALED WITHA CATALYZED RESIN OF EQUAL OR SUPERIOR CORROSION RESISTANCE TO THE MANUFACTURED PRODUCT.
5. REFER TO SPECIFICATION SECTION 06 70 00 FOR ADDITIONAL DESIGN REQUIREMENTS.

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9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	B. MIMIAGA
designed	checked
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

GENERAL STRUCTURAL NOTES

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drawing **0S-003** rev. **1**

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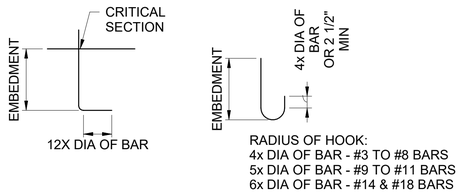
CONCRETE REINFORCEMENT SPLICE AND EMBEDMENT TABLE (ACI 318-14, f'c = 4000 PSI)					
BAR SIZE	SPLICES (IN)		EMBEDMENT (IN)		
	TOP BARS	OTHER BARS	TOP BARS	OTHER BARS	HOOKED BARS
3	16	12	12	12	6
4	21	16	16	13	8
5	26	20	20	16	9
6	31	24	24	19	11
7	51	40	40	31	13
8	65	50	50	39	15
9	80	61	61	47	17
10	98	75	75	58	19
11	116	90	90	69	21
14	NOT ALLOWED		121	93	35
18			192	148	46

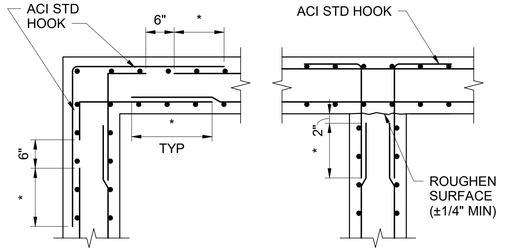
REINFORCING SPLICE AND EMBEDMENT TABLE NOTES:

1. LAP SPLICES REQUIRED FOR MASONRY ARE INDICATED ON DRAWING 0S-502.
2. REINFORCING BAR EMBEDMENT AND LAP SPLICE LENGTHS SHALL BE AS SHOWN IN THE ABOVE TABLE UNLESS NOTED OTHERWISE ON THE DRAWINGS.
3. THE LENGTHS SHOWN IN THE TABLE ARE BASED ON THE FOLLOWING CONCRETE COVERAGE AND REINFORCING C-C SPACING:
   A. BEAMS OR COLUMNS: COVER ≥ 1-1/2" CENTER TO CENTER (C-C) SPACING ≥ 6"
   B. ALL OTHERS: COVER ≥ 1-1/2" CENTER TO CENTER SPACING ≥ 6"
4. TOP BARS ARE DEFINED AS HORIZONTAL REINFORCEMENT PLACED SUCH THAT MORE THAN 12" OF FRESH CONCRETE IS CAST IN THE MEMBER BELOW THE DEVELOPMENT LENGTH OR SPLICE.
5. THE DEVELOPMENT AND SPLICE LENGTHS SHOWN SHALL NOT APPLY IF ANY OF THE FOLLOWING CONDITIONS OCCUR:
   A. f'c < 4000 psi
   B. fy > 60,000 psi
   C. THE COVER OR C-C BAR SPACING IS NOT AS LISTED ABOVE.
   D. THE REINFORCING STEEL IS EPOXY COATED.
   E. LIGHT WEIGHT CONCRETE IS USED.
6. WHERE BAR SPLICES ARE STAGGERED SUCH THAT ONE-HALF OR LESS OF TOTAL REINFORCEMENT IS SPLICED WITHIN REQUIRED LAP LENGTH, SPLICE LENGTH MAY EQUAL EMBEDMENT LENGTH.

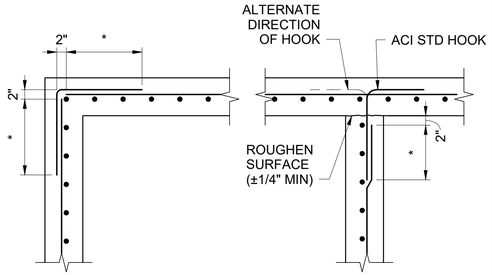


RADIUS OF HOOK:
4x DIA OF BAR - #3 TO #8 BARS
5x DIA OF BAR - #9 TO #11 BARS
6x DIA OF BAR - #14 & #18 BARS

LAP SPLICE TABLE
NOT TO SCALE



TWO LAYERS REINFORCING

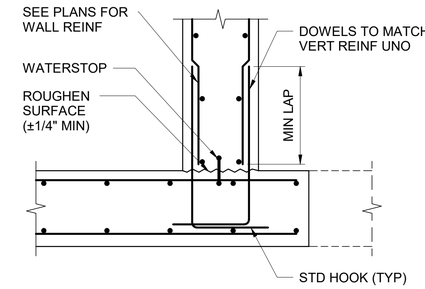


SINGLE LAYER REINFORCING

NOTES:

1. USE AT ALL CORNERS FOR ALL CONCRETE MEMBERS INCLUDING THICKENED SLAB ON GRADE, WALLS, CURBS, BEAMS, GRADE BEAMS AND SLABS, UNLESS INDICATED OTHERWISE.
2. *TYPICAL CONCRETE REINFORCEMENT LAP SLICE PER TABLE (THIS SHEET) UNLESS INDICATED OTHERWISE.

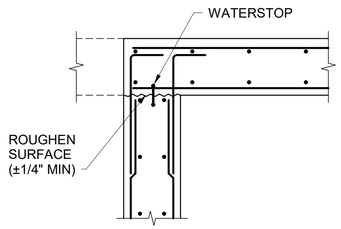
CORNER BAR DETAILS
NOT TO SCALE



NOTE:
1. WALL REINFORCEMENT MAY BE SINGLE LAYER, SEE PLANS.

CJ-1 WITH WATERSTOP
CJ-2 WITHOUT WATERSTOP

CJ-1/CJ-2, WALL-TO-SLAB JOINT
NOT TO SCALE



CJ-8 WITH WATERSTOP
CJ-9 WITHOUT WATERSTOP

CJ-8/CJ-9, WALL TO TOP SLAB JOINT
NOT TO SCALE

CJ-10 WITH WATERSTOP
CJ-11 WITHOUT WATERSTOP

CJ-10/CJ-11, WALL JOINT
NOT TO SCALE

CJ-3 WITH WATERSTOP
CJ-4 WITHOUT WATERSTOP

CJ-3/CJ-4, JOINT IN MAT SLAB
NOT TO SCALE

NOTE:
1. CONTINUOUS REINFORCING IN LIEU OF SPLICE ACO

CJ-12 WITH WATERSTOP
CJ-13 WITHOUT WATERSTOP

CJ-12/CJ-13, JOINT IN ELEVATED SLAB
NOT TO SCALE

CJ INTERSECTION DETAIL
NOT TO SCALE

NOTE:
MITER, WELD, AND SMOOTH GRIND ANGLES AT ALL CORNERS.

CE-4
NOT TO SCALE

CC-1
NOT TO SCALE

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CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

STANDARD DETAILS I

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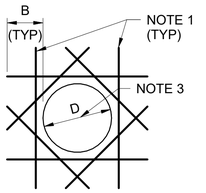
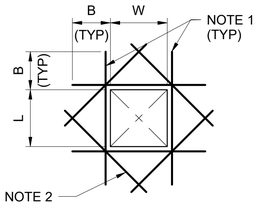


CO-1

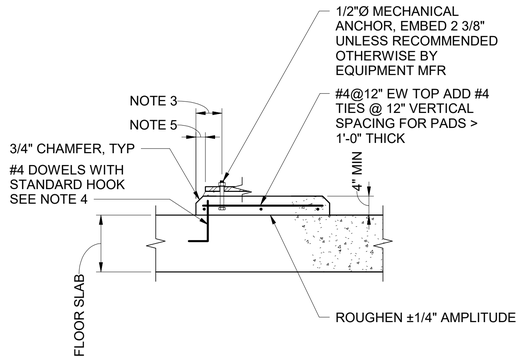


CO-2

OPENING REINFORCING NOTES:

1. ADD BARS EQUAL TO THE TOTAL AREA OF REGULAR REINFORCING CUT BY THE OPENING EACH MAT. PLACE ONE HALF TOTAL AREA EACH SIDE OF OPENING EACH MAT.
2. (1) #5 BAR x 3'-0" EACH CORNER EACH MAT FOR CONCRETE THICKNESS < 18"
   (1) #6 BAR x 4'-0" EACH CORNER EACH MAT FOR CONCRETE THICKNESS ≥ 18"
3. (4) #5 BARS x D + 12" @ 45° TO REGULAR REINFORCING EACH MAT FOR CONCRETE THICKNESS < 18"
   (4) #6 BARS x D + 12" @ 45° TO REGULAR REINFORCING EACH MAT FOR CONCRETE THICKNESS ≥ 18"
4. B = TOP BAR LAP SPLICE
5. CENTER ALL BARS ON OPENING.
6. FOR OPENINGS (W, L, D) LESS THAN 12" NO ADD BARS REQUIRED IF NO REGULAR REINFORCING IS CUT BY THE OPENING, OTHERWISE SEE NOTE 1.
7. REINFORCE OPENINGS WITH W, L, OR D LARGER THAN 54" AS INDICATED ON THE DRAWINGS. IF NOT INDICATED CONTACT THE ENGINEER.

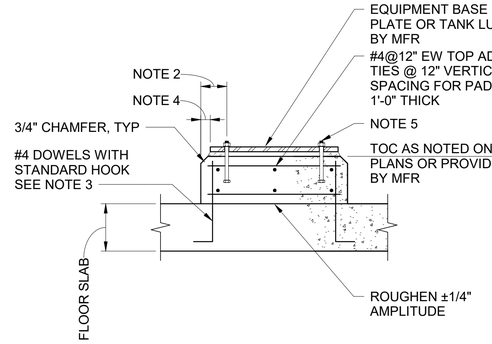
CO-1/CO-2
NOT TO SCALE



HOUSEKEEPING PAD GENERAL NOTES:

1. PROVIDE EP-1 EQUIPMENT PAD FOUNDATION FOR EQUIPMENT WHEN OTHER FOUNDATIONS HAVE NOT BEEN INDICATED.
2. GROUT EQUIPMENT BASE WITH NON-SHRINK GROUT AS RECOMMENDED BY MFR.
3. DIMENSION SHALL BE 4" MINIMUM FOR PADS WITH ANCHORS ≤1"Ø, 6" MINIMUM FOR PADS WITH ANCHORS >1"Ø.
4. PROVIDE DOWELS @ CORNERS AND 18" MAXIMUM CENTER TO CENTER.
   A. DRILL AND EPOXY EMBED DOWELS INTO THE FLOOR SLAB WITH 5" MIN EMBEDMENT AT CONTRACTORS OPTION.
5. PROVIDE 2" MINIMUM CLEARANCE TO THE EDGE OF THE EQUIPMENT BASE.

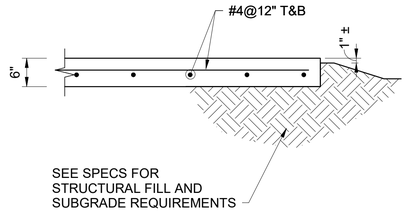
EP-1: LIGHT LOAD EQUIPMENT PAD
NOT TO SCALE



EQUIPMENT & TANK PAD NOTES:

1. EQUIPMENT SHALL BE GROUTED IN PLACE W/ NON-SHRINK GROUT, UNLESS OTHERWISE RECOMMENDED BY THE EQUIPMENT MFR.
2. DIMENSION SHALL BE 4" MINIMUM FOR PADS WITH ANCHORS ≤1"Ø, 6" MINIMUM FOR PADS WITH ANCHORS >1"Ø.
3. PROVIDE DOWELS @ 12" MAXIMUM CENTER TO CENTER.
   A. DRILL AND EPOXY EMBED DOWELS INTO THE FLOOR SLAB WITH 5" MIN EMBEDMENT AT CONTRACTORS OPTION.
4. PROVIDE 2" MINIMUM CLEARANCE TO THE EDGE OF THE EQUIPMENT BASE.
5. EQUIPMENT ANCHORS SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF COLORADO. CALCULATIONS SHALL BE SUBMITTED FOR REVIEW.

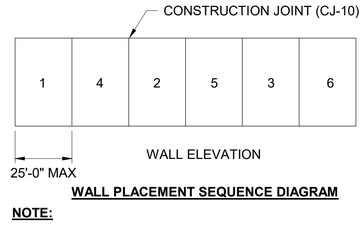
EP-2: HEAVY LOAD EQUIPMENT PAD
NOT TO SCALE



NOTE:

1. SLAB FOR SWITCHGEAR & MISC HVAC EQUIPMENT. SEE CIVIL DWGS FOR LOCATION. COORDINATE SIZE W/ EQUIPMENT MANUFACTURER.
2. PAD SHALL HAVE A LIGHT BROOM FINISH.
3. PROVIDE ISOLATION JOINT WHERE SLAB MEETS VERTICAL CONCRETE SURFACE.

EP-3: TYPICAL EXTERIOR HVAC/ELEC EQUIPMENT SLAB
NOT TO SCALE

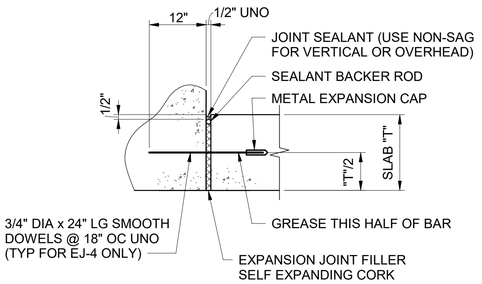


WALL PLACEMENT SEQUENCE DIAGRAM

NOTE:

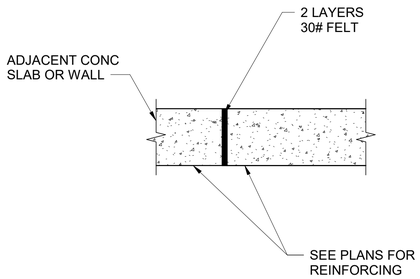
MAXIMUM LENGTH OF WALL TO BE PLACED IN SINGLE PLACEMENT SHALL BE 25'-0" AND SHALL BE ALTERNATED AS SHOWN IN DIAGRAM ABOVE. ALLOW 14 DAY CURE TIME PRIOR TO PLACING CONCRETE ADJACENT TO PREVIOUSLY PLACED CONCRETE OR CURE TIME APPROVED BY ENGINEER. NUMBER INDICATES PLACEMENT SEQUENCE (EXAMPLE ONLY).

WALL PLACEMENT SEQUENCE DIAGRAM
NOT TO SCALE

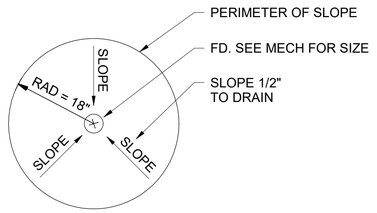


EJ-1 WITHOUT DOWEL
EJ-2 WITH DOWEL
EJ-3 WITH SEALANT, NO DOWEL
EJ-4 WITH SEALANT & DOWEL

EJ, EXPANSION JOINT W/ SEALANT
NOT TO SCALE



IJ-1, ISOLATION JOINT
NOT TO SCALE



FD-1, FLOOR DRAIN
NOT TO SCALE

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SHAWN T. DALGLISH
58555
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PROFESSIONAL ENGINEER

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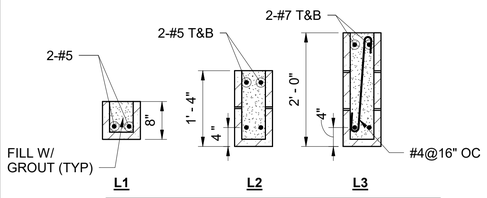
MASONRY NOTES (SECTION 04 22 00)

1. MATERIALS: CMU: LIGHT WEIGHT MASONRY WITH TYPE S MORTAR (f'm 2000psi) AND REINFORCING (Fy=60ksi)
2. ALL WALLS SHALL BE RUNNING BOND TYPE CONSTRUCTION.
3. ALL CMU CELLS WITH REINFORCING OR ANCHORS SHALL BE FILLED WITH GROUT.
4. ALL VERTICAL CMU WALL REINFORCING SHALL HAVE FULL CONTACT LAP SPICES WITH DOWELS FROM FOUNDATION.
5. INSERTING DOWELS INTO FRESH OR PARTIALLY HARDENED CONCRETE OR GROUT IS PROHIBITED.
6. ALL CMU BOND BEAMS SHALL BE KNOCKOUT TYPE.
7. CMU IS DESIGNED FOR FULL STRESSES. SPECIAL INSPECTION IS REQUIRED PER IBC 2021.
8. VERTICAL CMU REINFORCEMENT SHALL BE CONTINUOUS THROUGH LINTELS AND SHALL EXTEND THE ENTIRE HEIGHT OF THE WALL.
9. BOND BEAMS LOCATED BELOW BEARING ELEVATIONS, ABOVE DOUBLE TEE FLANGES, AND TOP OF WALLS ARE STRUCTURAL BOND BEAMS AND SHALL HAVE REINFORCEMENT CONTINUOUS THROUGH CONTROL JOINTS.
10. JOINT REINFORCING AND INTERMEDIATE BOND BEAM (THOSE NOT INCLUDED IN NOTE 9 ABOVE) REINFORCING SHALL BE DISCONTINUOUS AT CONTROL JOINTS.
11. FOR TYPICAL CONNECTION OF CMU TO CONCRETE AT THE BASE OF INTERIOR WALLS, SEE DETAIL THIS SHEET.
12. MASONRY/GROUT BEARING SUPPORT FOR STEEL LINTELS SHALL BE SMOOTH AND LEVEL TO PROVIDE FULL BEARING CONTACT BELOW STEEL BEAM.
13. SPLICES OF VERICAL REINFORCING SHALL NOT OCCUR WITHIN STEEL LINTEL BEAMS. LAP SPLICES SHALL OCCUR ABOVE OR BELOW STEEL BEAM.
14. REINFORCING LAP SPLICE LENGTHS (UNO):

MASONRY REINFORCEMENT LAP SPLICE TABLE

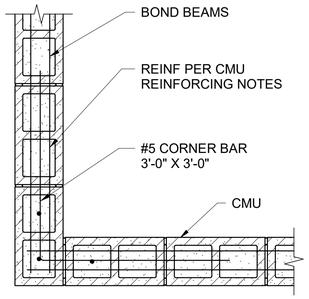
BAR SIZE	LAP SPLICES (IN)
3	18
4	24
5	30
6	36
7	42
8	48

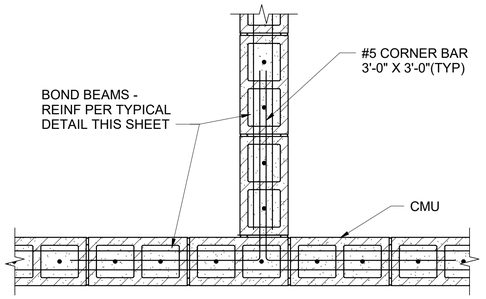


LINTEL SCHEDULE, UNO		
TYPE	CMU MAX OPENING SIZE	
	8" CMU	12" CMU
L1	3'-4"	3'-4"
L2	8'-0"	8'-0"
L3	14'-0"	14'-0"

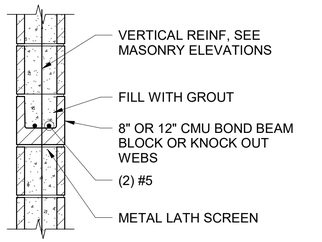
NOTES:
1. THIS SCHEDULE SHALL BE USED FOR OPENINGS IN NON-LOAD BEARING WALLS NOT SHOWN ON DRAWINGS. CONSULT ENGINEER FOR OPENINGS NOT SHOWN IN LOAD BEARING WALLS.
2. L3 LINTEL DOES NOT INCLUDE SHEAR REINFORCING. L3A INCLUDES SHEAR REINFORCING.
3. LINTELS SHALL EXTEND A MINIMUM OF 1'-4" BEYOND EACH SIDE OF OPENING.
4. VERTICAL BARS ABOVE LINTELS SHALL BE EMBEDDED IN LINTELS.
5. WHERE BOND BEAMS ARE COINCIDENT W/ LINTEL REINF, PLACE ONLY THE LINTEL REINFORCING AND SPLICE WITH THE BOND BEAM REINFORCING AT EACH END.

NOTES:
SEE MASONRY ELEVATIONS FOR VERTICAL REINFORCEMENT.

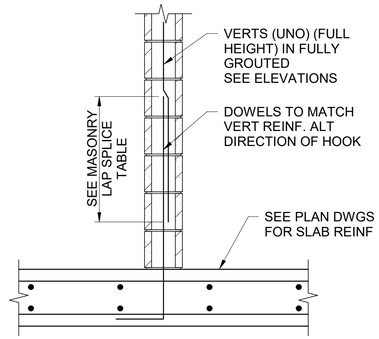




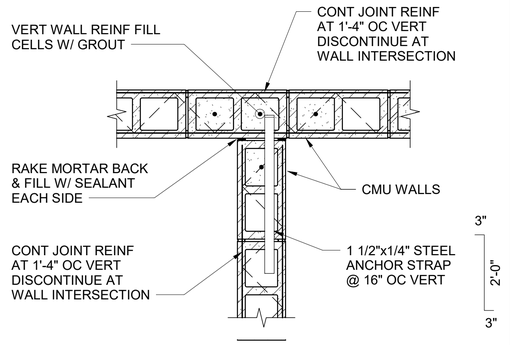
TYPICAL CMU CORNER AND TEE INTERSECTION DETAIL
NOT TO SCALE



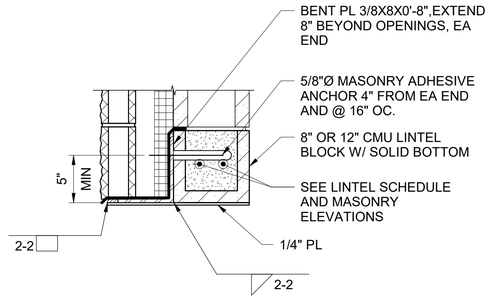
TYPICAL BOND BEAM
NOT TO SCALE



MS-1
NOT TO SCALE

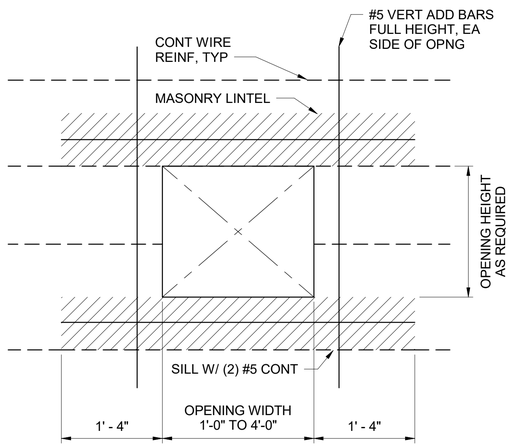


TYPICAL CMU WALL INTERSECTION DETAIL
NOT TO SCALE

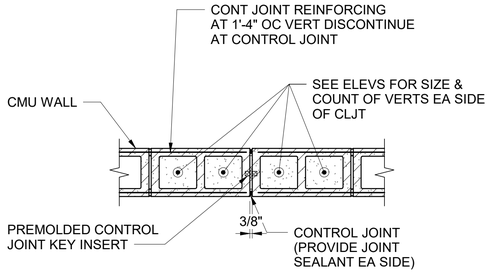


NOTES:
1. SEE ARCH FOR DETAILS NOT SHOWN OR CALLED OUT.
2. PROVIDE AT ALL MANDOORS, OVERHEAD DOORS, AND AND WINDOWS.

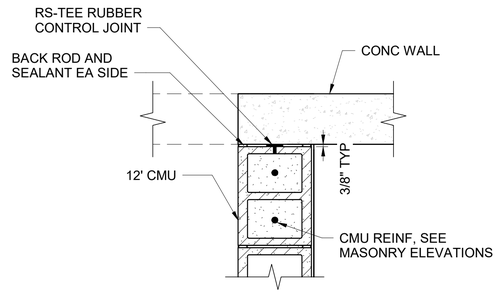
TYPICAL LINTEL ANGLE DETAIL
NOT TO SCALE



TYPICAL CMU WALL OPENING REINFORCING
NOT TO SCALE



TYPICAL CONTROL JOINT DETAIL
NOT TO SCALE



MJ-1 MASONRY TO CONC WALL JOINT DETAIL
NOT TO SCALE

no.	date	by	ckd	description
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1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: B. MIMIAGA
designed: S. DALGLISH	checked: J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

STANDARD DETAILS III

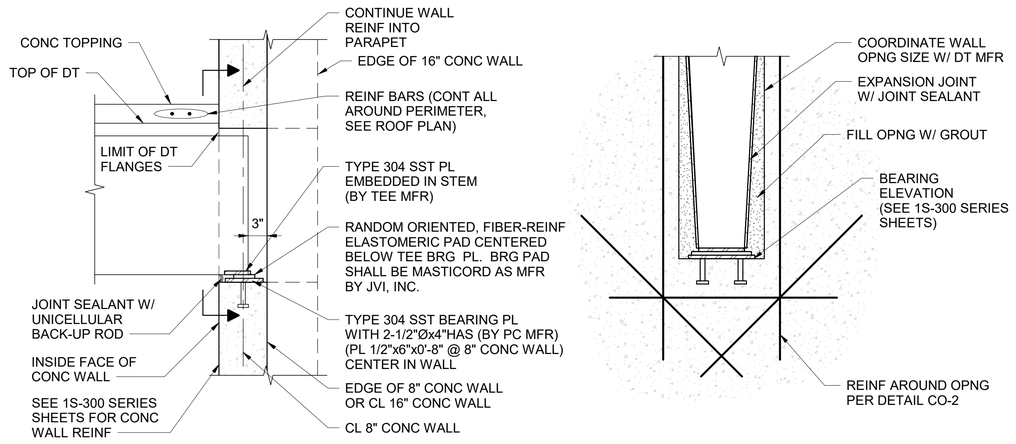
project: 135303	contract:
drawing: 0S-502	rev.: 1
sheet:	of: sheets
file:	

COLORADO LICENSED
SHAWN T. DALGLISH
58555
05/08/2025
PROFESSIONAL ENGINEER

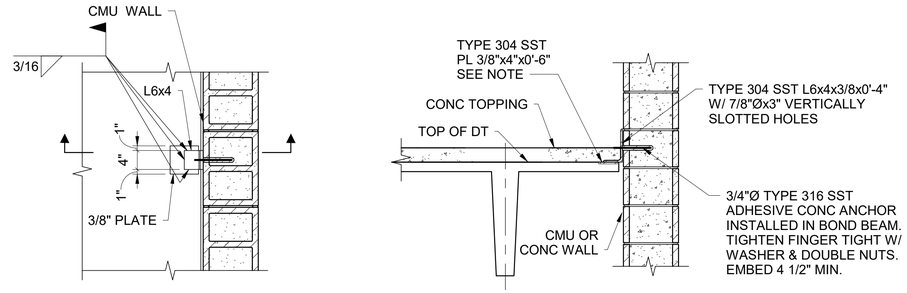
Scale For Microfilming: Millimeters / Inches

5/8/2025 9:57:10 AM

Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt

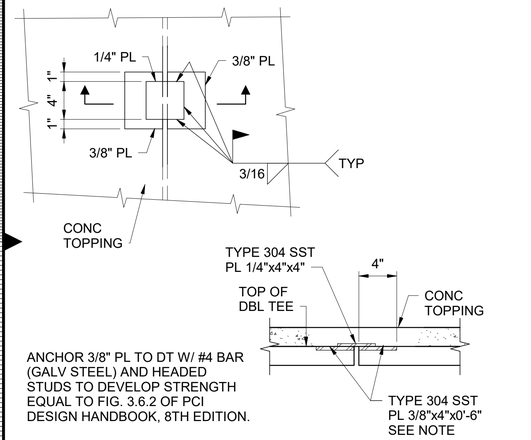


DT-1A - CONC BEARING DETAIL
NOT TO SCALE



NOTE:
ANCHOR 3/8" PL TO DT W/ #4 BAR (GALV STEEL) AND HEADED STUDS TO DEVELOP STRENGTH REQUIRED BY THE PCI DESIGN HANDBOOK.

DT-2
NOT TO SCALE



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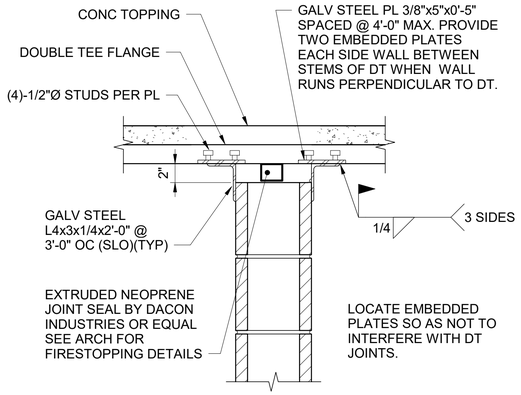

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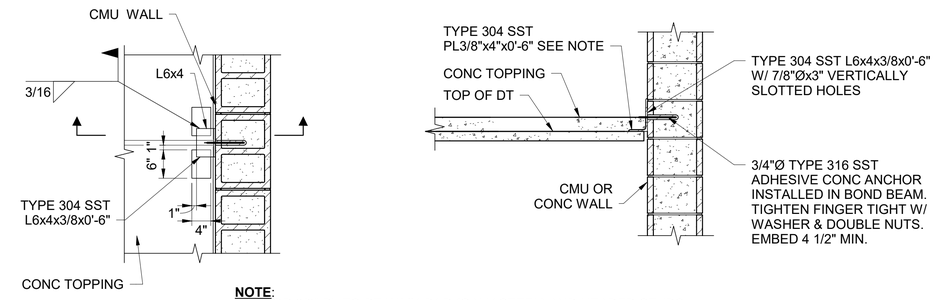
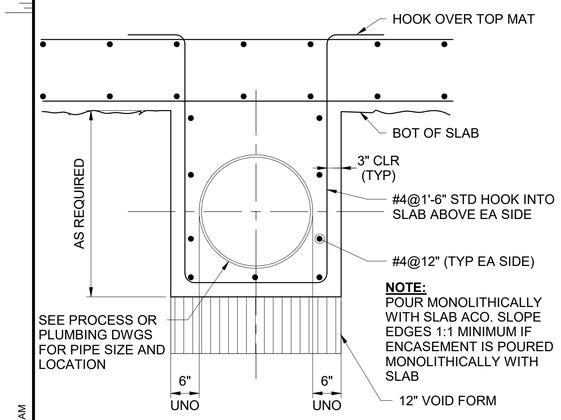


NOTE:
ANCHOR 3/8" PL TO DT W/ #4 BAR (GALV STEEL) AND HEADED STUDS TO DEVELOP STRENGTH REQUIRED BY THE PCI DESIGN HANDBOOK.

DT-9
NOT TO SCALE



PE-2
NOT TO SCALE

no.	date	by	ckd	description
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date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

STANDARD DETAILS IV

project	contract
135303	

drawing 0S-503 — **rev.** 1

sheet of sheets

file

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SHAWN T. DALGLISH
58555
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PROFESSIONAL ENGINEER

Millimeters
Inches
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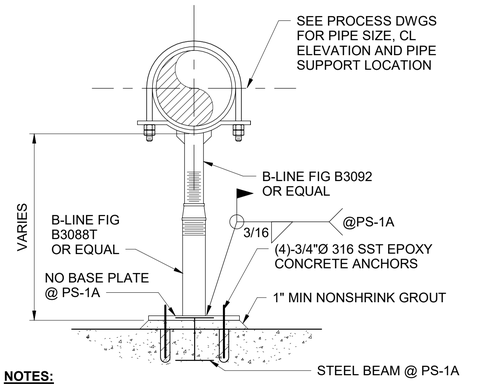
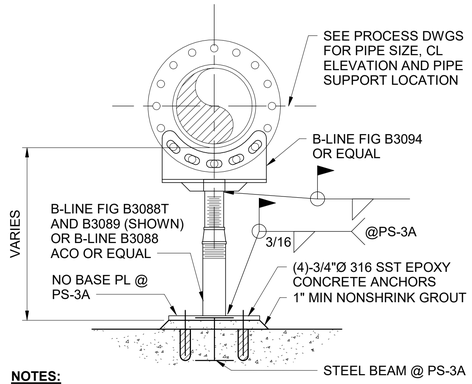


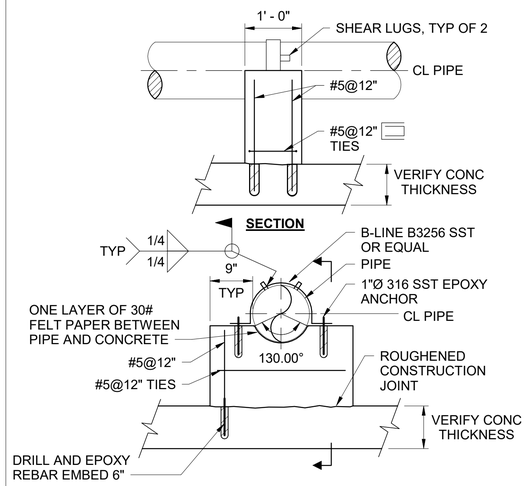
NOTES:
1. COAT PIPE SUPPORT SYSTEM USING SYSTEM D-1 AS SPECIFIED IN SECTION 099000.
2. PROVIDE STAINLESS STEEL SYSTEM WHERE PIPE SUPPORT IS CONTINUOUSLY SUBMERGED.

PS-1/PS-1A
NOT TO SCALE



NOTES:
1. COAT PIPE SYSTEM USING SYSTEM D-1 AS SPECIFIED IN SECTION 099000.
2. PROVIDE STAINLESS STEEL SYSTEM WHERE PIPE SUPPORT IS CONTINUOUSLY SUBMERGED.

PS-3/PS-3A
NOT TO SCALE



PS-4/PS-4S
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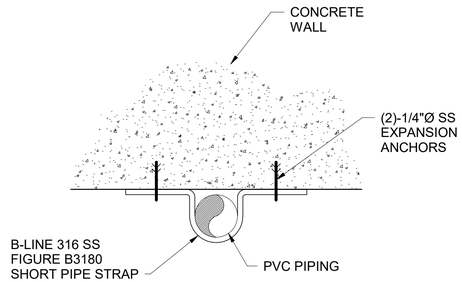

PS-5
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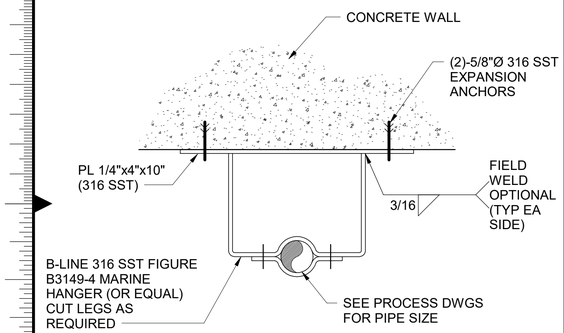
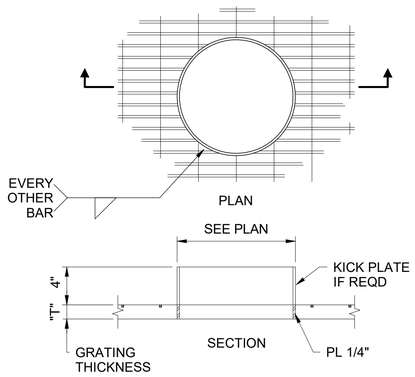


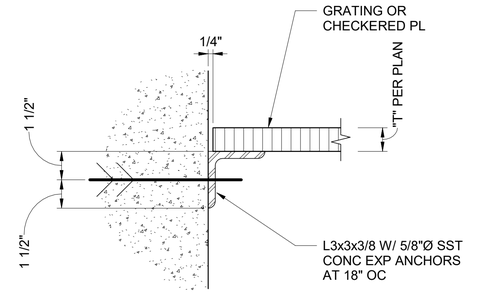
PS-6
NOT TO SCALE



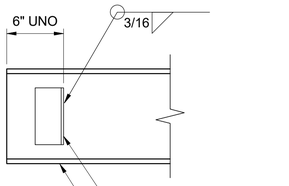
COVER ALL OPENINGS DURING CONSTRUCTION.

GO-1: WITH KICK PLATE
GO-2: WITHOUT KICK PLATE

GO-1/GO-2, GRATING OPENINGS
NOT TO SCALE



GS-1
NOT TO SCALE



MONORAIL - PERMANANT STOP
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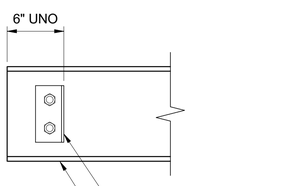

MONORAIL - STOP REMOVABLE
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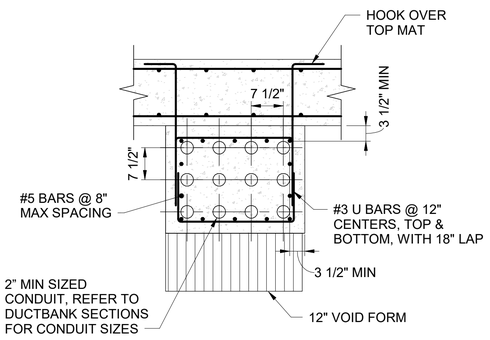

DBE-1 DUCT BANK DETAIL
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	STD	JJZ	ISSUED FOR CONSTRUCTION
1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: B. MIMIAGA
designed: S. DALGLISH	checked: J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

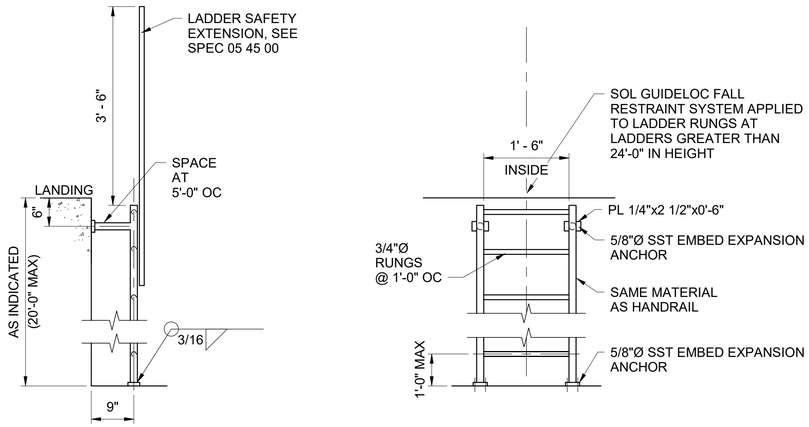
STANDARD DETAILS V

project: 135303	contract:
drawing: 0S-504	rev.: 1
sheet:	of: sheets:
file:	

COLORADO LICENSED
SHAWN T. DALGLISH
58555
05/08/2025
PROFESSIONAL ENGINEER

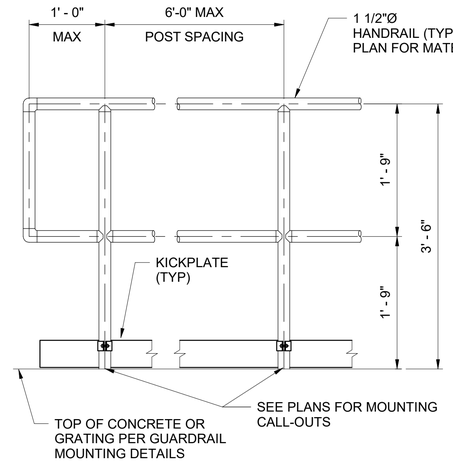
Millimeters
Scale For Microfilming
Inches
5/8/2025 9:57:12 AM

Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt



WITH LADDER SAFETY EXTENSION

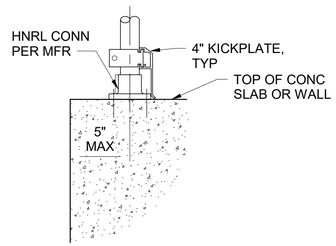
L-1
NOT TO SCALE



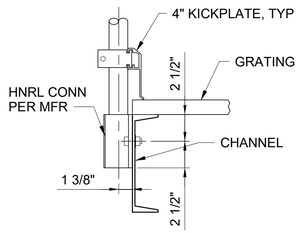
GR-1A
NOT TO SCALE

RAILINGS AND HANDRAILS:

1. HANDRAILS AND GUARDRAILS ARE A DEFERRED DESIGN SUBMITTAL AND SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER REGISTERED IN THE STATE OF COLORADO.
2. RAILINGS SHALL BE DESIGNED TO MEET THE FOLLOWING PERFORMANCE REQUIREMENTS:
   A. DEAD LOAD: AS DETERMINED BY MFR.
   B. LIVE LOADS:
      a. UNIFORM LOAD OF 50PLF APPLIED IN ANY DIRECTION OR;
      b. CONCENTRATED LOAD OF 200LBS APPLIED IN ANY DIRECTION.
   C. THERMAL MOVEMENTS: 120°F AMBIENT TEMPERATURE CHANGE.
3. HANDRAILS AND RAILINGS SHALL BE ALUMINUM CONSTRUCTION WITH CONCEALED FASTENERS DESIGNED TO MEET IBC LOADING REQUIREMENTS.
4. RAILS AND POSTS:
   A. CONFORM TO ASTM B221 OR B429.
   B. 1-1/2-INCH NOMINAL DIAMETER (1.9-INCH OD), ALUMINUM ALLOY 6105-T5 WITH CLEAR ANODIZED FINISH ALUMINUM ASSOCIATION DESIGNATION M32-C22-A41 (215-R1). PIPE SCHEDULE SHALL BE AS REQUIRED BY DESIGN BUT SHALL BE NOT LESS THAN SCHEDULE 40.
   C. PROVIDE LINEAR EXPANSION JOINTS A MAXIMUM OF 40'-0" OC.
5. FITTINGS AND ACCESSORIES:
   A. FASTENERS AND ANCHORS OF STAINLESS STEEL AND OF TYPE AS REQUIRED BY SUBSTRATE.
6. TOE BOARD (KICK PLATE):
   A. TOE BOARD SHALL CONFORM TO OSHA STANDARDS. TOE BOARD SHALL BE A MINIMUM OF 4" HIGH AND SHALL BE AN EXTRUSION THAT ATTACHES TO THE POSTS WITH CLAMPS THAT WILL ALLOW FOR EXPANSION AND CONTRACTION BETWEEN POSTS. TOE BOARDS SHALL BE SET 1/4" ABOVE THE WALKING SURFACE. TOE BOARDS SHALL BE PROVIDED ON ALL HANDRAILS AND GUARDRAILS. TOE BOARDS SHALL BE SHIPPED IN STOCK LENGTHS FOR FIELD INSTALLATION.



CE-18A
NOT TO SCALE



SE-14A
NOT TO SCALE

no.	date	by	ckd	description
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1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

STANDARD DETAILS VI

project: 135303	contract:
drawing: 0S-505	rev.: 1
sheet:	of: sheets:
file:	

COLORADO LICENSED SHAWN T. DALGLISH 58555 PROFESSIONAL ENGINEER 05/08/2025

Millimeters
Inches
Scale For Microfilming
5/8/2025 9:57:12 AM
Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt

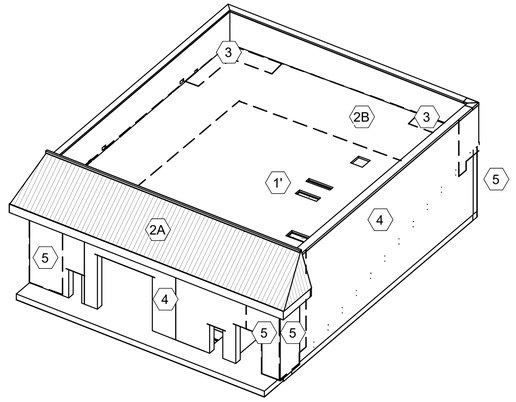
PUMP STATION STRUCTURAL GENERAL NOTES:

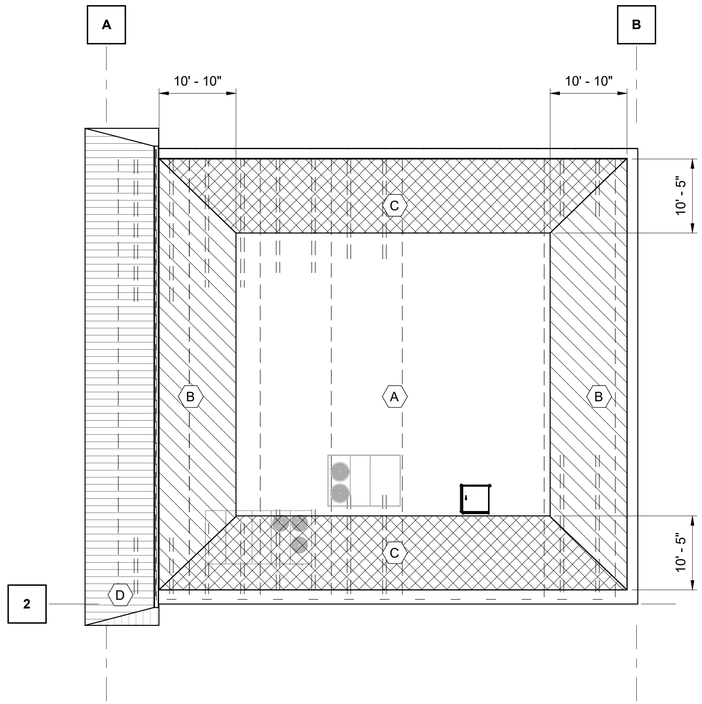
1. VALUES BELOW ARE SPECIFIC TO THE PUMP STATION STRUCTURE. FOR GENERAL VALUES THAT ARE SIMILAR FOR ALL STRUCTURES REFER TO 0S-003.

STRUCTURAL DESIGN LOADING/CRITERIA:

VALUES BELOW ARE SPECIFIC TO THE PUMP STATION STRUCTURE. FOR GENERAL VALUES THAT ARE SIMILAR FOR ALL STRUCTURES ON THE PROJECT REFER TO 0S-003.

1. DEAD LOADS
   - A. SELF WEIGHT OF MATERIALS OF CONSTRUCTION
   - B. WEIGHT OF FIXED SERVICE EQUIPMENT
     - a. AS INDICATED ON THE STRUCTURAL DRAWINGS FOR EQUIPMENT WEIGHING IN EXCESS OF 300 LBS. FRAMING AND FOUNDATIONS ARE DESIGNED FOR EQUIPMENT WHICH SATISFIES THE CONTRACT SPECIFICATIONS.
     - b. IF EQUIPMENT FURNISHED IS HEAVIER THAN THE WEIGHTS INDICATED, OR REQUIRES STRUCTURAL CHANGES FOR ANY OTHER REASON, PROVIDE ENGINEERING DESIGN CALCULATIONS AND ADDITIONAL STRUCTURAL WORK NECESSARY TO SUPPORT ALL LOADS IN ACCORDANCE WITH THE DESIGN STANDARDS SPECIFIED ABOVE, AT NO ADDITIONAL COST TO THE OWNER AND WITH NO INCREASE IN CONTRACT TIME.
   - C. SUPERIMPOSED DEAD LOAD.....17 PSF
2. LIVE LOADS:
   - A. STAIRS, WALKWAYS, PLATFORMS..... 100 PSF, UNIFORM
300 LB, CONCENTRATED
   - B. PUMP AND ELECTRICAL ROOMS..... 250 PSF, UNIFORM
3,000 LB, CONCENTRATED
   - C. 3 TON BRIDGE CRANE LOADS:
     - a. MAXIMUM WHEEL LOAD..... 5000 LB
     - b. VERTICAL IMPACT FORCE..... 500 LB
     - c. LATERAL FORCE..... 1300 LB
     - d. LONGITUDINAL FORCE..... 500 LB
3. SNOW LOADS:
   - A. THERMAL FACTOR (C_t).....1.0 (MAIN ROOF), 1.1 (MANSARD CANOPY)
   - B. SLOPE FACTOR (C_s)..... 1.0 (BOTH ROOFS)
   - C. DRIFT SURCHARGE LOADS.....SEE DIAGRAM THIS SHEET
4. WIND DESIGN DATA:
   - A. INTERNAL PRESSURE COEFFICIENT..... ±0.55
   - B. COMPONENTS AND CLADDING LOADS.....SEE DIAGRAM THIS SHEET
5. SEISMIC DESIGN DATA:
   - A. BASIC SEISMIC FORCE RESISTING SYSTEM(S):
     - a. INTERMEDIATE REINFORCED MASONRY SHEAR WALLS
     - b. CONCRETE SHEAR WALLS
   - B. DESIGN BASE SHEARS(S)..... 111.1 KIPS
   - C. SEISMIC RESPONSE COEFFICIENT(S) (C_S).....0.08
   - D. RESPONSE MODIFICATION COEFFICIENT(S) (R).....3.5
   - E. ANALYSIS PROCEDURE USED.....EQUIVALENT LATERAL FORCE





SNOW DRIFT DIAGRAM
NOT TO SCALE

C&C WIND LOAD DIAGRAM
NOT TO SCALE

C&C WIND LOADS (X)	
ZONE	PSF
1'	45.9
2A	78.9
2B	45.9
3	78.9
4	42.7
5	45.2

SNOW DRIFT DIAGRAM (X)					
ZONE	PF (PSF)	PS (PSF)	DRIFT (PSF)	W (FT)	TOTAL (PSF)
A	38	-	-	-	38
B	38	-	52.2	10.8	90.2
C	38	-	49.9	10.4	87.9
D	-	38	48.6	5.6	86.6

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

STRUCTURAL GENERAL NOTES

project	contract
135303	

drawing **1S-001** rev. **1**

sheet of sheets

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COLORADO LICENSED SHAWN T. DALGLISH 58555 PROFESSIONAL ENGINEER 05/08/2025

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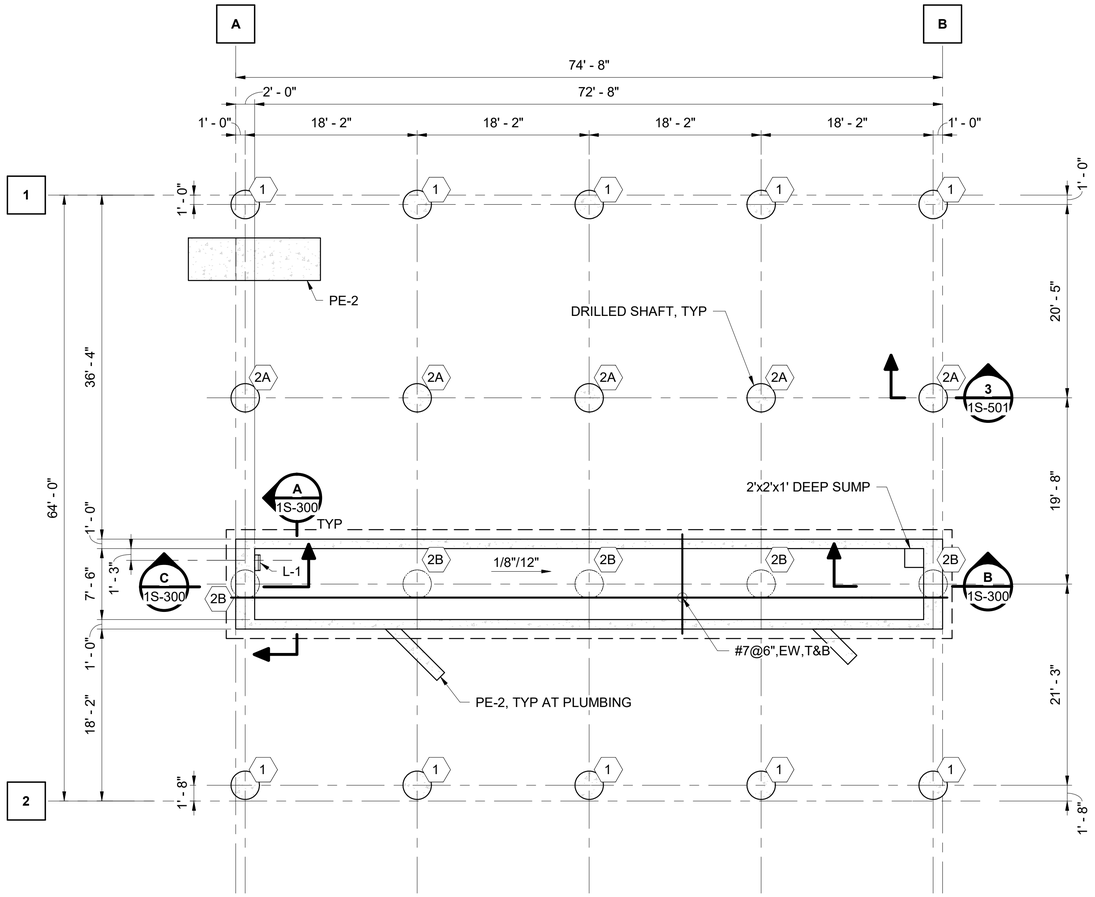

NOTES:

1. SEE 0S-001 FOR ABBREVIATIONS AND LEGEND.
2. SEE 0S-002 FOR STRUCTURAL SPECIAL INSPECTIONS.
3. SEE 0S-003 FOR GENERAL STRUCTURAL NOTES.
4. SEE 0S-500 SERIES FOR TYPICAL STRUCTURAL DETAILS.

FOUNDATION NOTES:

1. KEYNOTE INDICATES DRILLED SHAFT TYPE. SEE SHEET 1S-501 FOR DRILLED SHAFT SCHEDULE AND DETAILS.
2. SEE SPECIFICATION SECTION 03 30 05 FOR VOID FORM REQUIREMENTS.

FOUNDATION PLAN

0 4' 8' 16'
SCALE IN FEET

NORTH

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BROOMFIELD TANKS AND PUMP STATION

PUMP STATION FOUNDATION PLAN

project	contract
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drawing 1S-100 — **rev.** 1

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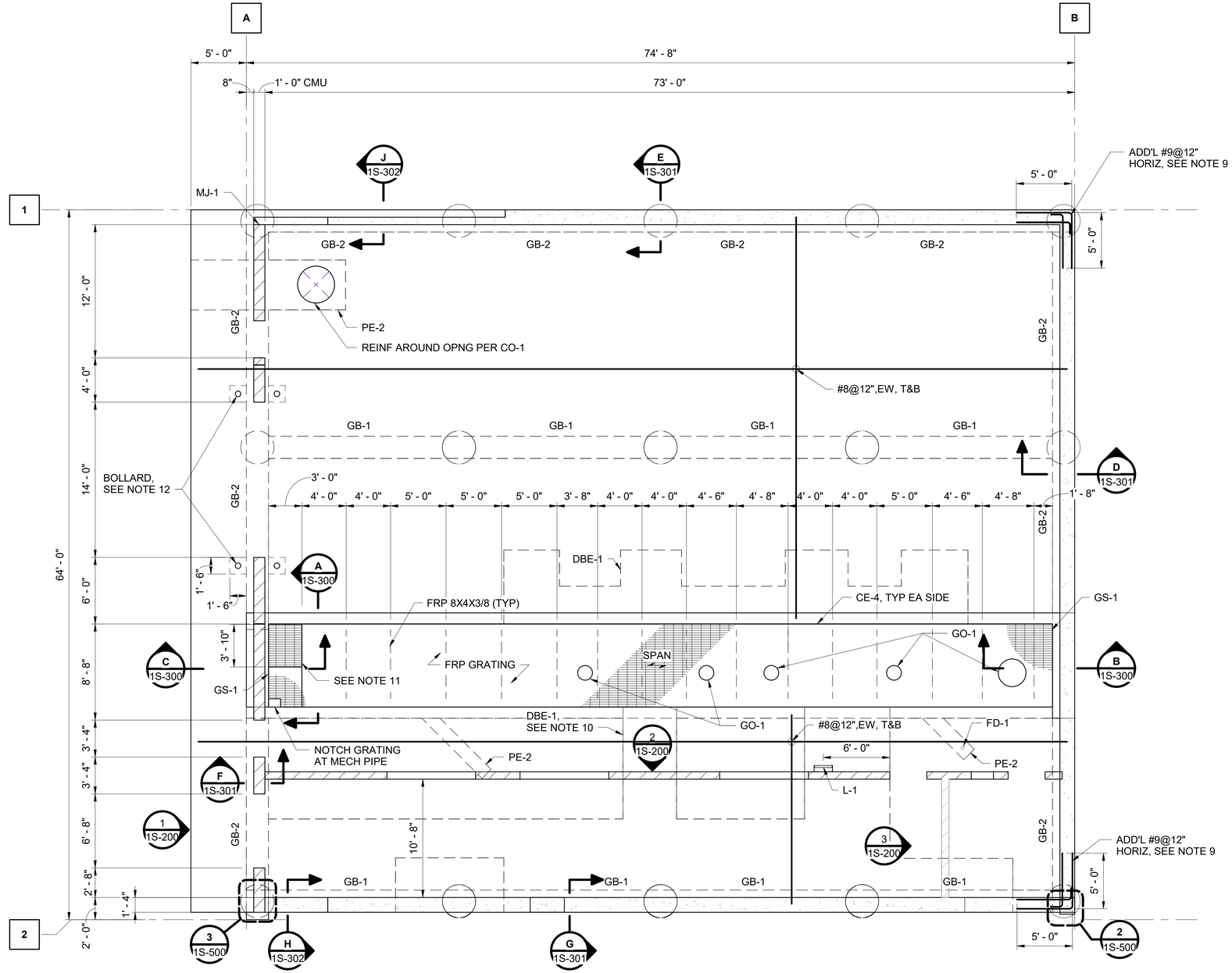

TOP SLAB PLAN

0 4' 8' 16'

SCALE IN FEET

NORTH

NOTES:

1. SEE 0S-001 FOR ABBREVIATIONS AND LEGEND.
2. SEE 0S-002 FOR STRUCTURAL SPECIAL INSPECTIONS.
3. SEE 0S-003 FOR GENERAL STRUCTURAL NOTES.
4. SEE 0S-500 SERIES FOR TYPICAL STRUCTURAL DETAILS.
5. DIMENSIONS ARE TO FACE OF CONCRETE OR WALL, UNLESS NOTED OTHERWISE.
6. PROVIDE EQUIPMENT PADS (EP-1) UNDER ALL EQUIPMENT. EQUIPMENT PAD SHALL BE 4" HIGH UNLESS NOTED OTHERWISE. COORDINATE LOCATION OF THE EQUIPMENT PAD BLOCKOUTS W/ EQUIPMENT MFR PRIOR TO CONSTRUCTION.
7. WALLS SHALL BE SEQUENCED PER THE WALL PLACEMENT SEQUENCE DIAGRAM ON 00S-500. ALL 16" CONCRETE FOUNDATION WALLS SHALL BE PLACED PRIOR TO PLACEMENT OF STRUCTURAL FILL.
8. STRUCTURAL FILL ADJACENT TO FOUNDATION WALLS SHALL BE CDOT CLASS 1 STRUCTURAL FILL WITH LESS THAN 20% PASSING THE NO. 200 SIEVE. FILL SHALL BE PLACED IN MAXIMUM 8-INCH UNIFORM LIFTS. STRUCTURAL FILL SHALL BE COMPACTED TO A MINIMUM PERCENTAGE OF STANDARD PROCTOR MAXIMUM DRY DENSITY (ASTM D698) OF 95% AT FOUNDATION WALLS.
9. PROVIDE ADDITIONAL REINFORCING AT EXTERIOR CONCRETE WALLS PER CALL OUT. ALTERNATE WITH TYPICAL REINFORCING FOR 6" SPACING.
10. DUCT BANK ENCASEMENT BELOW STRUCTURAL SLAB PER DETAIL DBE-1. COORDINATE SIZE AND LOCATION WITH ELECTRICAL DRAWINGS AND DUCT BANK SUBMITTAL. SEE ELECTRICAL DRAWINGS FOR CONDUIT SIZE AND ROUTING.
11. PROVIDE HINGED REMOVABLE GRATING AT LADDER ACCESS.
12. PROVIDE BOLLARD AT INTERIOR AND EXTERIOR OF OVERHEAD DOOR. SEE BOLLARD DETAIL ON CIVIL DRAWINGS. PROVIDE 1'-6"X1'-6"X 3'-0" CONC EMBEDMENT AT BOLLARD. CAST BOLLARD IN PLACE DURING CONCRETE POUR FOR STRUCTURAL SLAB.

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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: B. MIMIAGA
designed: S. DALGLISH	checked: J. ZEMLICKA

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION FLOOR PLAN

project: 135303	contract:
drawing: 1S-101	rev.: 1
sheet:	of: sheets:
file:	

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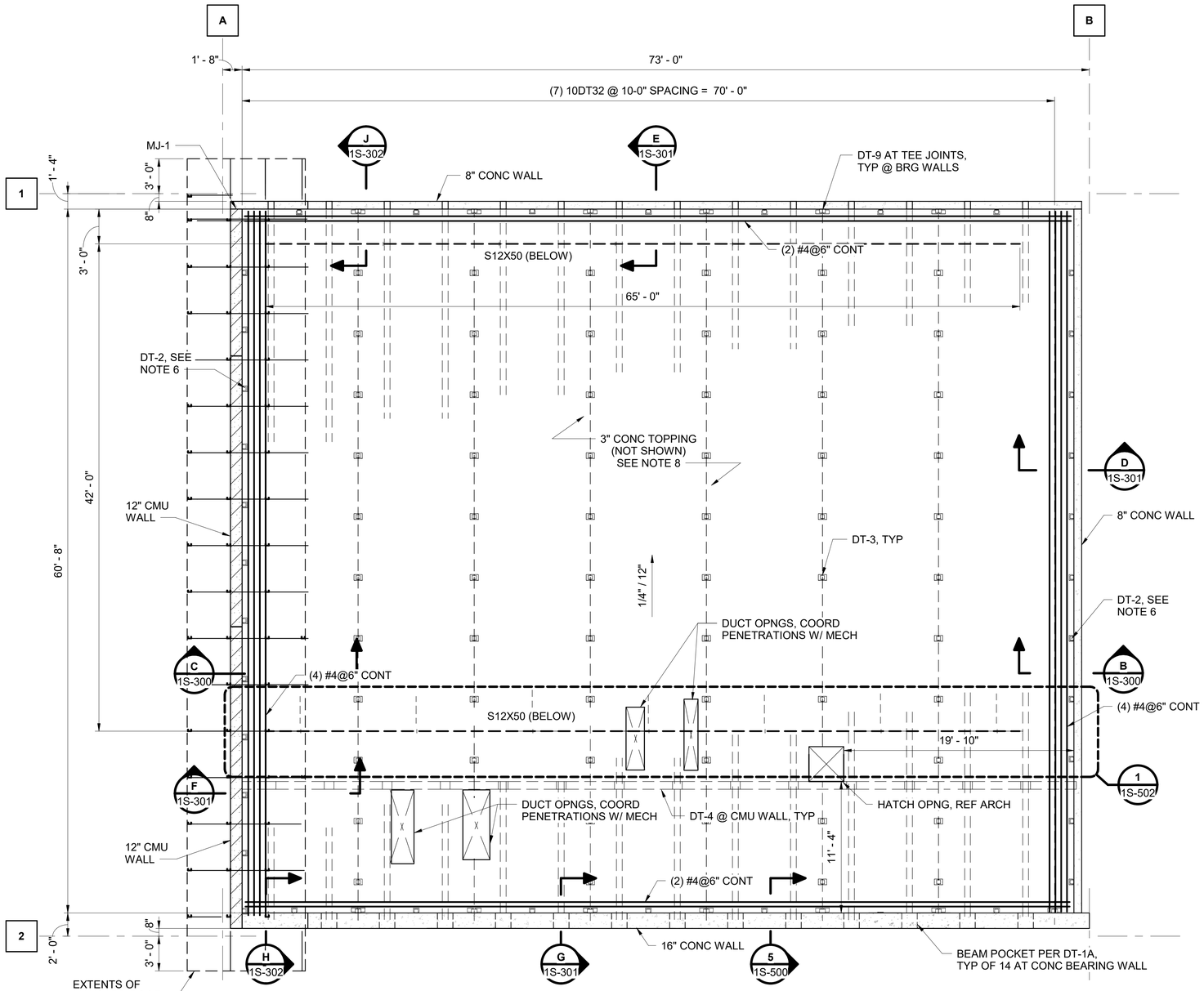
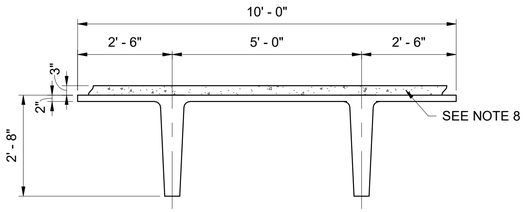


ROOF FRAMING PLAN

0 4' 8' 16'

SCALE IN FEET

NORTH



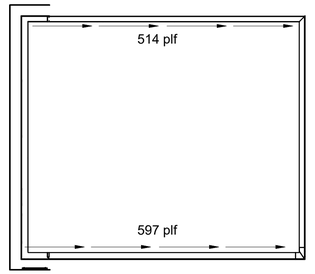
TYPICAL DOUBLE TEE, 10DT32
NOT TO SCALE

NOTES:

1. SEE 0S-001 FOR ABBREVIATIONS AND LEGEND.
2. SEE 0S-002 FOR STRUCTURAL SPECIAL INSPECTIONS.
3. SEE 0S-003 FOR GENERAL STRUCTURAL NOTES.
4. SEE 0S-500 SERIES FOR TYPICAL STRUCTURAL DETAILS.

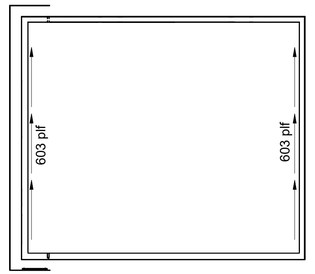
ROOF PLAN NOTES:

1. ALL BACKFILL SHALL BE PLACED AND COMPACTED PRIOR TO PLACEMENT OF THE DOUBLE TEES ROOF MEMBERS.
2. ALL PRECAST CONCRETE SHALL BE DESIGNED PER THE DESIGN LOADS SHOWN ON 0S-003 AND ADDITIONAL LOADS ON THIS SHEET.
3. ADDITIONAL DESIGN LOADS:
   A. ADDITIONAL DEAD LOADS (UNFACTORED):
      a. 3" CONCRETE TOPPING: 38 PSF
      b. ROOFING: 5 PSF
      c. COLLATERAL: 10 PSF
      d. SNOW DRIFT PER DIAGRAM ON SHEET 1S-001.
      e. CRANE LOADS PER SHEET 1S-103 .
      f. DIAPHRAGM LOADS PER DIAGRAMS THIS SHEET.
4. CONTRACTOR SHALL COORDINATE ALL ROOF OPENING LOCATIONS WITH ARCHITECTURAL, MECHANICAL, PLUMBING, PROCESS AND ELECTRICAL DRAWINGS AND PROVIDE OPENING DIMENSIONS TO THE PRECAST MANUFACTURER.
5. FIELD CUT OR DRILLED OPENINGS ARE NOT PERMITTED WITHOUT APPROVAL FROM THE PRECAST CONCRETE MANUFACTURER.
6. DT-2 CONNECTIONS AT 5'-0" OC MAX. DT-2 CONNECTION SHALL HAVE 16" MINIMUM CLEARANCE BETWEEN CONNECTION AND MASONRY CONTROL JOINTS. ACTUAL SPACING TO BE DETERMINED BY THE PRECAST MANUFACTURER BASED ON SHEARS SHOWN ON THIS SHEET.
7. SEE SPECIFICATION SECTION 03 41 00 FOR ADDITIONAL REQUIREMENTS.
8. PROVIDE UNIFORM 3" CAST-IN-PLACE CONCRETE TOPPING WITH WWF 6x6x-W2.0xW2.0. SEE SPEC 03 30 00 FOR CONCRETE MIX DESIGN.



Y
X

X-DIRECTION
NOT TO SCALE



Y-DIRECTION
NOT TO SCALE

DIAPHRAGM NOTES:

1. SEISMIC LOADS CONTROL THE DESIGN IN BOTH DIRECTIONS.
2. LOADS SHOWN ARE PER 2021 INTERNATIONAL BUILDING CODE AT STRENGTH LEVELS.
3. DESIGN DIAPHRAGM FOR LOADS AS SHOWN AND FOR REVERSAL OF LOAD DIRECTION. DIAPHRAGM LOADS INCLUDE MAXIMUM SHEAR WITH ADDITION OF FUTURE REUSE PUMP STATION.

ROOF DIAPHRAGM LOAD DIAGRAMS
NOT TO SCALE

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BROOMFIELD TANKS AND PUMP STATION

PUMP STATION ROOF PLAN

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drawing **1S-102** — **rev.** **1**

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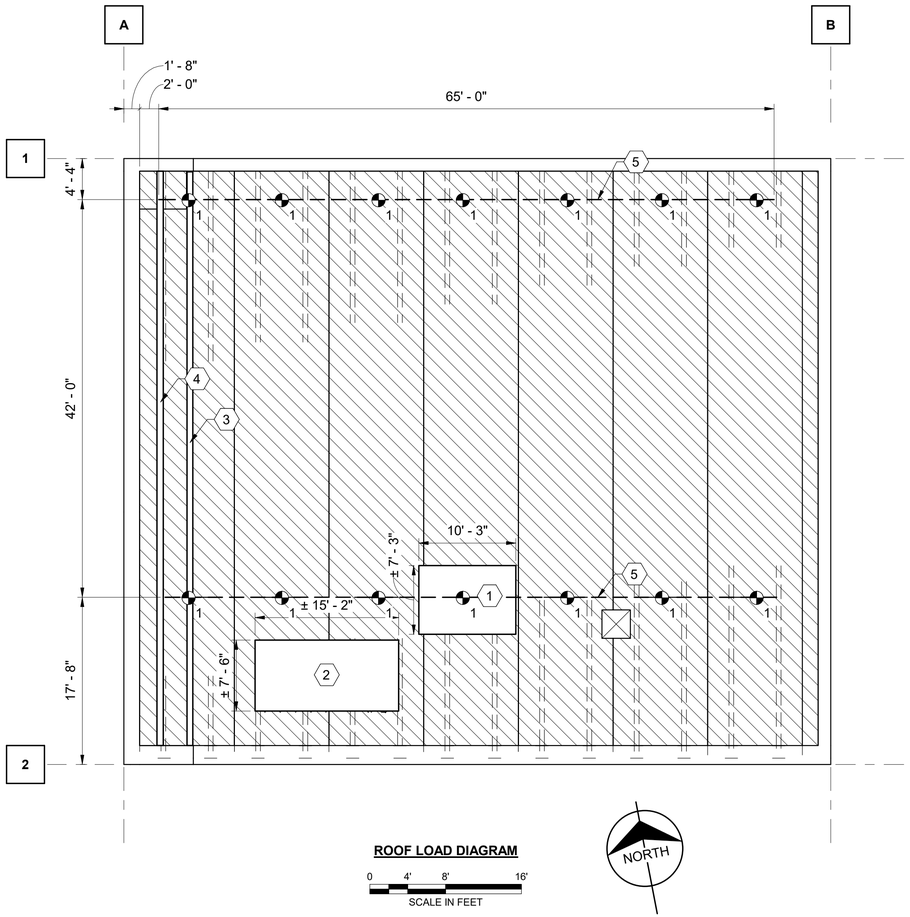

ROOF LOAD DIAGRAM

0 4' 8' 16'

SCALE IN FEET

NORTH

HATCH	AREA	STRUCTURE	SUPERIMPOSED DEAD LOAD (PSF)	LIVE LOAD (PSF)
	ROOF	3" CONC TOPPING W/ TPO ROOFING	6 (COLLATERAL) + 38 (3" TOPPING)+9 ROOFING = 53 TOTAL	20
#	SERVICE LOAD OR EQUIPMENT	NONE	NONE	SEE TABLE THIS SHEET

POINT LOADS	STRUCTURAL USE	VERTICAL DESIGN LOADS	LATERAL DESIGN LOADS
1	BRIDGE CRANE SUPPORT	DL = 0.5 KIPS LL = 4.7 KIPS	LLX = 1.4 KIPS (LONGITUDINAL) LLY = 1.3 KIPS (TRANSVERSE)

TAG NUMBER	EQUIPMENT NAME	SERVICE LOAD
1	RTU-181	DL = 2,000 LBS
2	RTU-182	DL = 5,000 LBS
3	CFS FRAMING REACTION 1 @24"	DL = -10 LBS SL = 50 LBS WL = -4.93, +4.86 LBS
4	CFS FRAMING REACTION 2 @ 24"	DL = 50 LBS SL = 120 LBS WL = -4.93, +4.40 LBS
5	BRIDGE CRANE MOVING LOAD	VERTICAL IMPACT = 5.5 KIPS LONGITUDINAL = 0.5 KIPS TRANSVERSE = 1.1 KIPS

LOAD DIAGRAM NOTES:

1. LOADS SHOWN ARE SERVICE LEVEL (UNFACTORED) LOADS.
2. SEE 1S-001 FOR ADDITIONAL LOAD REQUIREMENTS.
3. CONTRACTOR TO VERIFY ACTUAL WEIGHTS OF EQUIPMENT. CONTACT ENGINEER IF ACTUAL WEIGHTS ARE GREATER THAN WEIGHTS SHOWN ON THIS SHEET.
4. CONTRACTOR TO COORDINATE ACTUAL DIMENSONS, WEIGHTS, AND LOCATIONS WITH PRECAST MFR.

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designed	**checked**
S. DALGLISH	J. ZEMLICKA

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BROOMFIELD TANKS AND PUMP STATION

ROOF SERVICE LOAD PLAN

project	contract
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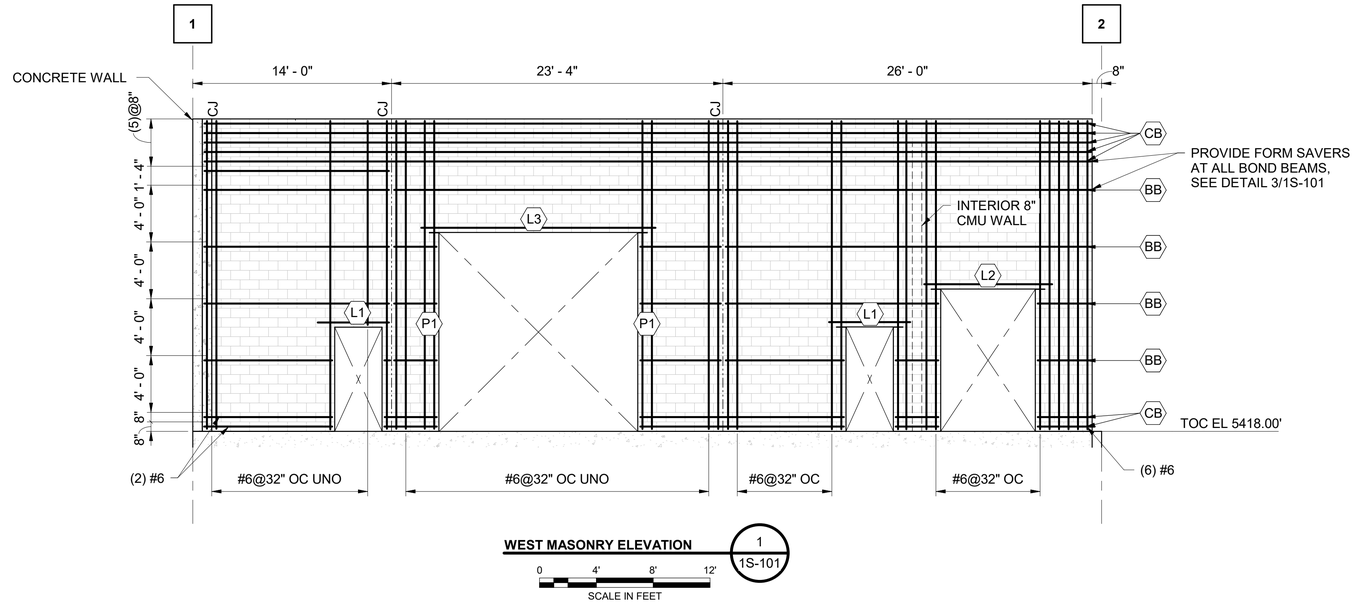
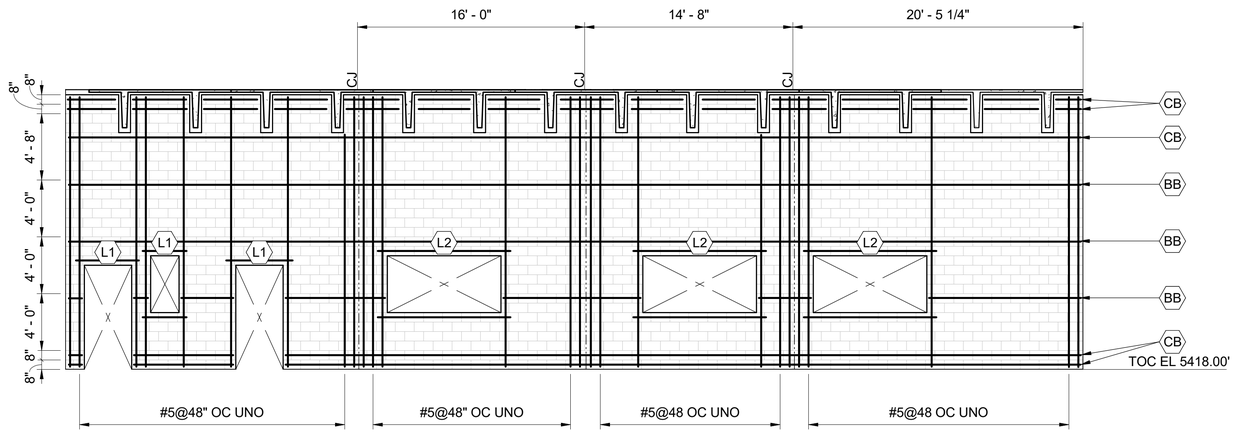


WEST MASONRY ELEVATION — 1 / 1S-101

0 4' 8' 12'

SCALE IN FEET



SOUTH MASONRY ELEVATION — 2 / 1S-101

0 4' 8' 12'

SCALE IN FEET

NOTES:

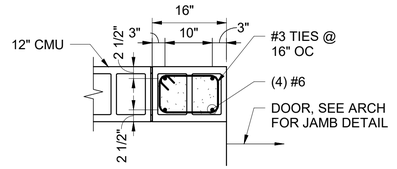
1. FOR GENERAL NOTES, INSPECTION NOTES AND STANDARD DETAILS SEE DRAWINGS 0S-000 SERIES.
2. FOR STANDARD MASONRY GENERAL NOTES AND DETAILS SEE 0S-502, USE STANDARD DETAILS UNO.
3. LOCATE VERTS AT LOCATIONS SHOWN AND AT MAX SPACING OF 32" UNO. COORDINATE DOOR OPENINGS WITH ARCH.
4. COORDINATE ALL OPENINGS FOR PIPING, CONDUIT AND MECHANICAL EQUIPMENT WITH PROCESS, ELECTRICAL, AND MECHANICAL.
5. WHERE LINTEL AND BOND BEAM REINFORCING OCCUR IN THE SAME BLOCK, PROVIDE ONLY THE LARGER REINFORCING AND LAP ON EITHER SIDE OF THE OPENING.
6. PROVIDE MASONRY DOWELS PER DETAIL MS-1 UNO AT FOUNDATION SLAB AT ALL MASONRY VERTICAL REINFORCING BARS. REBAR DOWELS TO MATCH VERTICAL REINFORCING.

⟨LX⟩ DENOTES LINTEL BEAM SEE TYPICAL DETAIL ON 0S-502.

⟨BB⟩ DENOTES BOND BEAM DISCONTINUOUS THROUGH CONTROLJOINTS. SEE TYPICAL DETAIL ON 0S-502.

⟨CB⟩ DENOTES BOND BEAM CONTINUOUS THROUGH CONTROL JOINT. SEE TYPICAL DETAIL ON 0S-502.

⟨PX⟩ DENOTES MASONRY PILASTER. SEE DETAIL THIS SHEET.



PILASTER P1
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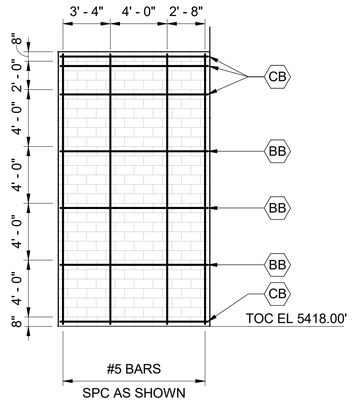

INTERIOR MASONRY ELEVATION II — 3 / 1S-101

0 4' 8' 12'

SCALE IN FEET

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BROOMFIELD TANKS AND PUMP STATION

MASONRY ELEVATIONS

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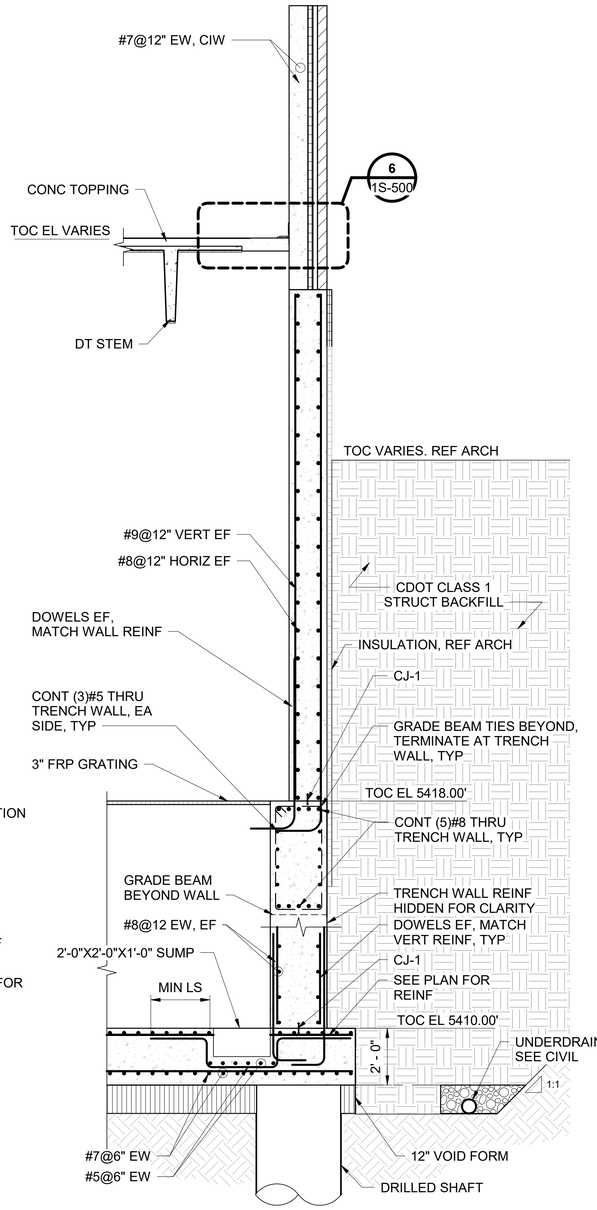

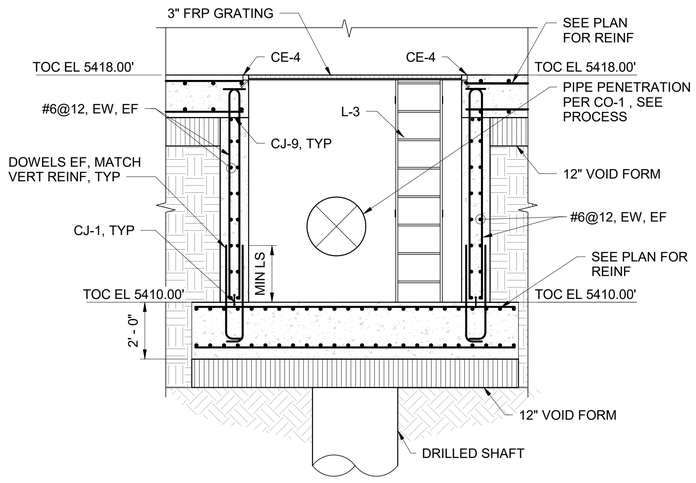

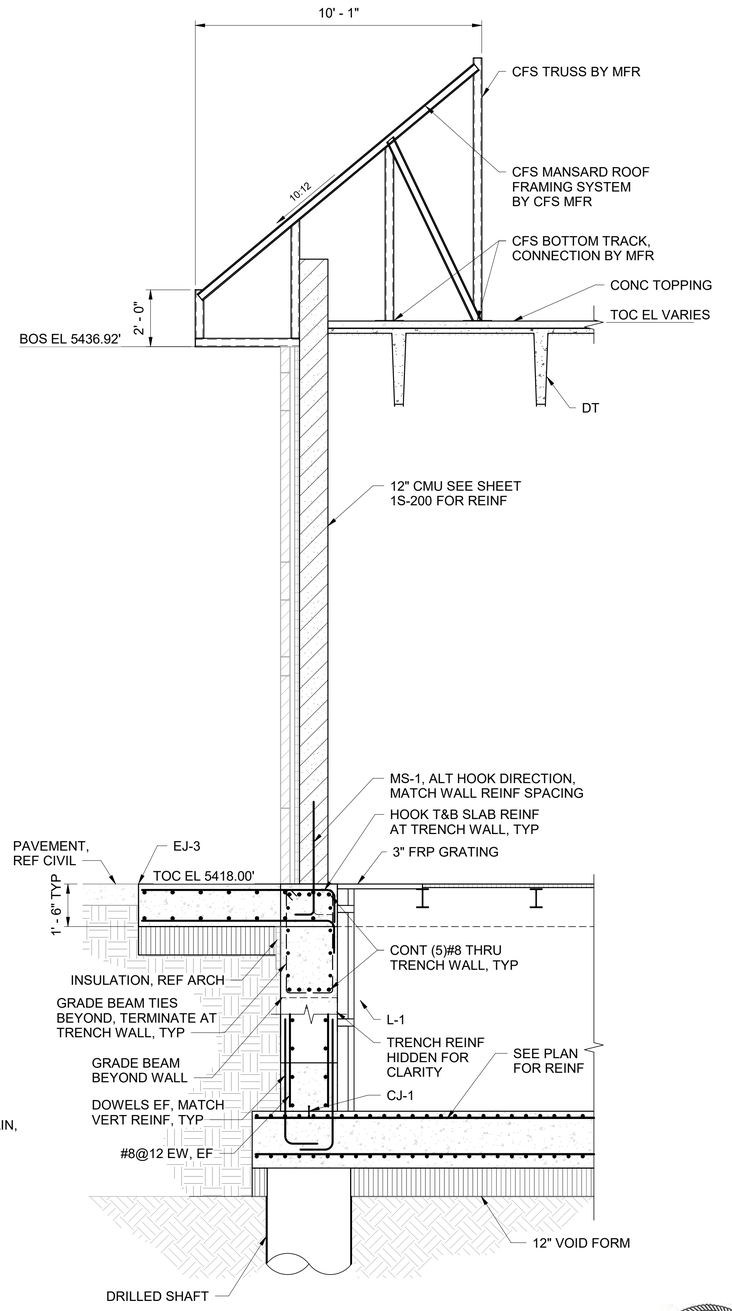

SECTION A 1S-100
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SCALE IN FEET

SECTION B 1S-100
0 2' 4' 6'
SCALE IN FEET

SECTION C 1S-100
0 2' 4' 6'
SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	STD	JJZ	ISSUED FOR CONSTRUCTION
1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION SECTIONS I

project	contract
135303	

drawing 1S-300 — **rev.** 1

sheet of **sheets**

file

COLORADO LICENSED
SHAWN T. DALGLISH
58555
05/08/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
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Inches

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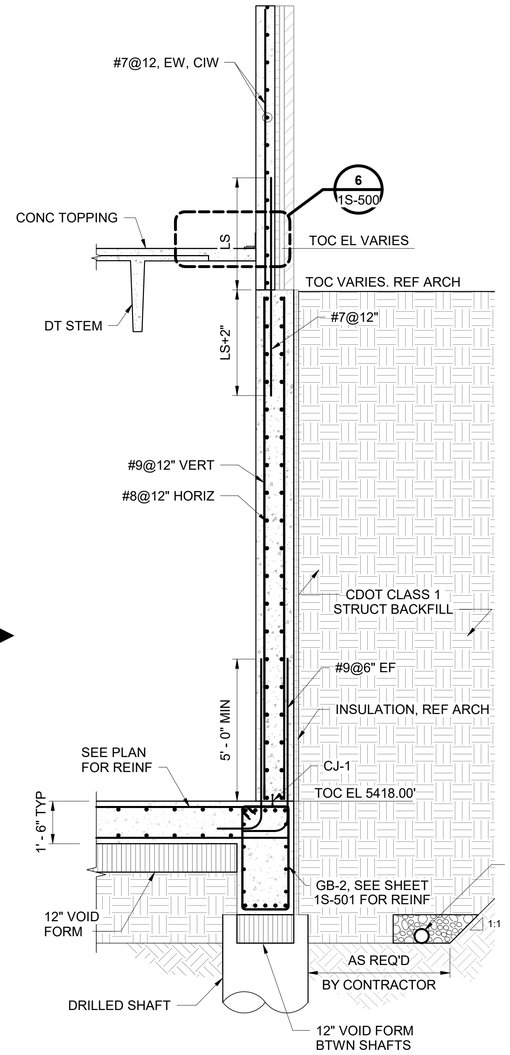

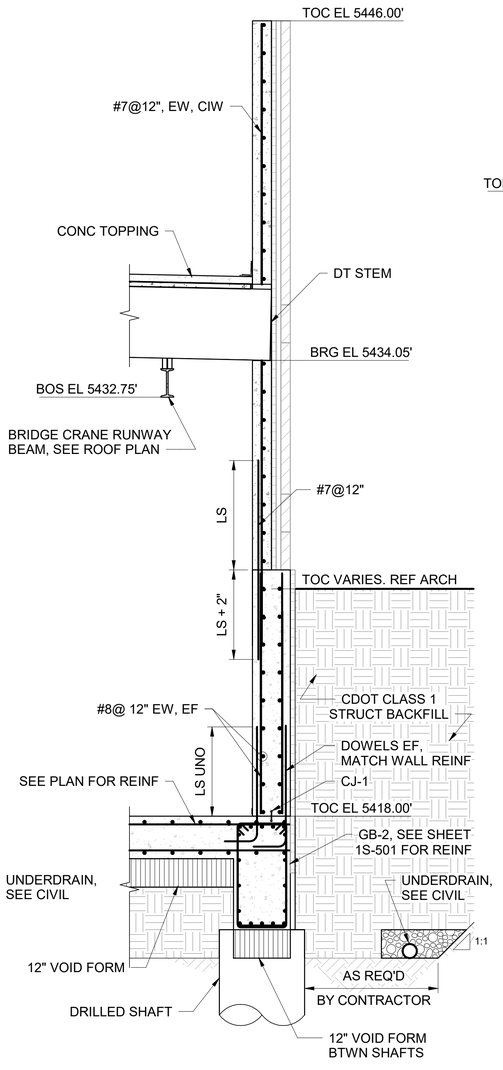

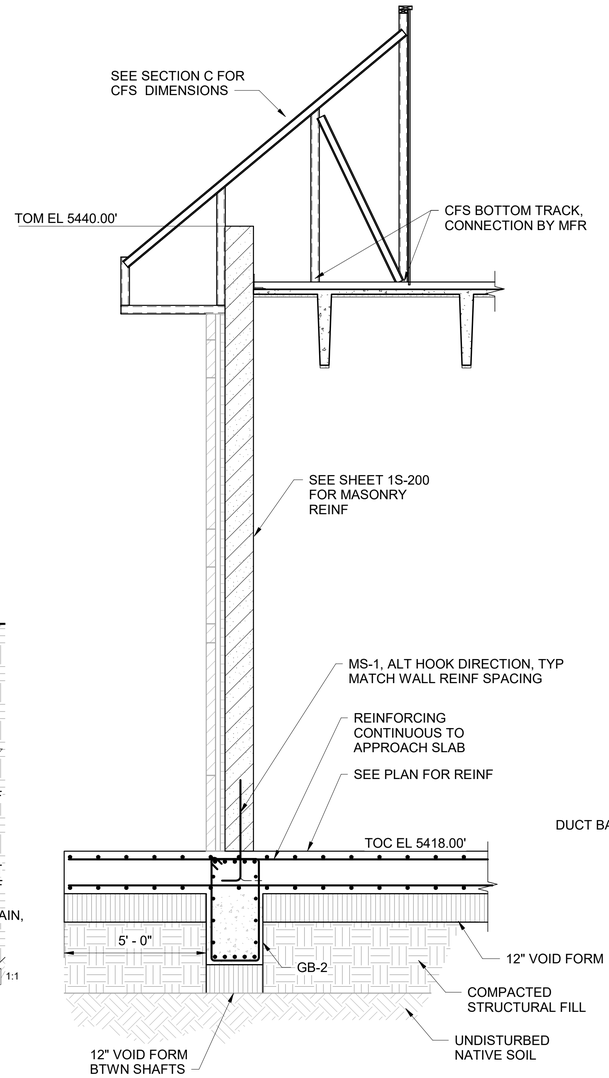

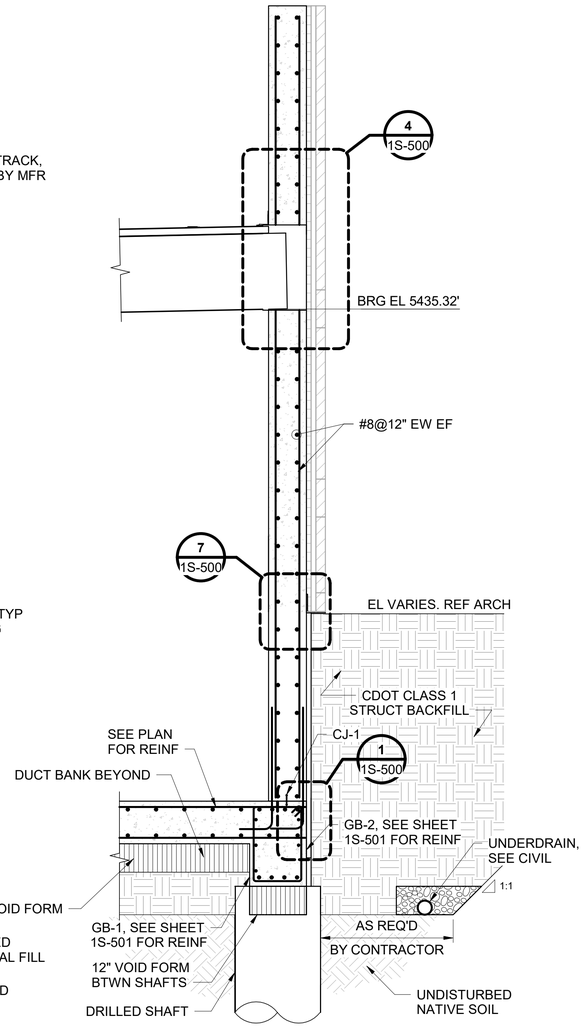

NOTE: PROVIDE FORM SAVERS AT SLAB REINFORCING FOR FUTURE EXPANSION.

SECTION D 1S-101
0 2' 4' 6'
SCALE IN FEET

SECTION E 1S-101
0 2' 4' 6'
SCALE IN FEET

SECTION F 1S-101
0 2' 4' 6'
SCALE IN FEET

SECTION G 1S-101
0 2' 4' 6'
SCALE IN FEET

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designed	**checked**
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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION SECTIONS II

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sheet of sheets

file

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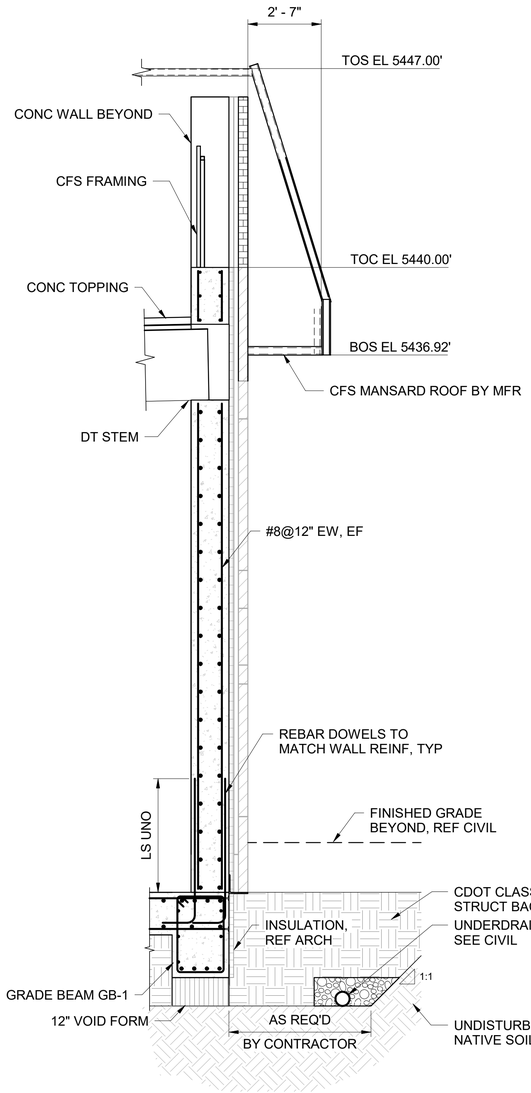

SECTION H 1S-101

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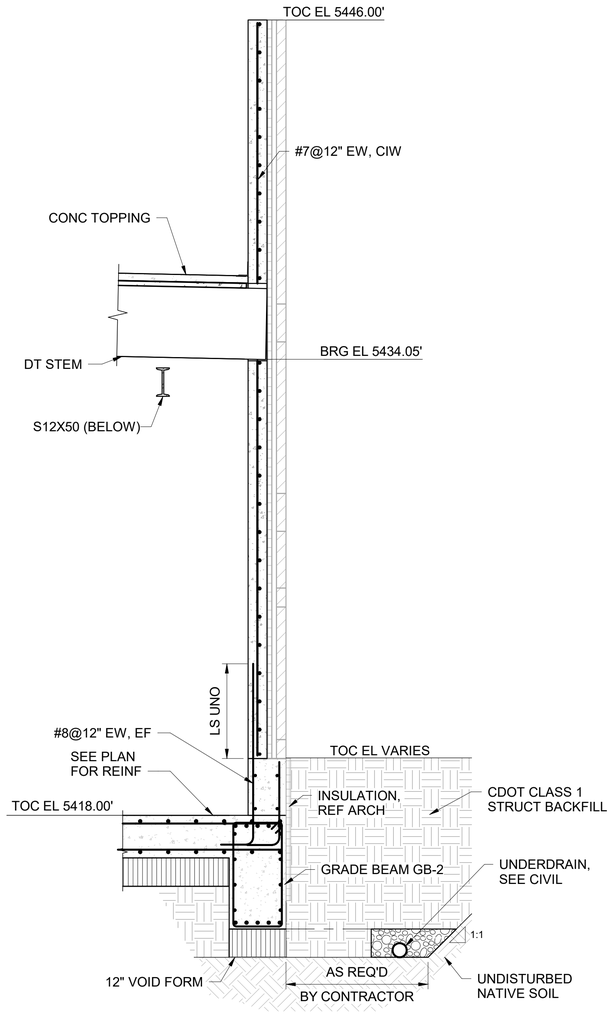
SCALE IN FEET



DETAIL J 1S-101

0 2' 4' 6'

SCALE IN FEET

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION SECTIONS III

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drawing **1S-302** — rev. **1**

sheet of sheets

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 05/08/2025 PROFESSIONAL ENGINEER

Millimeters

Inches

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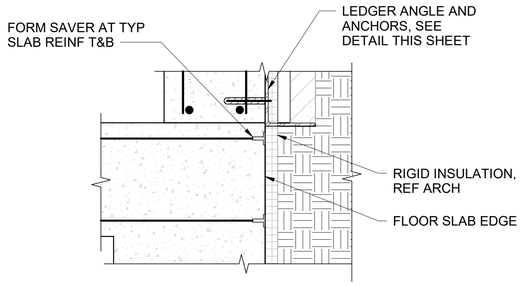
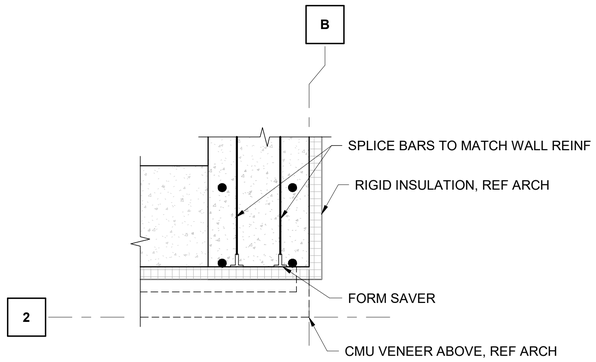


NOTE: VERTICAL WALL DOWELS AND SLAB REINFORCING HIDDEN FOR CLARITY.

DETAIL 1 / 1S-301

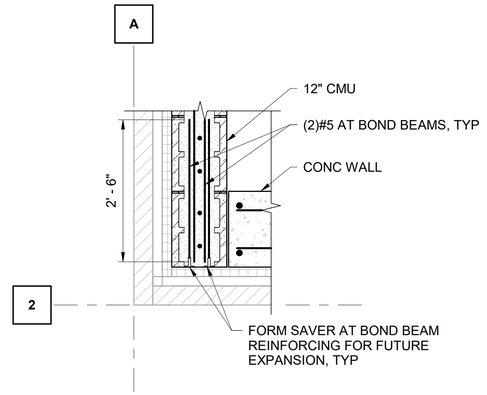
0 1/2' 1' 2'
SCALE IN FEET



NOTE: WALL REINFORCING HIDDEN FOR CLARITY.

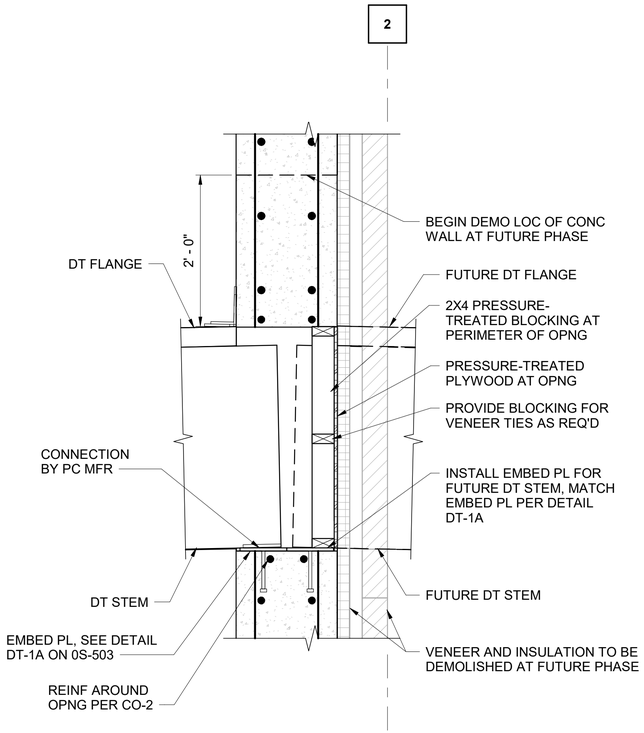
DETAIL 2 / 1S-101

0 1/2' 1' 2'
SCALE IN FEET



DETAIL 3 / 1S-101

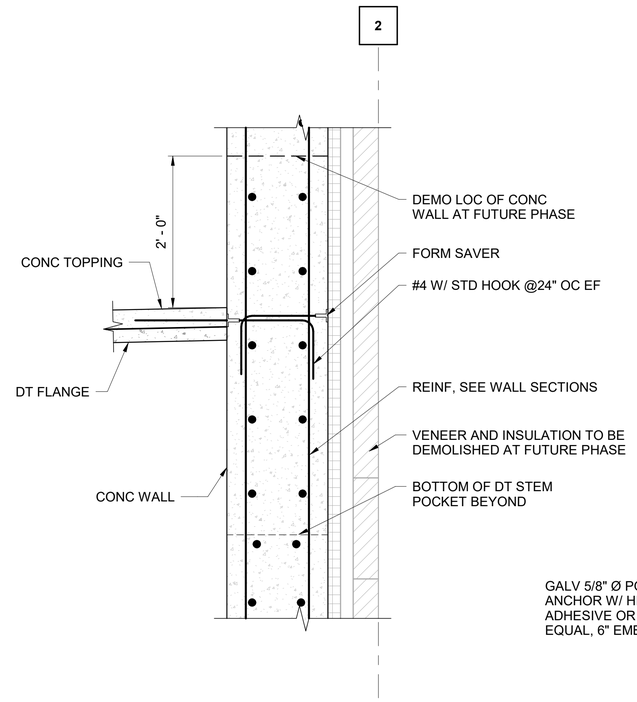
0 1' 2' 3'
SCALE IN FEET



NOTE: DETAIL IS TYPICAL AT SOUTH DT BEAM POCKETS.

DETAIL 4 / 1S-301

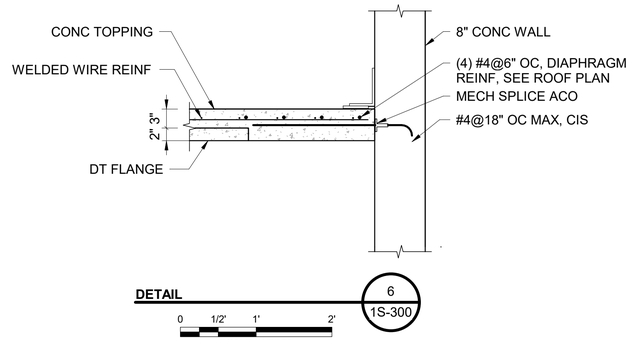
0 1' 2' 3'
SCALE IN FEET



NOTE: DETAIL IS TYPICAL BETWEEN SOUTH DT BEAM POCKETS.

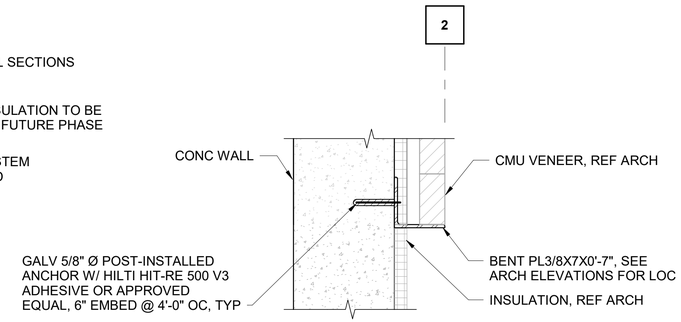
DETAIL 5 / 1S-102

0 1/2' 1' 2'
SCALE IN FEET



DETAIL 6 / 1S-300

0 1/2' 1' 2'
SCALE IN FEET



DETAIL 7 / 1S-301

0 1/2' 1' 2'
SCALE IN FEET

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BROOMFIELD TANKS AND PUMP STATION

PUMP STATION DETAILS I

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drawing **1S-500** — rev. **1**

sheet of sheets

file

COLORADO LICENSED
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PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches

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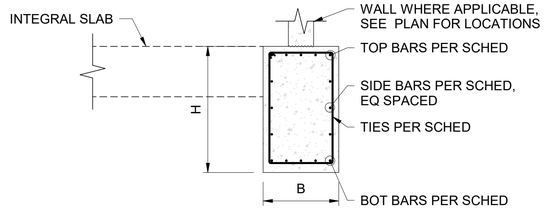
GRADE BEAM SCHEDULE						
TYPE	WIDTH (B)	DEPTH (H)	TOP BARS	BOTTOM BARS	SIDE BARS	TIES
GB-1	2'-0"	3'-0"	(4)-#8	(4)-#8	(3)-#5 EF	#4@8" OC
GB-2	2'-0"	4'-0"	(5)-#8	(5)-#8	(4)-#6 EF	#4@8" OC



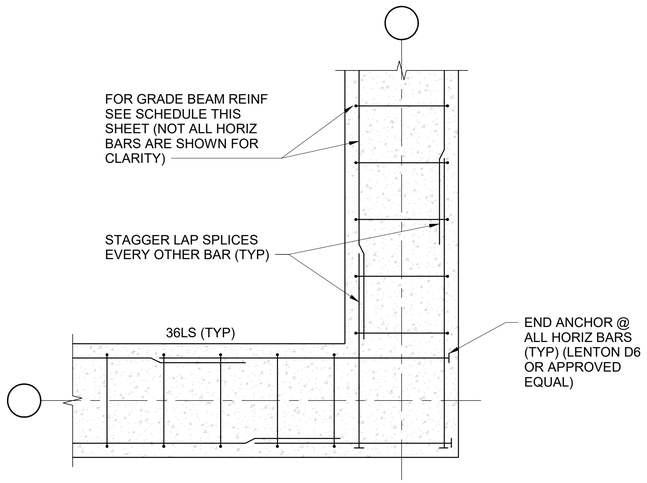
NOTES:
1. PROVIDE TENSION LAP SPLICED REINFORCEMENT WHEN NECESSARY AT THE FOLLOWING LOCATIONS:
   A. TOP BARS: 1/2 SPAN.
   B. BOTTOM BARS: 1/3 SPAN.
   C. SIDE BARS: 1/3 SPAN.
2. WHERE GRADE BEAM WIDTH CHANGES, PROVIDE BENT BARS LAP SPLICED WITH DISCONTINUOUS BARS FROM WIDER GRADE BEAM INTO NARROWER GRADE BEAM.
3. WHERE CONSTRUCTION JOINTS ARE NECESSARY IN GRADE BEAM, LOCATE AT 1/3 SPAN.

GRADE BEAM DETAIL
NOT TO SCALE

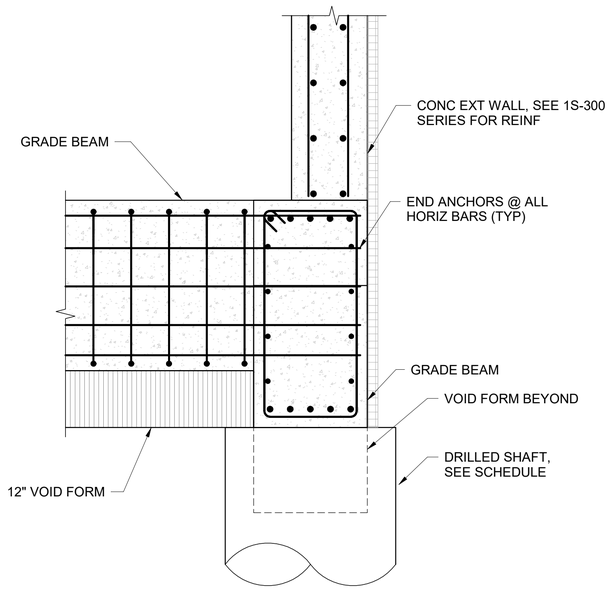
DRILLED SHAFT SCHEDULE							
TYPE	DIAMETER	TOC/SHAFT ELEVATION	TOTAL EMBEDMENT LENGTH (FT)	MINIMUM BEDROCK EMBEDMENT LENGTH (FT)	VERTICAL REINF	TRANSVERSE REINF	REMARKS
1	36"	5416.50'	22	15'-6"	(14)#8	#4 TIES @ 12" OC	
2A	36"	5416.50'	22	15'-6"	(14)#9	#4 TIES @ 12" OC	
2B	36"	5408.00'	20	19'-0"	(14)#9	#4 TIES @ 12" OC	
3	24"	5416.50'	22	15'-6"	(14)#8	#3 TIES @ 12" OC	
4	24"	5405.83'	22	15'-6"	(14)#8	#3 TIES @ 12" OC	

DRILLED SHAFT NOTES:

1. BASE OF SHAFT ELEVATIONS WILL VARY. EXTEND REINFORCEMENT FULL DEPTH OF SHAFT.
2. BOTH SPECIFIED ROCK SOCKET AND MINIMUM EMBEDMENT LENGTH PER SCHEDULE AND NOTES MUST BE SATISFIED.
3. REPRESENTATIVE FROM GEOTECHNICAL ENGINEER SHALL BE PRESENT FULL TIME DURING DRILLING AND INSTALLING SHAFTS. THE GEOTECHNICAL REPRESENTATIVE SHALL VERIFY THE TOTAL DEPTH OF EMBEDMENT OF EACH SHAFT SO THAT BOTH THE MINIMUM TOTAL EMBEDMENT AND MINIMUM ROCK SOCKET ARE ATTAINED.
4. IF THE GEOTECHNICAL REPRESENTATIVE REQUIRES INCREASE IN TOTAL EMBEDMENT LENGTH TO ATTAIN THE MINIMUM ROCK SOCKET, THE REINFORCING CAGE SHALL BE EXTENDED TO INCLUDE THE ADDITIONAL DEPTH IF GREATER THAN 2FT. REINFORCING CAGE EXTENSION SHALL USE STANDARD LAP SPLICES AS INDICATED ON 0S-500.
5. THE FULL LENGTH OF BEDROCK PENETRATION IN ALL SHAFT HOLES SHALL BE ARTIFICIALLY ROUGHED USING HORIZONTAL GROVES. MINIMUM GROOVE HEIGHT IS 3" AND MINIMUM GROVE DEPTH IS 2". HORIZONTAL GROVES SHALL BE VERTICALLY SPACED AT 1.5' ON CENTER.
6. WHERE NOTED IN THE DRILLED SHAFT SCHEDULE, IF CLAYSTONE BEDROCK IS NOT PRESENT AT THE T/SHAFT LOCATION, CONTACT THE ENGINEER FOR MODIFIED EMBEDMENT CRITERIA.
7. REFER TO SPEC SECTION 31 63 29 FOR ADDITIONAL REQUIREMENTS FOR DRILLED SHAFT INSTALLATION.
8. AT CORNERS AND EDGE LOCATIONS HOOK SHALL BE REPLACED WITH LENTON TERMINATOR D6 OR APPROVED EQUAL.
9. DRILLED SHAFT TYPES 3 AND 4 ARE SUPPORTING DELEGATED DESIGN EQUIPMENT OR PRECAST STRUCTURES TO BE REVIEWED DURING THE SUBMITTAL PHASE. DRILLED SHAFT DESIGN IS SUBJECT TO CHANGE DURING SUBMITTAL PHASE AS REQUIRED TO CONFORM TO FINAL APPROVED SUBMITTAL.
10. PROVIDE DOWELS FROM PIERS INTO CONCRETE SLAB OR GRADE BEAM. COORDINATE DOWELS LOCATIONS IN PIERS WITH SLABS OR GRADE BEAMS.

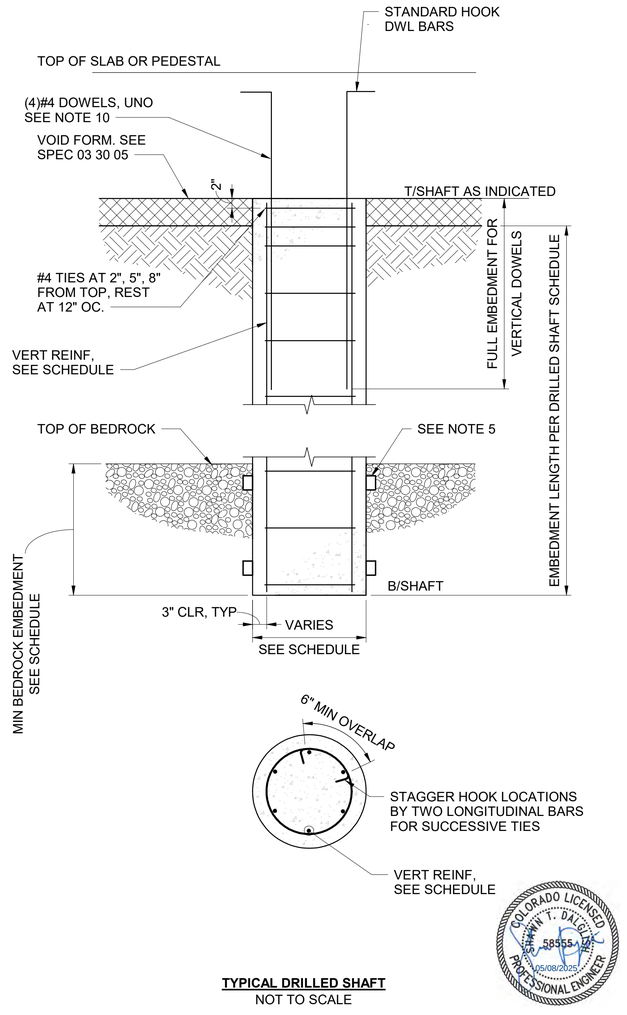


GRADE BEAM CORNER DETAIL
NOT TO SCALE



NOTE: SLAB REBAR, WALL DOWELS, AND DRILLED SHAFT REINFORCEMENT HIDDEN FOR CLARITY.

GRADE BEAM END DETAIL
NOT TO SCALE



TYPICAL DRILLED SHAFT
NOT TO SCALE

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION DETAILS II

project	contract
135303	

drawing	rev.
1S-501	1

sheet of sheets
file

COLORADO LICENSED
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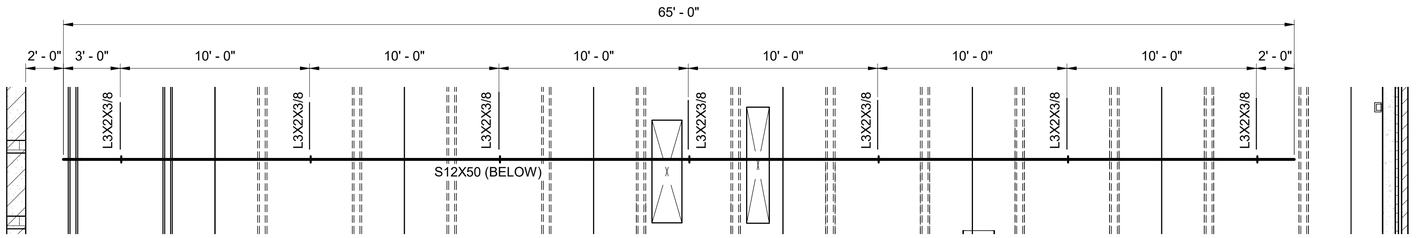
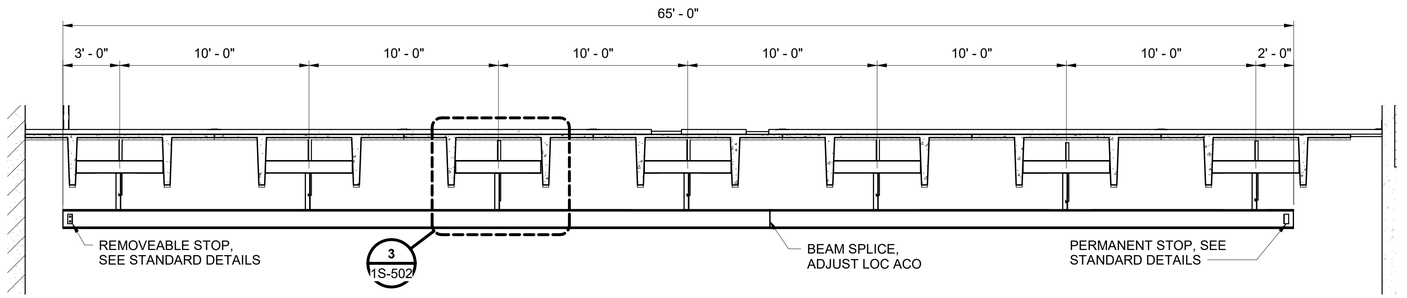


BRIDGE CRANE PLAN 1 / 1S-102

0 2' 4' 8'

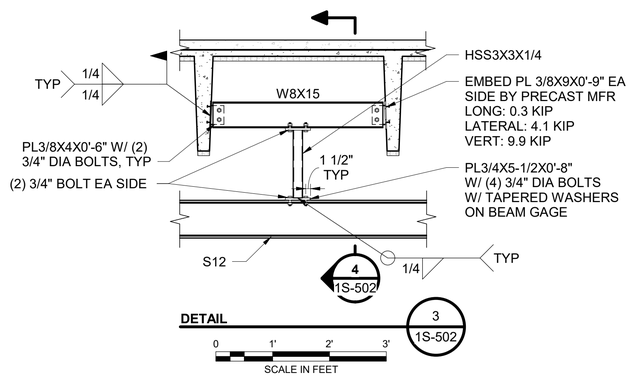
SCALE IN FEET



BRIDGE CRANE ELEVATION

0 2' 4' 8'

SCALE IN FEET



DETAIL 3 / 1S-502

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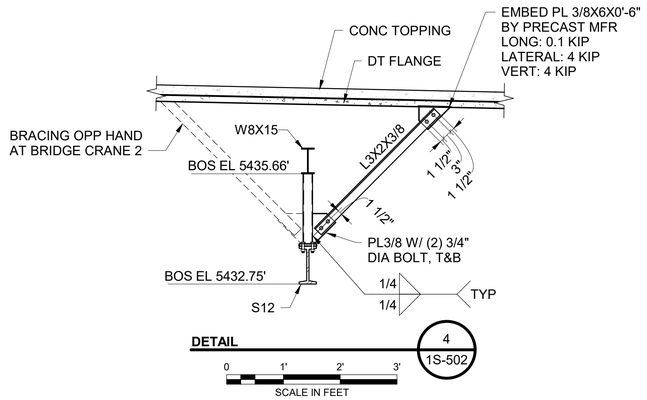
SCALE IN FEET



DETAIL 4 / 1S-502

0 1' 2' 3'

SCALE IN FEET

STRUCTURAL STEEL

1. ALL DESIGN, FABRICATION, AND ERECTION SHALL BE DONE IN ACCORDANCE WITH THE LATEST EDITION OF THE AISC SPECIFICATIONS, THE AWS CODE, AND THE OSHA STANDARDS.
2. STEEL GRADES:
   - STRUCTURAL WIDE FLANGE SHAPES: ASTM A992, GRADE 50
   - STRUCTURAL PIPE: ASTM A53, GRADE B
   - HSS SQUARE & ROUND SHAPES: ASTM A500, GRADE C
   - PLATES AND BARS: ASTM A36
   - OTHER STRUCTURAL SHAPES: ASTM A36
3. UNLESS NOTED OTHERWISE, PRIMARY BOLTED CONNECTIONS SHALL BE BEARING TYPE USING HIGH-STRENGTH BOLTS CONFORMING TO ASTM F3125 GRADE A325 WITH NUTS CONFORMING TO ASTM A563, GRADE DH. SIZE OF BOLTS SHALL BE 3/4"Ø UNLESS OTHERWISE NOTED ON THE DRAWINGS AND SHALL HAVE ONE PLAIN HARDENED WASHER. BOLT AND NUT THREADS SHALL BE LUBRICATED. PRIMARY BOLTED CONNECTIONS SHALL CONFORM TO AISC "SPECIFICATIONS FOR STRUCTURAL JOINTS USING HIGH STRENGTH BOLTS".
4. ALL PRIMARY CONNECTIONS SHALL HAVE A MINIMUM OF 2 BOLTS, UNO.
5. WELDING ELECTRODES SHALL BE SERIES E70XX CONFORMING TO THE AMERICAN WELDING SOCIETY SPECIFICATIONS A5.1 OR A5.5
6. ERECTION BOLTS, COLUMN BASE PLATE SHIMS AND TEMPORARY FASTENINGS REQUIRED FOR ERECTION SHALL BE FURNISHED BY THE STEEL ERECTOR.
7. MINIMUM BOLT HOLE EDGE DISTANCE SHALL BE MAINTAINED PER TABLE J3.4
8. AXIALLY STRESSED MEMBERS MEETING AT A POINT SHALL HAVE THEIR GRAVITY AXIS MEET AT A POINT (UNO).
9. SUBSTITUTIONS OF SPECIFIED MEMBER SIZE OR CHANGE IN DETAILS OR DIMENSIONS OF ANY KIND SHALL NOT BE PERMITTED WITHOUT PRIOR WRITTEN APPROVAL OF THE ENGINEER.
10. FIELD BURNING AND CUTTING IS NOT PERMITTED EXCEPT BY THE SPECIFIC APPROVAL OF THE FIELD ENGINEER.
11. THE CONTRACTOR SHALL PROVIDE ADDITIONAL GUYS AND BRACING DURING CONSTRUCTION TO RESIST STRESSES DUE TO WIND LOADS, PILES OF MATERIAL, OR ERECTION LOADS.
12. ALL EXPOSED STEEL SHALL BE COATED PER SYSTEM D-1 IN SPECIFICATION SECTION 09 90 00, UNO.

BRIDGE CRANE NOTES:

1. PROVIDE 3-TON UNDERHUNG SINGLE GIRDER BRIDGE CRANE PER SPECIFICATION 41 22 00.
   A. BASIS OF DESIGN: HARRINGTON MODEL NO. CUML/S/H-3-0335
   B. BRIDGE CRANE SHALL BE COATED PER MANUFACTURER'S STANDARD AND PER SPECIFICATION 41 22 00. COLOR TO BE SAFETY YELLOW.
2. CONTRACTOR SHALL SUBMIT TO THE ENGINEER FOR REVIEW ALL APPLICABLE EQUIPMENT REACTION LOADS FROM THE BRIDGE CRANE APPLIED TO THE SUPPORTING STRUCTURE.
   A. DOUBLE TEES SHALL BE DESIGNED FOR BRIDGE CRANE LONGITUDINAL AND LATERAL LOADS PER THIS SHEET AND LOADS SPECIFIED ON SHEET 1S-103.

no.	date	by	ckd	description
0	01/28/25	STD	JJZ	ISSUED FOR CONSTRUCTION
1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION BRIDGE CRANE DETAILS

project	contract
135303	

drawing 1S-502 — **rev.** 1

sheet **of** **sheets**

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 PROFESSIONAL ENGINEER 05/08/2025

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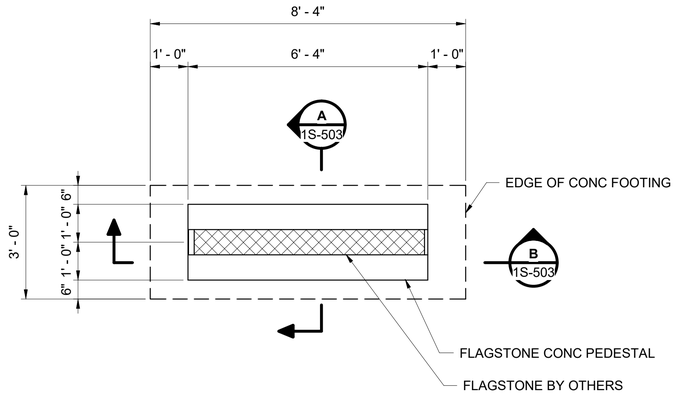
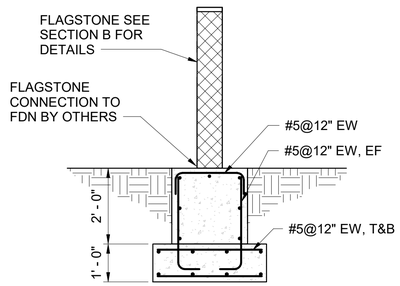


FLAGSTONE PLAN

0 1' 2' 4'
SCALE IN FEET



SECTION A 1S-503

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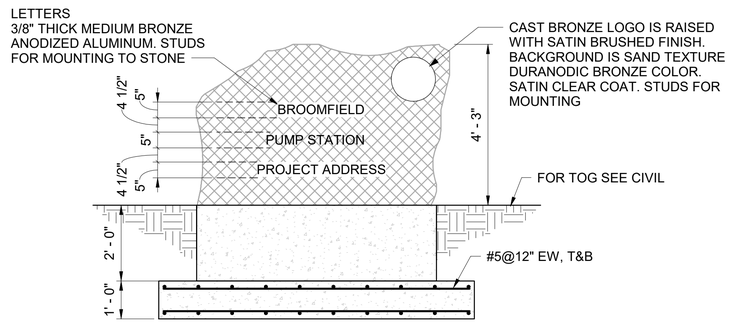
SCALE IN FEET



SECTION B 1S-503

0 1' 2' 4'
SCALE IN FEET

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date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

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FLAGSTONE SIGN PLAN & DETAILS

project	contract
135303	

drawing 1S-503 — **rev.** 1

sheet **of** **sheets**

file

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S. T. DALGLISH
58555
05/08/2025

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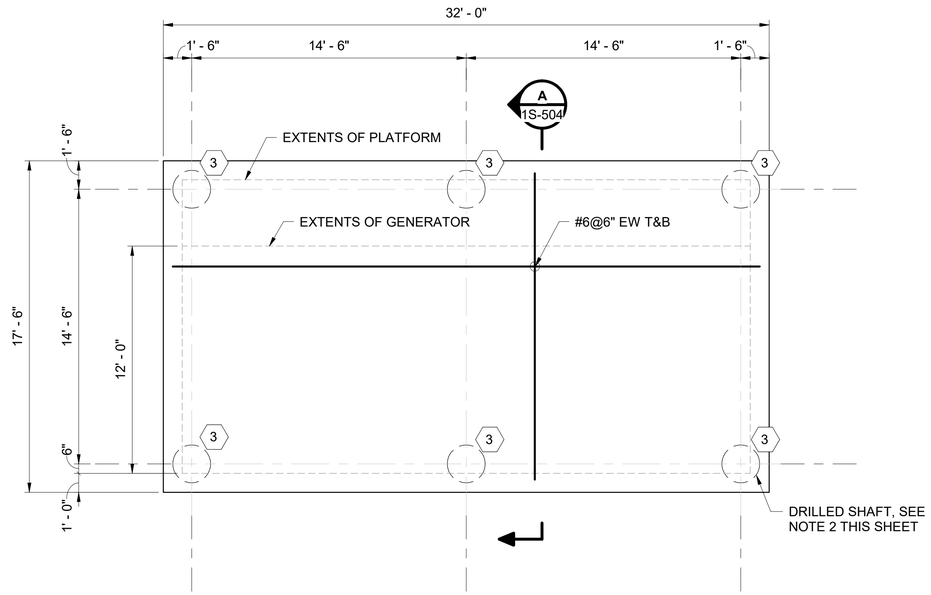
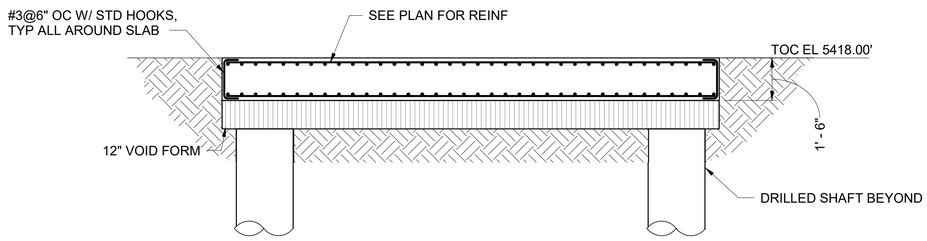


POTABLE WATER GENERATOR SLAB

0 2' 4' 8'
SCALE IN FEET

NORTH



SECTION A 1S-504

0 2' 4' 8'
SCALE IN FEET

STRUCTURAL DESIGN LOADING/CRITERIA:

VALUES BELOW ARE SPECIFIC TO THE GENERATOR FOUNDATION. FOR GENERAL VALUES THAT ARE SIMILAR FOR ALL STRUCTURES ON THE PROJECT REFER TO 0S-003.

1. DEAD LOADS
   A. SELF-WEIGHT OF MATERIALS OF CONSTRUCTION
   B. WEIGHT OF FIXED SERVICE EQUIPMENT
      a. AS INDICATED ON THE STRUCTURAL DRAWINGS FOR EQUIPMENT WEIGHING IN EXCESS OF 300 LBS. FRAMING AND FOUNDATIONS ARE DESIGNED FOR EQUIPMENT WHICH SATIFIES THE CONTRACT SPECIFICATIONS.
      b. IF EQUIPMENT FURNISHED IS HEAVIER THAN THE WEIGHTS INDICATED, OR REQUIRES STRUCTURAL CHANGES FOR ANY OTHER REASON, PROVIDE ENGINEERING DESIGN CALCULATIONS AND ADDITIONAL STRUCTURAL WORK NECESSARY TO SUPPORT ALL LOADS IN ACCORDANCE WITH THE DESIGN STANDARDS SPECIFIED ABOVE, AT NO ADDITIONAL COST TO THE OWNER AND WITH NO INCREASE IN CONTRACT TIME.
   C. ELECTRICAL GENERATORS
      a. POTABLE WATER GENERATOR.....80,000 LBS
2. LIVE LOADS
   A. STAIRS, WALKWAYS, PLATFORMS.....100 PSF, UNIFORM
      300 LBS, CONCENTRATED
3. SNOW LOAD
   A. THERMAL FACTOR (Ct).....1.2 (OPEN AIR STRUCTURES)
4. SEISMIC DESIGN FOR NON-STRUCTURAL COMPONENTS
   A. HORIZONTAL DESIGN SEISMIC FORCE.....7.9 KIP
   B. COMPONENT RESPONSE FACTOR (R_P).....2.5 KIP

FOUNDATION NOTES:

1. DEEP FOUNDATION AND SLAB DESIGN IS BASED ON ESTIMATED DEAD LOAD AND SIZES PRIOR TO SUBMITTAL APPROVAL OF THE ELECTRICAL GENERATORS. SIZE ASSUMPTIONS ARE PROVIDED BELOW. DEEP FOUNDATION DESIGN SHALL BE VERIFIED DURING THE SUBMITTAL PHASE IN ACCORDANCE WITH NOTE 1.b. IN THE STRUCTURAL DESIGN CRITERIA NOTES ABOVE. CENTER OF GRAVITY FOR DESIGN WAS ASSUMED TO BE AT THE CENTER OF THE AREA.
   A. POTABLE WATER GENERATOR: 359 IN (L) x 144 IN (W) x 147 IN (H)
2. SEE SHEET 1S-501 FOR DRILLED SHAFT TYPE AND DETAILS.

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date	detailed
MAY 2025	S. DALGLISH
designed	**checked**
S. DALGLISH	J .KIENHOLZ

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BROOMFIELD TANKS AND PUMP STATION

GENERATOR SLAB FOUNDATION PLAN

project	contract
135303	

drawing 1S-504 — **rev.** 1

sheet of **sheets**

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 05/08/2025 PROFESSIONAL ENGINEER

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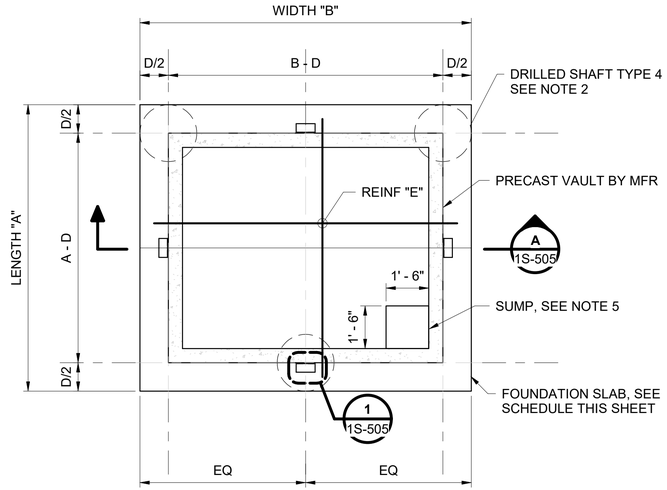
PRECAST VAULT FOUNDATION SCHEDULE												
DRILLED SHAFT SCHEDULE									FOUNDATION SLAB SCHEDULE			
NO.	TYPE	DRILLED SHAFT DIAMETER, D	FOUNDATION SLAB TOC (FT)	TOC/SHAFT ELEVATION (FT)	MIN EMBEDMENT LENGTH (FT)	DRILLED SHAFT LENGTH (FT)	VERTICAL REINF	TRANSVERSE REINF	THICKNESS (IN)	"A" (FT)	"B" (FT)	SLAB REINFORCEMENT "E"
PW-01	VAULT	24"	5407.06	5405.56	15	23	(6)#8	#3 TIES @12" OC	18	13'-8"	12'-0"	#6 @ 6" OC, EW, T&B
PW-02	VAULT	24"	5428.58	5427.08	15	23	(6)#8	#3 TIES @12" OC	18	11'-3"	11'-6"	#6 @ 6" OC, EW, T&B
PW-03	VAULT	24"	5427.08	5425.58	15	23	(6)#8	#3 TIES @12" OC	18	11'-3"	11'-6"	#6 @ 6" OC, EW, T&B
PW-04	OVERFLOW MANHOLE	24"	5416.33	5414.83	15	23	(6)#8	#3 TIES @12" OC	18	11'-0"	-	#6 @ 6" OC, EW, T&B
SW-02	MANHOLE	24"	5413.9	5412.40	15	23	(6)#8	#3 TIES @12" OC	18	11'-0"	-	#6 @ 6" OC, EW, T&B
SW-03	MANHOLE	24"	5398.14	5396.64	15	24	(6)#8	#3 TIES @12" OC	18	9'-0"	-	#6 @ 6" OC, EW, T&B
SW-04	MANHOLE	24"	5379.64	5378.14	15	24	(6)#8	#3 TIES @12" OC	18	9'-0"	-	#6 @ 6" OC, EW, T&B
SW-05	MANHOLE	24"	5347.88	5346.38	15	25	(6)#8	#3 TIES @12" OC	18	9'-0"	-	#6 @ 6" OC, EW, T&B

PRECAST VAULT NOTES:

1. SEE 0S-000 SERIES FOR STANDARD CONCRETE NOTES, DRILLED SHAFT NOTES, AND DRILLED SHAFT DETAILS.
2. SEE PRECAST VAULT SCHEDULE THIS SHEET FOR FOUNDATION SLAB DIMENSIONS, FOUNDATION SLAB REINFORCEMENT, DRILLED SHAFT LENGTH, TOP OF SHAFT ELEVATION, AND DRILLED SHAFT REINFORCING.
3. AT THE CONTRACTOR'S OPTION, PRECAST VAULTS AND MANHOLES MAY BE SUPPORTED ON SHALLOW FOUNDATIONS IF INLET AND OUTLET PIPES OF THE STRUCTURE INCLUDE FLEX COUPLINGS. CONTACT THE ENGINEER PRIOR TO CHANGING FOUNDATION REQUIREMENTS.
4. FOUNDATION SLAB TOP-OF-CONCRETE AND SHAFT ELEVATIONS ARE BASED ON A PRECAST BASE SLAB THICKNESS OF 8 INCHES. ADJUST ELEVATION ACCORDINGLY FOR DIFFERENT PRECAST SLAB THICKNESSES.
5. PRECAST VAULT DESIGN AND FABRICATION BY MANUFACTURER. SEE SPECIFICATION 33 05 61 FOR DETAILS. PRECAST MANUFACTURER SHALL CAST IN SST EMBED PLATES. SEE DETAILS THIS SHEET.
6. SEE PROCESS DRAWINGS FOR LOCATION OF ACCESS HATCHES, ACCESS LADDERS, PIPES, AND PIPE PENETRATIONS.
7. SEE PROCESS DRAWINGS FOR LOCATION OF SUMPS. PROVIDE REINFORCING IN FOUNDATION SLAB PER DETAIL CO-2.



VAULT FOUNDATION PLAN

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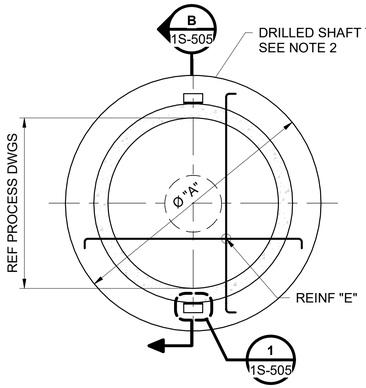
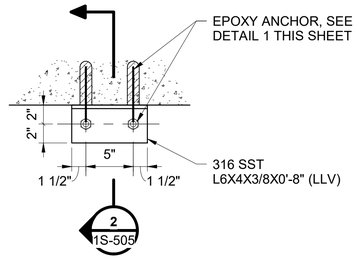
SCALE IN FEET



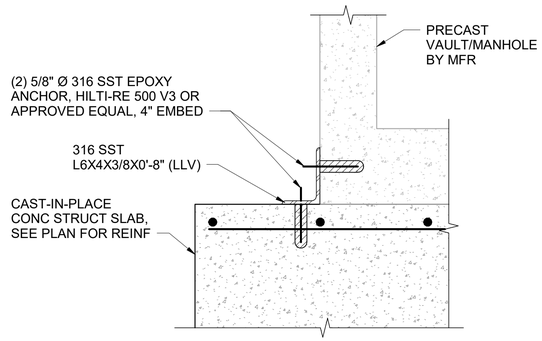
MANHOLE FOUNDATION PLAN

0 2' 4' 6'
SCALE IN FEET



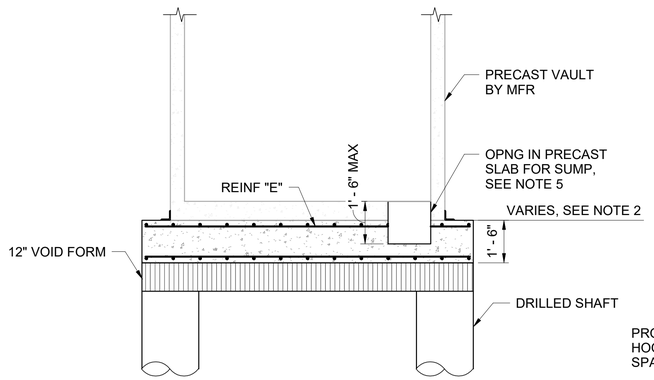
DETAIL 1 / 1S-505

0 1/2" 1' 1 1/2"
SCALE IN FEET



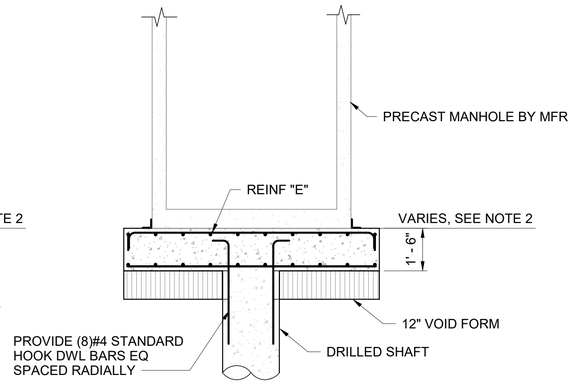
DETAIL 2 / 1S-505

0 1/2" 1' 1 1/2"
SCALE IN FEET



SECTION A / 1S-505

0 2' 4' 6'
SCALE IN FEET



SECTION B / 1S-505

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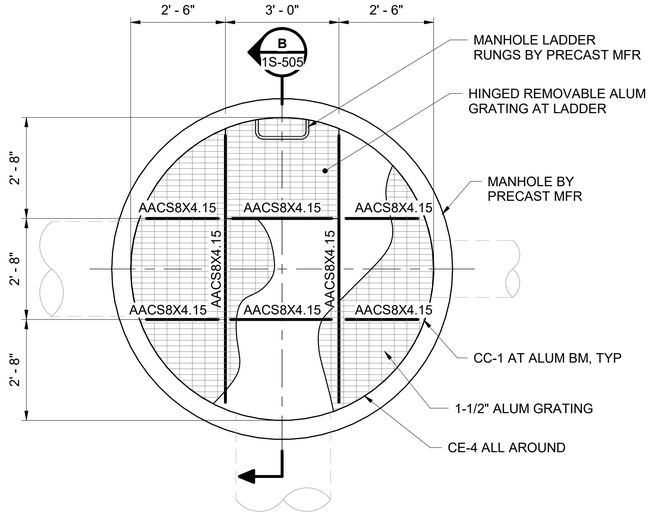
SCALE IN FEET



SW-02 MANHOLE TOP PLAN

0 1' 2' 4'
SCALE IN FEET

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designed	checked
S. DALGLISH	J .KIENHOLZ

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

VAULT FOUNDATION PLAN AND SCHEDULE

project	contract
135303	

drawing **1S-505** rev. **1**

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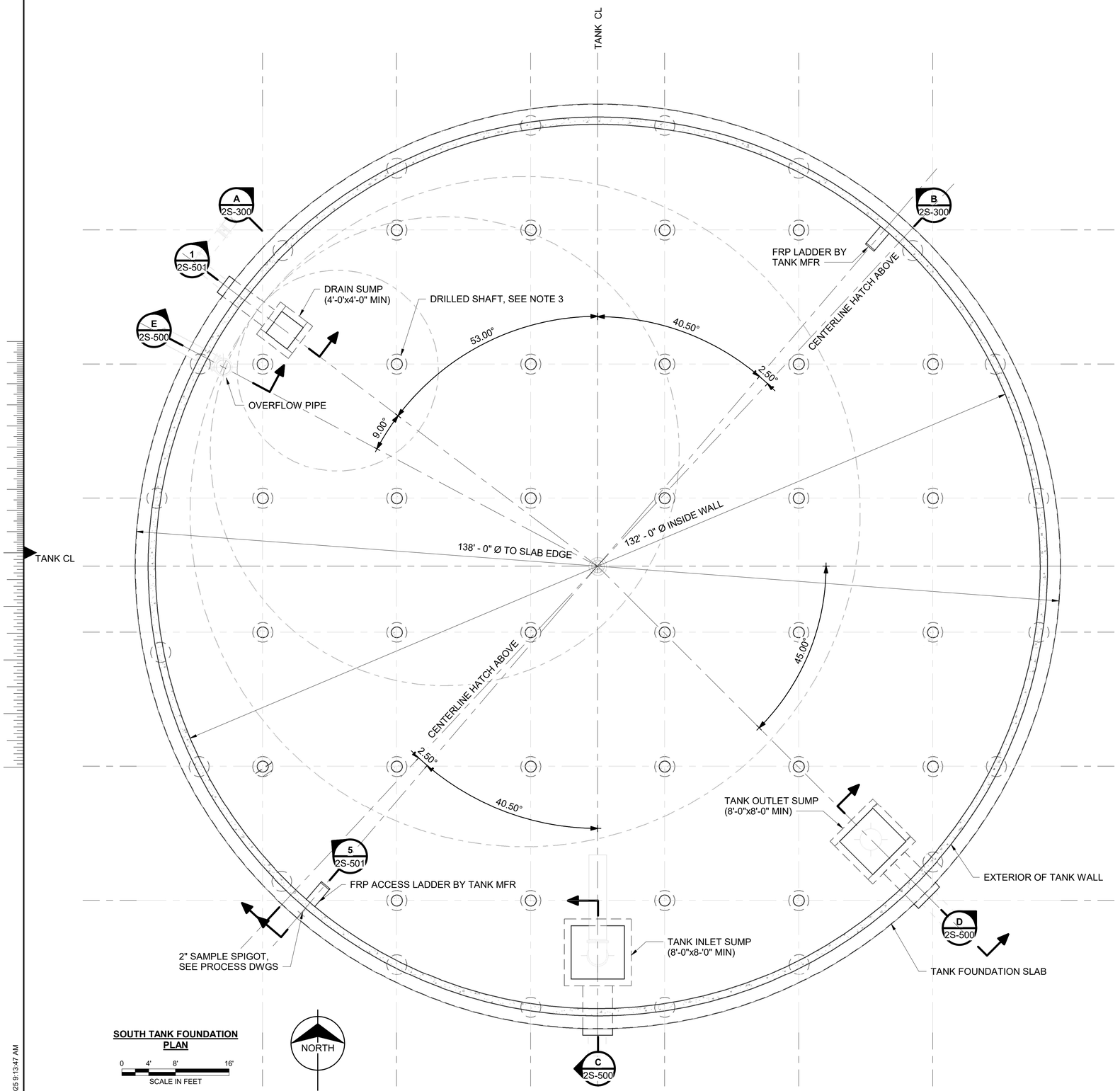

SOUTH TANK FOUNDATION PLAN

SHEET NOTES:

1. WATER STORAGE TANKS ARE A DELEGATED DESIGN SUBMITTAL. TANK SHALL BE AN AWWA D115 POST TENSIONED CONCRETE TANK. ALL LOADS SHALL BE AS REFERENCED ON 0S-003 AND AS REQUIRED FOR DESIGN BY THE TANK MANUFACTURER TO MEET ALL APPLICABLE BUILDING CODES AND STANDARDS.

2. TANK SHALL BE SUPPORTED ON A DEEP FOUNDATION SYSTEM DESIGNED BY THE TANK MANUFACTURER. DRILLED SHAFT SPACING AND SIZE BY THE TANK MANUFACTURER. DESIGN SHALL MEET ALL REQUIREMENTS PROVIDED IN THE SUBSURFACE INFORMATION REPORT.

3. CMGC CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK ASSOCIATED WITH PROVIDING A FINISHED TANK. ANY DETAILS NOT SHOWN ON THESE DRAWINGS SHALL BE THE TANK MFR'S STANDARD AND APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.

POTABLE TANK STRUCTURAL GENERAL NOTES:

1. REFER TO 0S-003 FOR OVERALL PROJECT STRUCTURAL GENERAL NOTES, CODES AND DESIGN STANDARDS.

TANK STRUCTURAL DESIGN LOADING/CRITERIA:

1. DEAD LOADS:
   A. SELF WEIGHT OF MATERIALS OF CONSTRUCTION
   B. WEIGHT OF FIXED SERVICE EQUIPMENT
      a. AS INDICATED ON THE STRUCTURAL DRAWINGS FOR EQUIPMENT WEIGHING IN EXCESS OF 300 LBS. FRAMING AND FOUNDATIONS ARE DESIGNED FOR EQUIPMENT WHICH SATISFIES THE CONTRACT SPECIFICATIONS.
   C. SUPERIMPOSED DEAD LOAD.....VARIES
2. LIVE LOADS:
   A. STAIRS, WALKWAYS, PLATFORMS.....100 PSF, UNIFORM
      300 LB, CONCENTRATED
3. ROOF LIVE LOAD:.....20 PSF
4. SNOW LOADS:
   A. SNOW LOAD IMPORTANCE FACTOR (I_s)..... 1.35
   B. GROUND SNOW LOAD (P_g)..... 30 PSF
   C. FLAT-ROOF SNOW LOAD..... 30 PSF
   D. SNOW EXPOSURE FACTOR (C_e)..... 1.0
   E. THERMAL FACTOR (C_t)..... 1.0
   F. SLOPE FACTOR (C_s)..... 1.0
5. WIND DESIGN DATA:
   A. ULTIMATE DESIGN WIND SPEED (V_{ult}).....142 MPH
   B. NOMINAL DESIGN WIND SPEED (V_{asd}).....110 MPH
   C. EXPOSURE CATEGORY..... C
6. SEISMIC DESIGN DATA:
   A. SEISMIC IMPORTANCE FACTOR (I_e)..... 1.25
   B. MAPPED SPECTRAL RESPONSE PARAMETERS:
      a. S_S.....0.204
      b. S_1.....0.057
   C. SOIL SITE CLASS..... C
   D. DESIGN SPECTRAL RESPONSE PARAMETERS:
      a. S_{DS}.....0.176
      b. S_{D1}.....0.057
   E. SEISMIC DESIGN CATEGORY..... C
   F. RESPONSE MODIFICATION COEFFICIENT(S) (R)....2
7. ROOF RAIN LOAD DATA:
   A. RAIN INTENSITY (i)..... 2.6 (IN/HR)
8. GEOTECHNICAL DATA:
   A. DESIGN LOAD BEARING VALUE.....N/A
9. DEEP FOUNDATIONS - DESIGN PARAMETERS
   A. PROVIDE IN ACCORDANCE WITH CONTRACT DRAWINGS AND SPECIFICATION SECTION 31 63 29 and 31 69 13.
   B. DRILLED SHAFT FOUNDATION SHALL CONFORM TO ACI 336.1 AND 336.3, UNLESS NOTED OTHERWISE.
   C. DESIGN PARAMETERS:
      a. ALLOWABLE END BEARING PRESSURE..... 35,000 PSF
      b. ALLOWABLE SKIN FRICTION.....2,650 PSF FOR PORTION BELOW THE DEPTH OF WETTING
      c. MINIMUM DEAD LOAD PRESSURE.....18,000 PSF
10. FLOOD DESIGN DATA:
    A. FLOOD DESIGN CLASS..... N/A

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

SOUTH POTABLE TANK FOUNDATION PLAN

project	contract
135303	

drawing **2S-100** rev. **1**

sheet of sheets
file

COLORADO LICENSED
MARK T. BAILEY
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PROFESSIONAL ENGINEER

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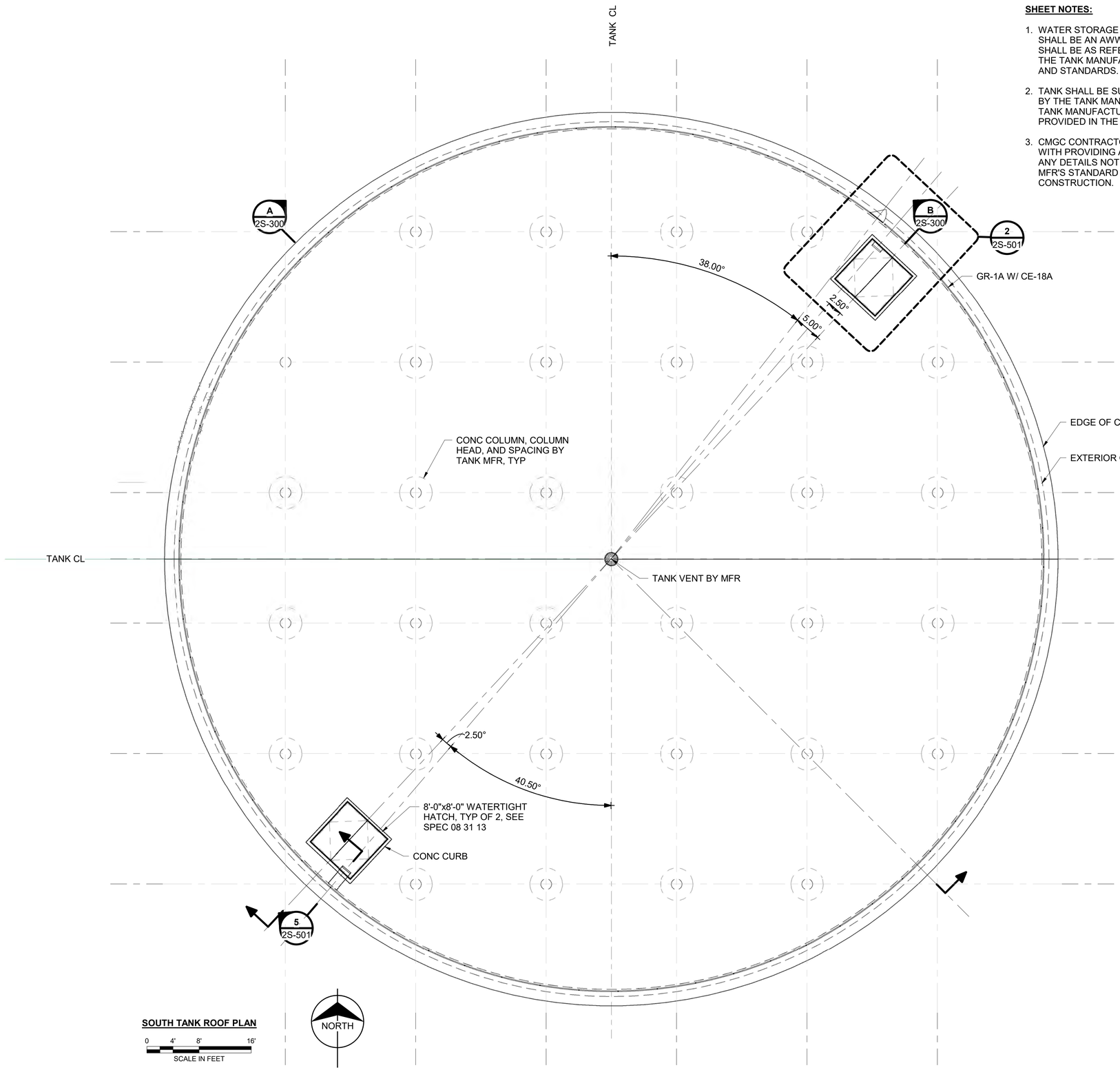

SHEET NOTES:

1. WATER STORAGE TANKS ARE A DELEGATED DESIGN SUBMITTAL. TANK SHALL BE AN AWWA D115 POST TENSIONED CONCRETE TANK. ALL LOADS SHALL BE AS REFERENCED ON 0S-003 AND AS REQUIRED FOR DESIGN BY THE TANK MANUFACTURER TO MEET ALL APPLICABLE BUILDING CODES AND STANDARDS.
2. TANK SHALL BE SUPPORTED ON A DEEP FOUNDATION SYSTEM DESIGNED BY THE TANK MANUFACTURER. DRILLED SHAFT SPACING AND SIZE BY THE TANK MANUFACTURER. DESIGN SHALL MEET ALL REQUIREMENTS PROVIDED IN THE SUBSURFACE INFORMATION REPORT.
3. CMGC CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK ASSOCIATED WITH PROVIDING A FINISHED TANK AND ALL RELATED ASTHETIC FINISHES. ANY DETAILS NOT SHOWN ON THESE DRAWINGS SHALL BE THE TANK MFR'S STANDARD AND APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.

SOUTH TANK ROOF PLAN

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Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: B. MIMIAGA
designed: S. DALGLISH	checked: J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

SOUTH POTABLE TANK ROOF PLAN

project: 135303	contract:

drawing: **2S-101** rev.: **1**

sheet of sheets

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 PROFESSIONAL ENGINEER 05/08/2025

Scale For Microfilming: Millimeters / Inches

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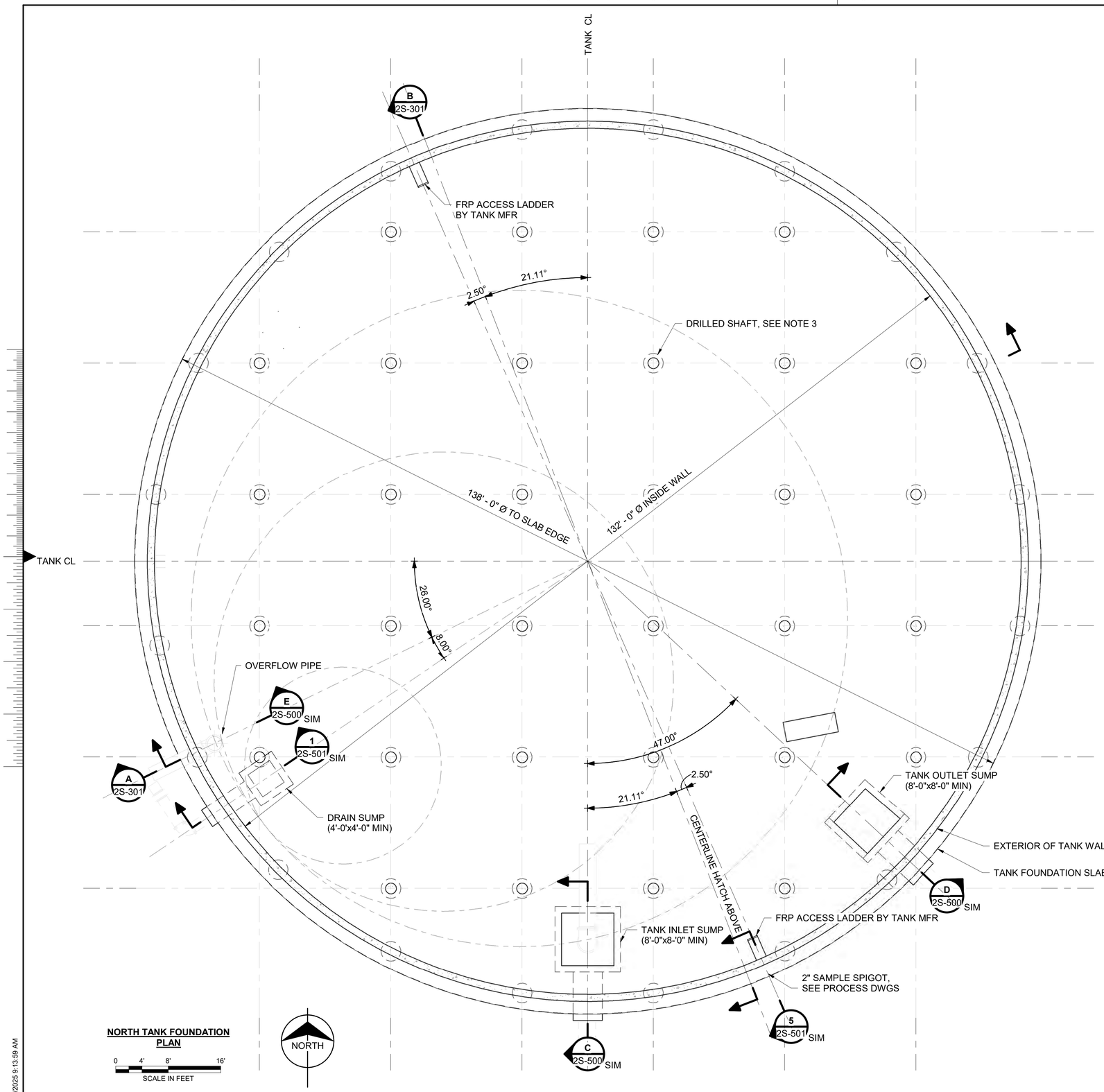
Autodesk Docs://135303_TanksProject/135303_02_S_POT.rvt



NORTH TANK FOUNDATION PLAN

SHEET NOTES:

1. WATER STORAGE TANKS ARE A DELEGATED DESIGN SUBMITTAL. TANK SHALL BE AN AWWA D115 POST TENSIONED CONCRETE TANK. ALL LOADS SHALL BE AS REFERENCED ON 0S-003 AND AS REQUIRED FOR DESIGN BY THE TANK MANUFACTURER TO MEET ALL APPLICABLE BUILDING CODES AND STANDARDS.
2. TANK SHALL BE SUPPORTED ON A DEEP FOUNDATION SYSTEM DESIGNED BY THE TANK MANUFACTURER. DRILLED SHAFT SPACING AND SIZE BY THE TANK MANUFACTURER. DESIGN SHALL MEET ALL REQUIREMENTS PROVIDED IN THE SUBSURFACE INFORMATION REPORT.
3. CMGC CONTRACTOR SHALL BE RESPONSIBLE FOR ALL WORK ASSOCIATED WITH PROVIDING A FINISHED TANK AND ALL RELATED ASTHETIC FINISHES. ANY DETAILS NOT SHOWN ON THESE DRAWINGS SHALL BE THE TANK MFR'S STANDARD AND APPROVED BY THE ENGINEER PRIOR TO CONSTRUCTION.

POTABLE TANK STRUCTURAL GENERAL NOTES:

1. REFER TO 0S-003 FOR OVERALL PROJECT STRUCTURAL GENERAL NOTES, CODES AND DESIGN STANDARDS.

TANK STRUCTURAL DESIGN LOADING/CRITERIA:

1. DEAD LOADS:
   - A. SELF WEIGHT OF MATERIALS OF CONSTRUCTION
   - B. WEIGHT OF FIXED SERVICE EQUIPMENT
     - a. AS INDICATED ON THE STRUCTURAL DRAWINGS FOR EQUIPMENT WEIGHING IN EXCESS OF 300 LBS. FRAMING AND FOUNDATIONS ARE DESIGNED FOR EQUIPMENT WHICH SATISFIES THE CONTRACT SPECIFICATIONS.
   - C. SUPERIMPOSED DEAD LOAD.....VARIES
2. LIVE LOADS:
   - A. STAIRS, WALKWAYS, PLATFORMS.....100 PSF, UNIFORM 300 LB, CONCENTRATED
3. ROOF LIVE LOAD:.....20 PSF
4. SNOW LOADS:
   - A. SNOW LOAD IMPORTANCE FACTOR (I_s)..... 1.35
   - B. GROUND SNOW LOAD (P_g)..... 30 PSF
   - C. FLAT-ROOF SNOW LOAD.....30 PSF
   - D. SNOW EXPOSURE FACTOR (C_e)..... 1.0
   - E. THERMAL FACTOR (C_t).....1.0
   - F. SLOPE FACTOR (C_s)..... 1.0
5. WIND DESIGN DATA:
   - A. ULTIMATE DESIGN WIND SPEED (V_{ult}).....142 MPH
   - B. NOMINAL DESIGN WIND SPEED (V_{asd}).....110 MPH
   - C. EXPOSURE CATEGORY..... C
6. SEISMIC DESIGN DATA:
   - A. SEISMIC IMPORTANCE FACTOR (I_e)..... 1.25
   - B. MAPPED SPECTRAL RESPONSE PARAMETERS:
     - a. S_S.....0.204
     - b. S_1.....0.057
   - C. SOIL SITE CLASS..... C
   - D. DESIGN SPECTRAL RESPONSE PARAMETERS:
     - a. S_{DS}.....0.176
     - b. S_{D1}.....0.057
   - E. SEISMIC DESIGN CATEGORY..... C
   - F. RESPONSE MODIFICATION COEFFICIENT(S) (R)....2
7. ROOF RAIN LOAD DATA:
   - A. RAIN INTENSITY (i)..... 2.6 (IN/HR)
8. GEOTECHNICAL DATA:
   - A. DESIGN LOAD BEARING VALUE.....N/A
9. DEEP FOUNDATIONS - DESIGN PARAMETERS
   - A. PROVIDE IN ACCORDANCE WITH CONTRACT DRAWINGS AND SPECIFICATION SECTION 31 63 29 and 31 69 13.
   - B. DRILLED SHAFT FOUNDATION SHALL CONFORM TO ACI 336.1 AND 336.3, UNLESS NOTED OTHERWISE.
   - C. DESIGN PARAMETERS:
     - a. ALLOWABLE END BEARING PRESSURE.....35,000 PSF
     - b. ALLOWABLE SKIN FRICTION.....2,650 PSF FOR PORTION BELOW THE DEPTH OF WETTING
     - c. MINIMUM DEAD LOAD PRESSURE.....18,000 PSF
10. FLOOD DESIGN DATA:
    - A. FLOOD DESIGN CLASS..... N/A

no.	date	by	ckd	description
0	01/28/25	STD	JJZ	ISSUED FOR CONSTRUCTION
1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: B. MIMIAGA
designed: S. DALGLISH	checked: J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

NORTH POTABLE TANK FOUNDATION PLAN

project	contract
135303	

drawing **2S-102** — rev. **1**

sheet of sheets

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 PROFESSIONAL ENGINEER 05/08/2025

Millimeters
Inches
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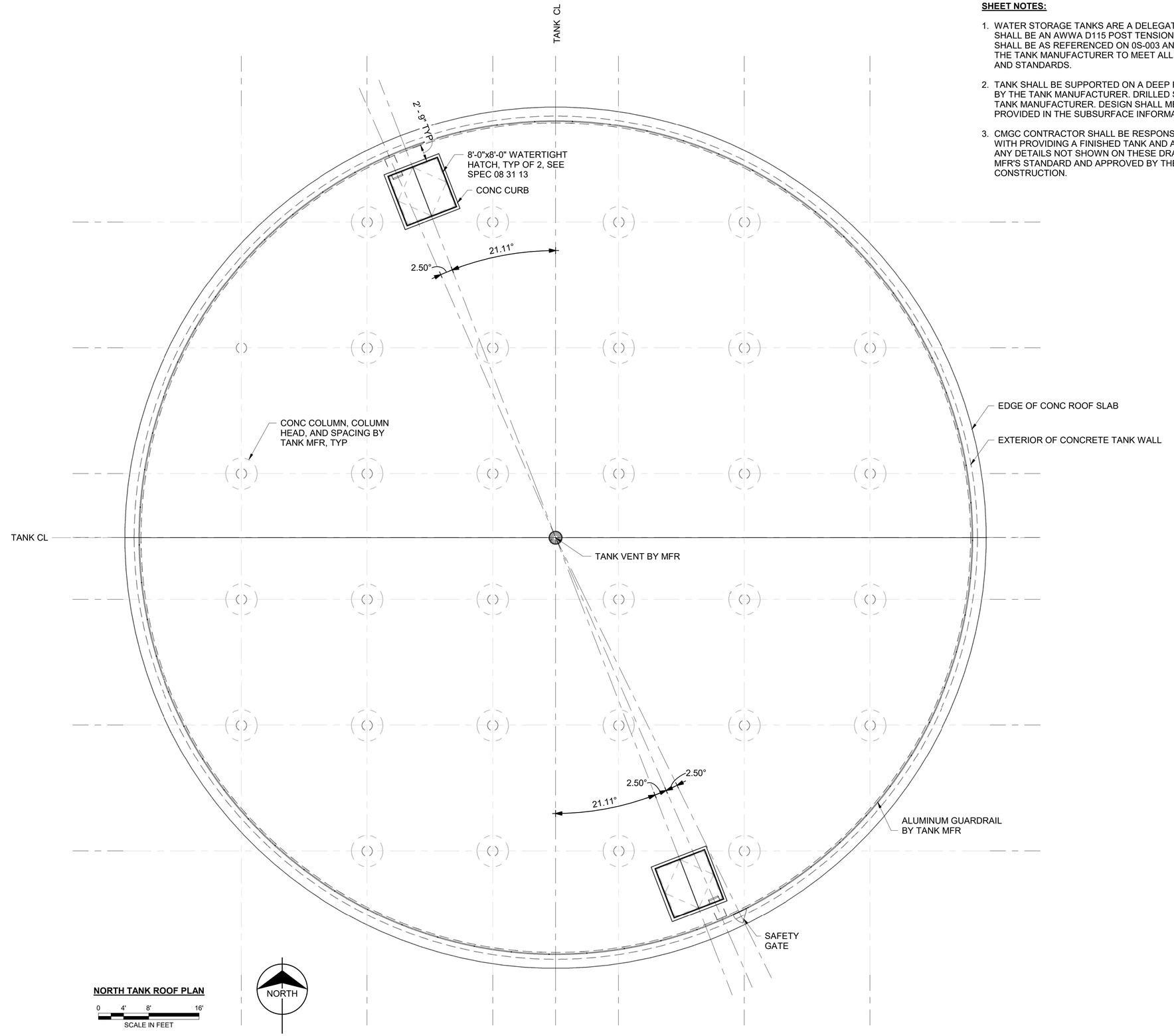

NORTH TANK ROOF PLAN

0 4' 8' 16'

SCALE IN FEET

SHEET NOTES:

1. WATER STORAGE TANKS ARE A DELEGATED DESIGN SUBMITTAL. TANK SHALL BE AN AWWA D115 POST TENSIONED CONCRETE TANK. ALL LOADS SHALL BE AS REFERENCED ON 0S-003 AND AS REQUIRED FOR DESIGN BY THE TANK MANUFACTURER TO MEET ALL APPLICABLE BUILDING CODES AND STANDARDS.
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designed	**checked**
S. DALGLISH	J. ZEMLICKA

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BROOMFIELD TANKS AND PUMP STATION

NORTH POTABLE TANK ROOF PLAN

project	contract
135303	

drawing **2S-103** — **rev.** **1**

sheet of **sheets**

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 PE 05/08/2025 PROFESSIONAL ENGINEER

Millimeters Inches Scale For Microfilming

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SHEET NOTES:

1. SOUTH POTABLE TANK IS SHOWN. NORTH TANK ELEVATION IS SIMILAR. REFER TO CIVIL PLANS FOR LOCATION AND ORIENTATION OF TANKS.
2. DIMENSION MAY VARY SLIGHTLY DEPENDING ON TANK ROOF SLOPE.

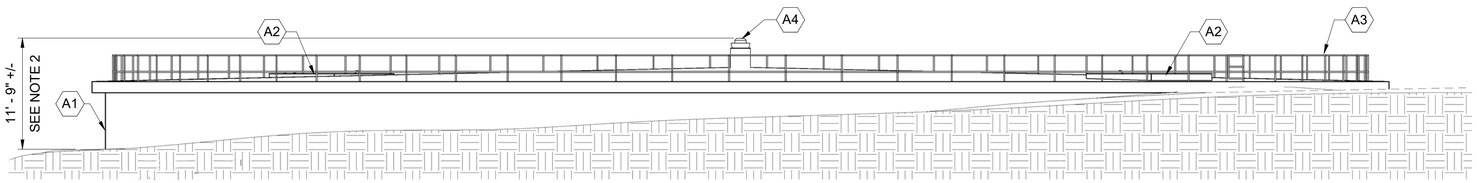
KEYNOTES:

A1 CONCRETE - EXTERIOR STAINED TAN

A2 CLEAR ANODIZED ALUM WATERTIGHT HATCH

A3 CLEAR ANODIZED ALUMINUM HANDRAIL

A4 TANK VENT, SEE DETAIL 6/2S-501



POTABLE TANK ELEVATION

0 4' 8' 16'

SCALE IN FEET

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designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

POTABLE TANK ELEVATION

project	contract
135303	

drawing **2S-200** — **rev.** **1**

sheet **of** **sheets**

file

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Inches

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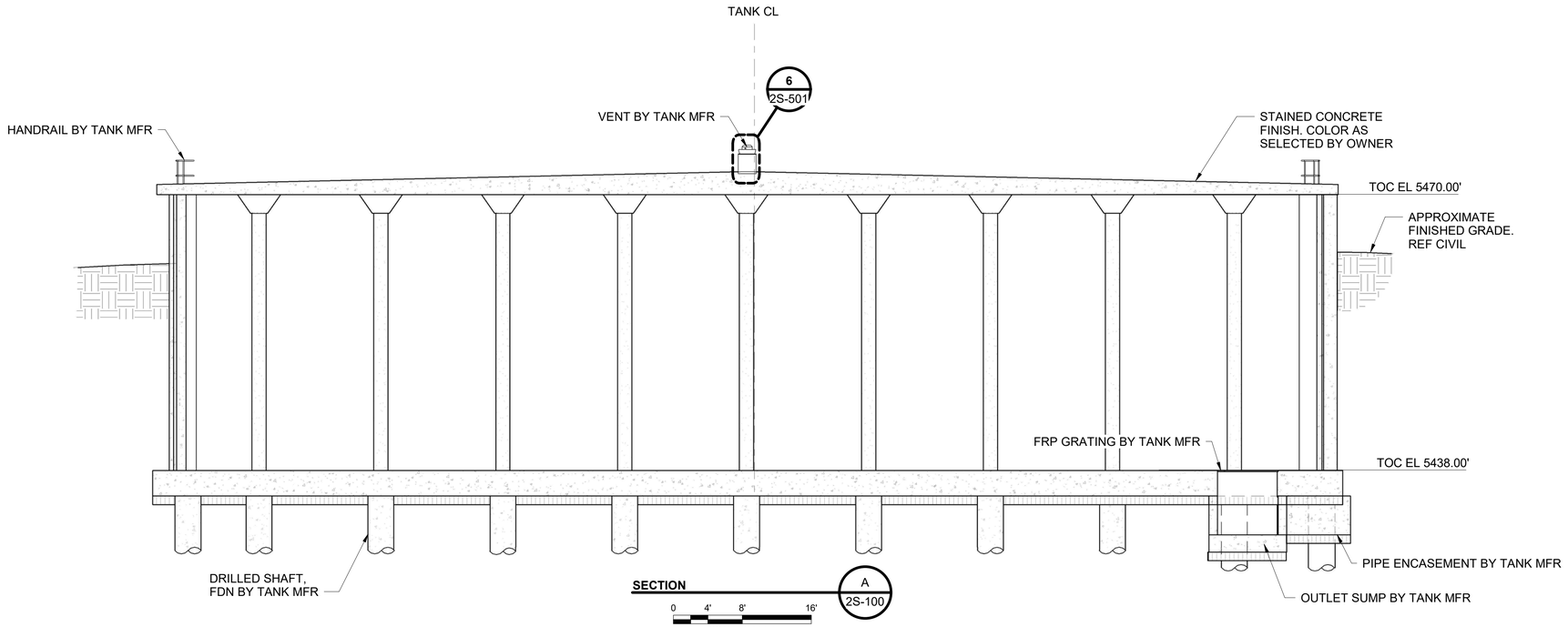

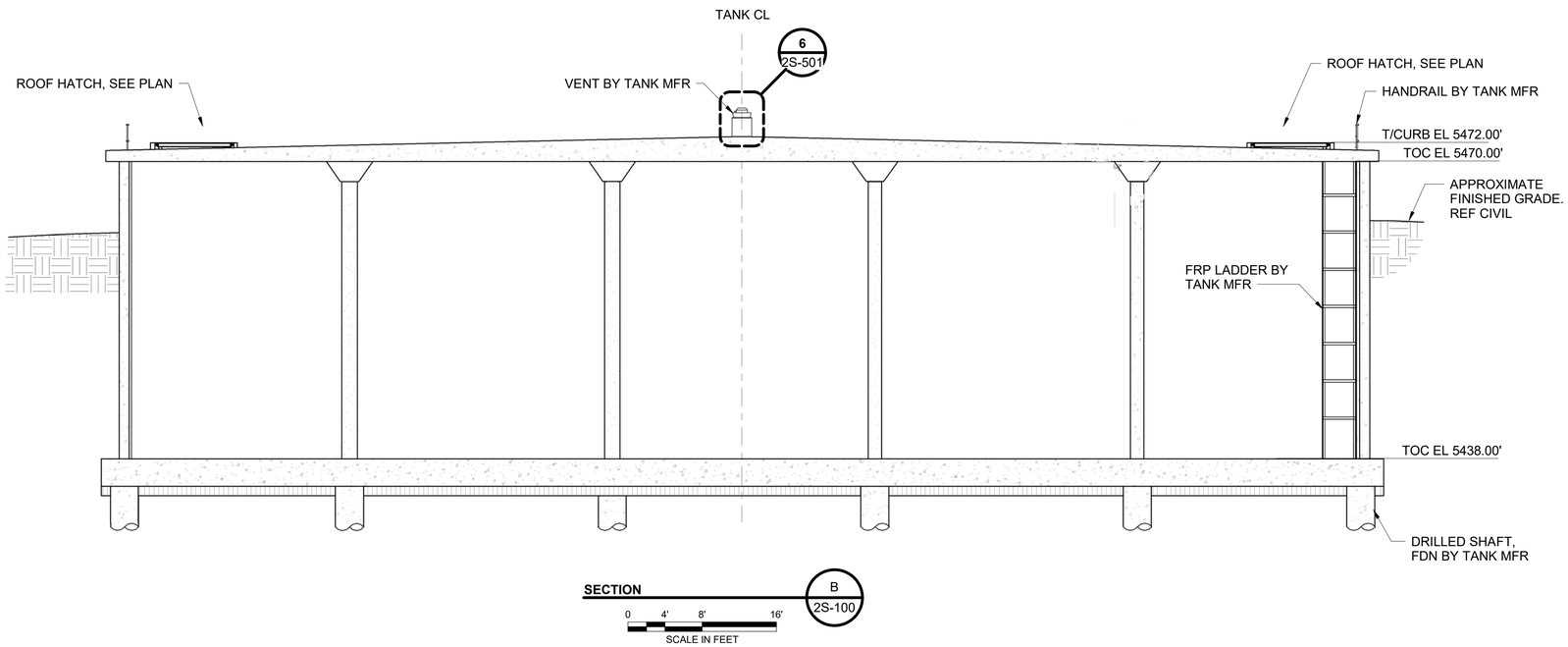

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MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

SOUTH POTABLE TANK SECTIONS

project	contract
135303	

drawing 2S-300 — **rev.** 1

sheet **of** **sheets**

file

COLORADO LICENSED SHAWN T. DALGLISH 58555 PE 05/08/2025 PROFESSIONAL ENGINEER

Millimeters
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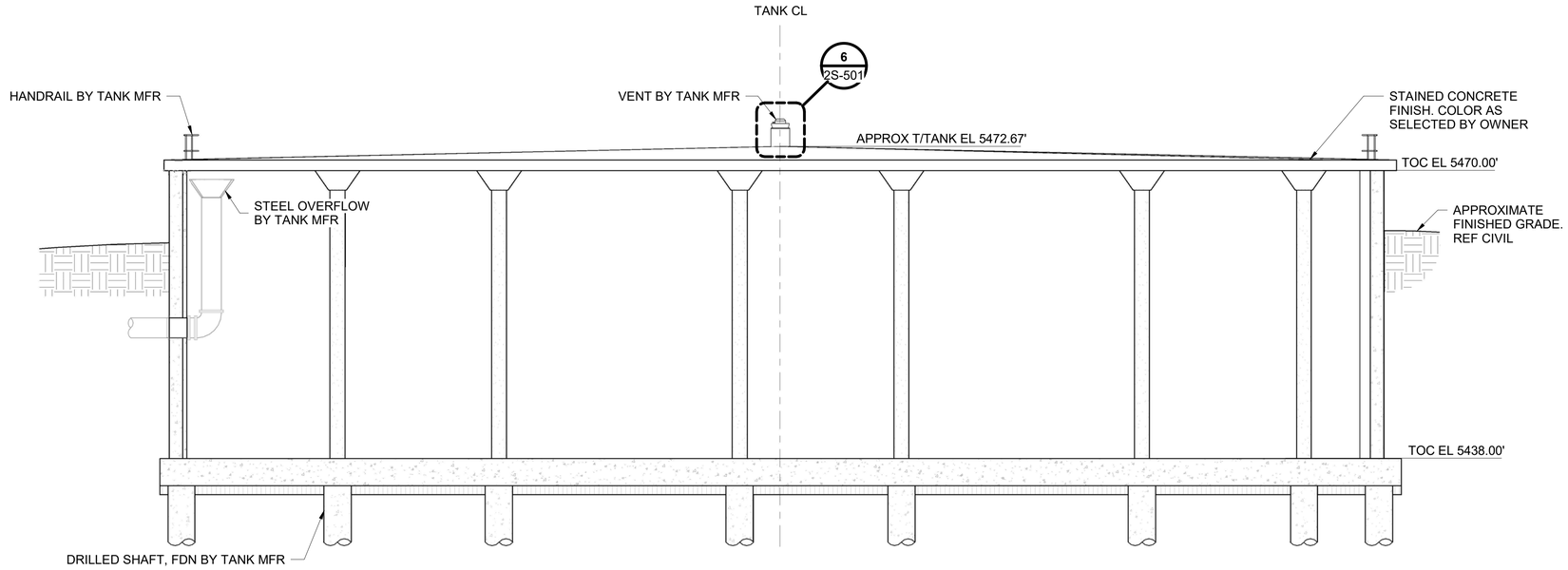

SECTION A 2S-102

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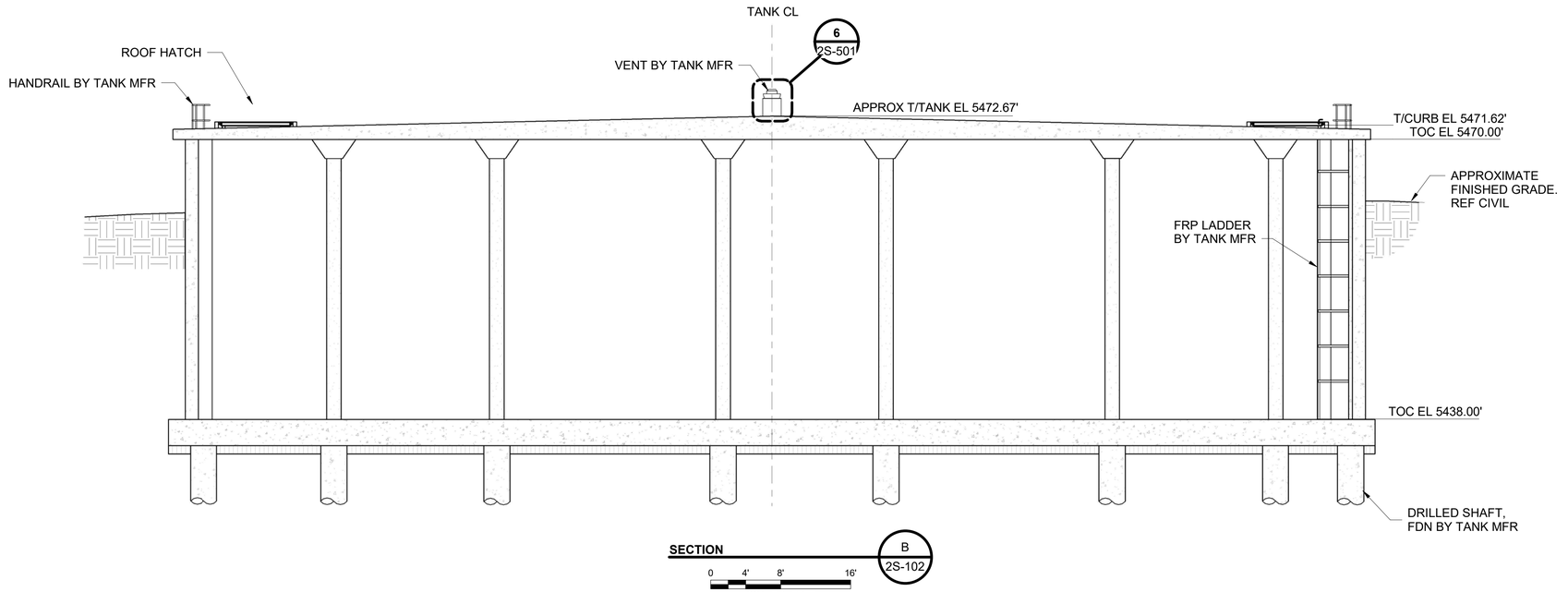

SECTION B 2S-102

0 4' 8' 16'

SCALE IN FEET

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date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

NORTH POTABLE TANK SECTIONS

project	contract
135303	

drawing 2S-301 — **rev.** 1

sheet **of** **sheets**

file

COLORADO LICENSED JAMES J. ZEMLICKA 58555 PE 05/08/2025 PROFESSIONAL ENGINEER

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Inches

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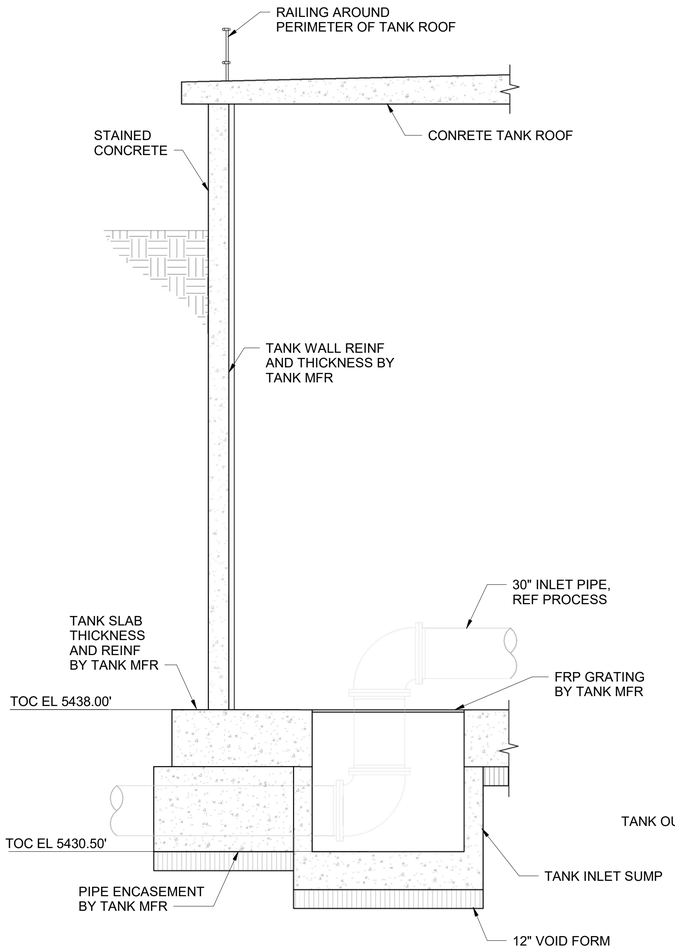

SECTION C 2S-100

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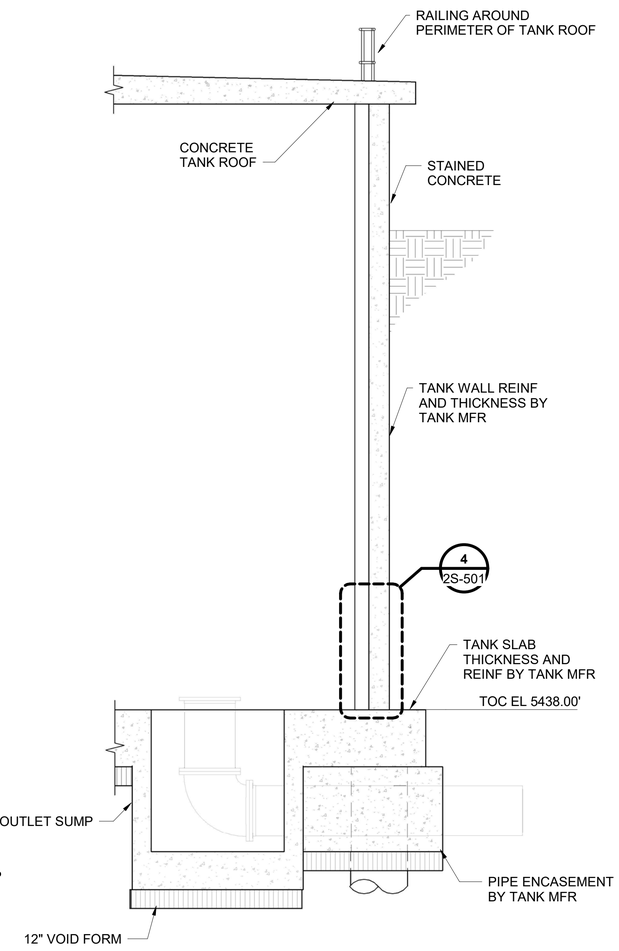

SECTION D 2S-100

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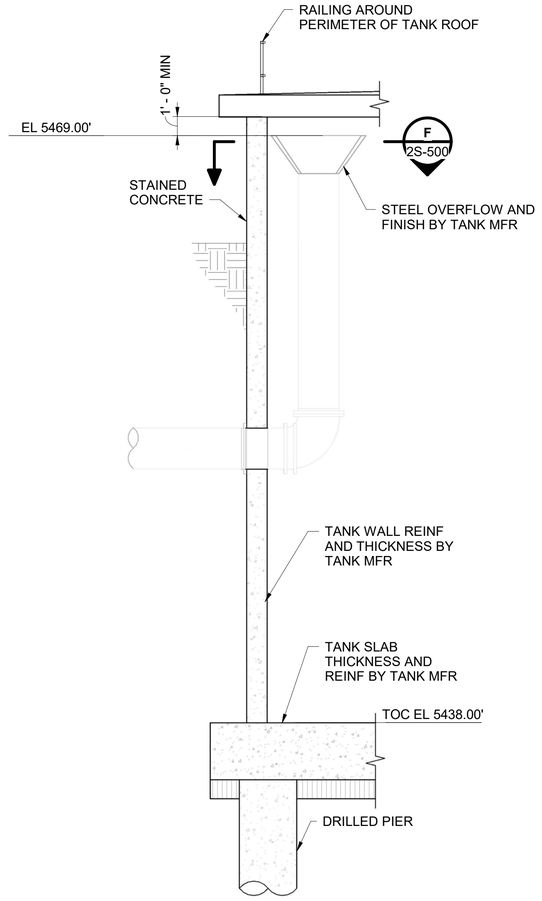

SECTION E 2S-100

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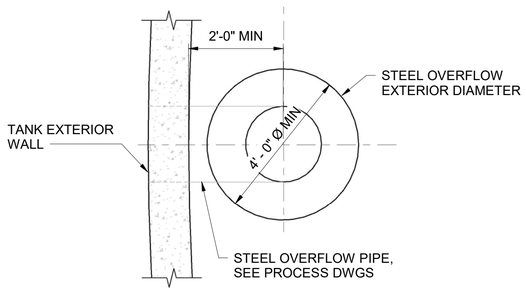

SECTION F 2S-500

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SCALE IN FEET

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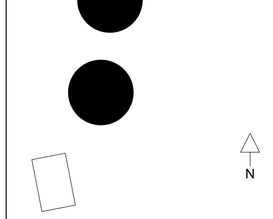

BURNS McDONNELL
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Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	M. NEIL
designed	**checked**
S. DALGLISH	J. ZEMLICKA

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BROOMFIELD TANKS AND PUMP STATION

POTABLE TANK DETAILS I

project	contract
135303	

drawing **2S-500** — **rev.** **1**

sheet **of** **sheets**

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Millimeters

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Inches

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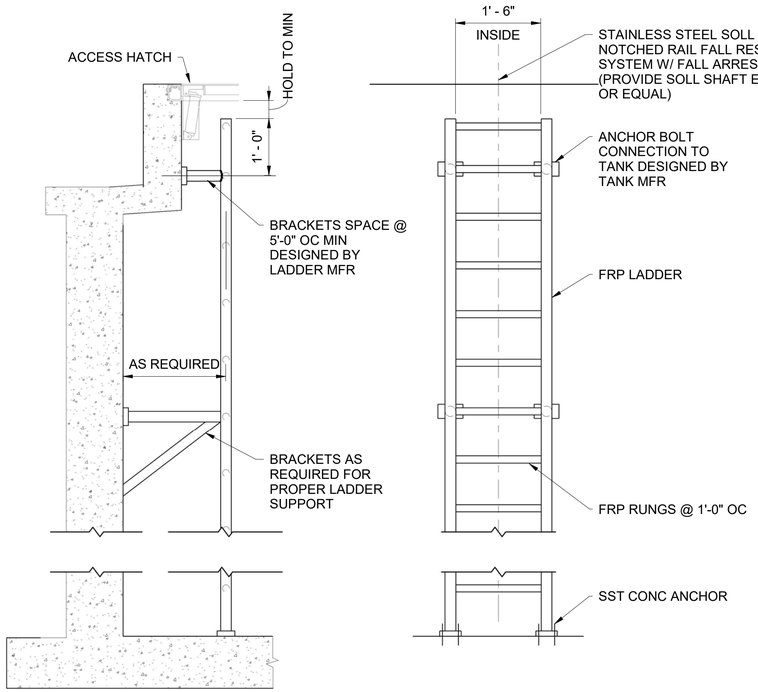
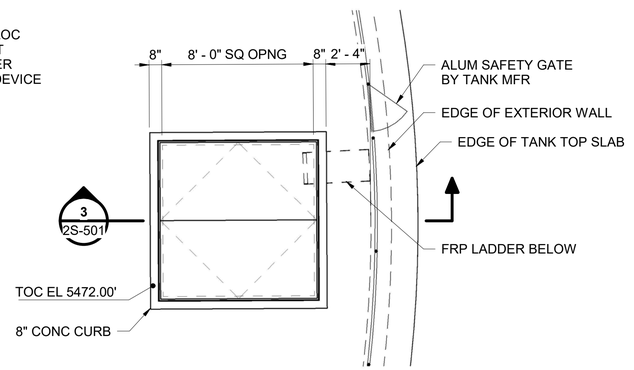


FRP INTERIOR TANK LADDER
NOT TO SCALE



DETAIL 2 / 2S-101

0 2' 4' 8'
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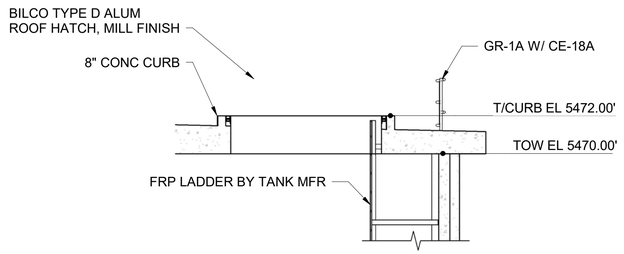

SECTION 3 / 2S-501

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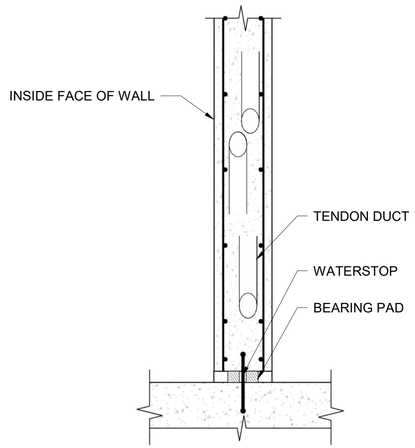

SECTION 4 / 2S-500
NOT TO SCALE

SECTION 5 / 2S-100

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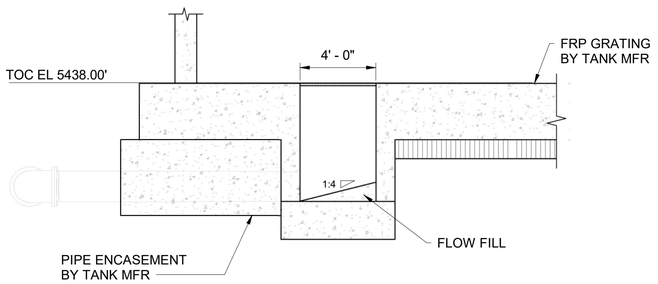

SECTION 1 / 2S-100

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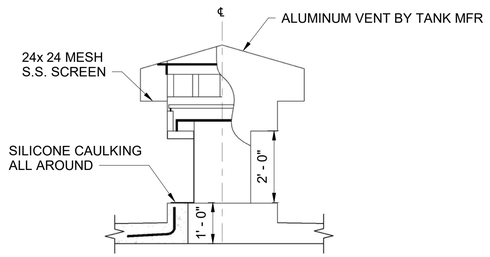

SECTION 6 / 2S-300

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

POTABLE TANK DETAILS II

project	contract
135303	

drawing 2S-501 — **rev.** 1

sheet of **sheets**
file

COLORADO LICENSED MARK T. BALCH 58555 PE 05/08/2025 PROFESSIONAL ENGINEER

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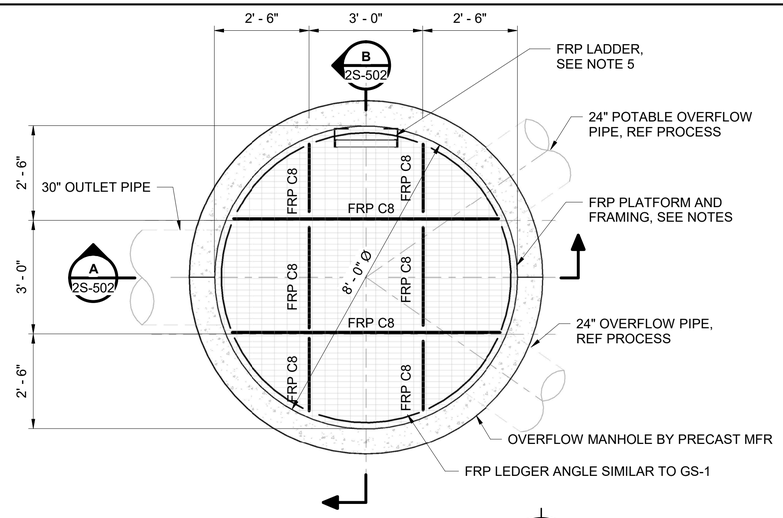
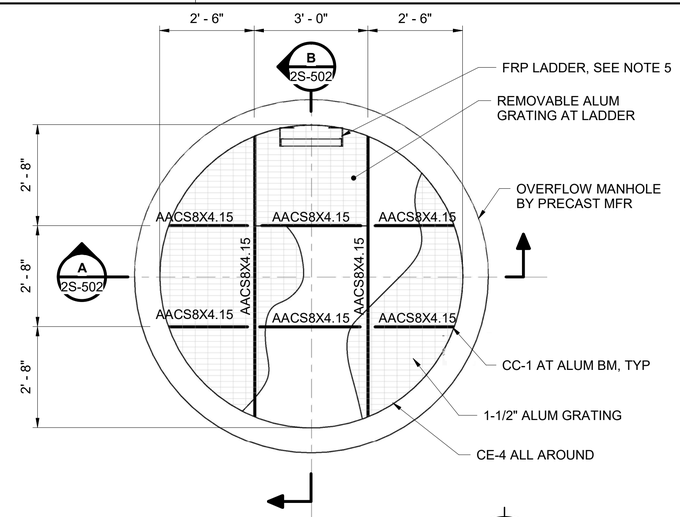


LOWER LEVEL PLAN

0 1' 2' 4'
SCALE IN FEET

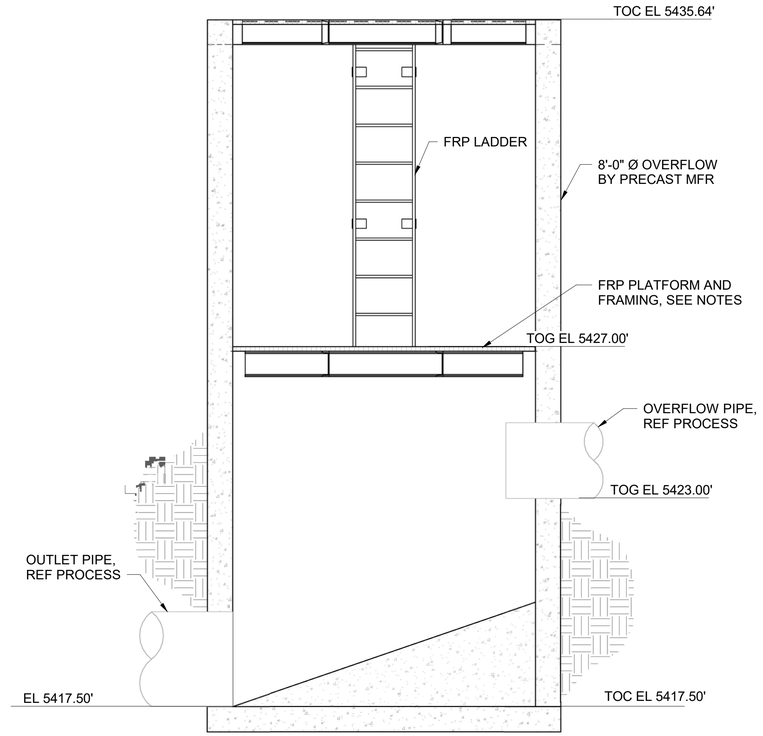
NORTH



TOP PLAN

0 1' 2' 4'
SCALE IN FEET

NORTH



SECTION A 2S-502

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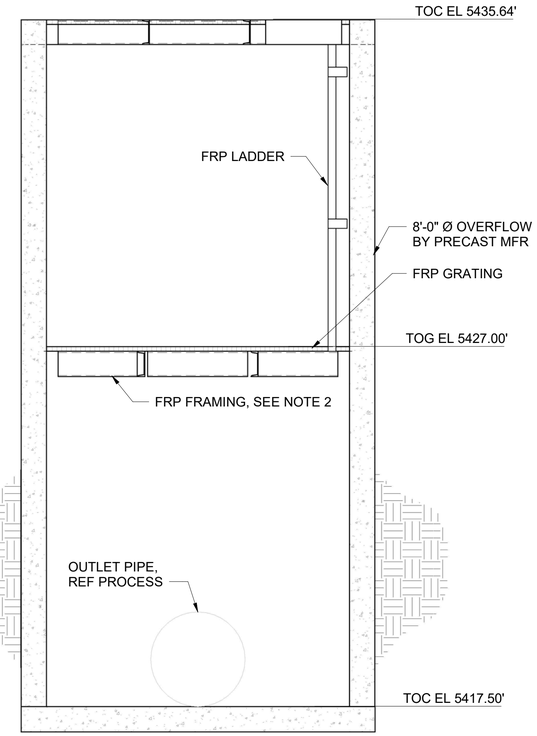
SCALE IN FEET



SECTION B 2S-502

0 1' 2' 4'
SCALE IN FEET

OVERFLOW MANHOLE NOTES:

1. FRP PLATFORM AND FRAMING SHALL BE DESIGNED BY A PROFESSIONAL ENGINEER IN THE STATE OF COLORADO.
2. ALUMINUM PLATFORM AND FRAMING SHALL BE DESIGNED BY A LICENSED PROFESSIONAL ENGINEER IN THE STATE OF COLORADO.
3. ALL GRATING AND FRAMING AT MANHOLE SHALL BE DESIGNED BY THE MANUFACTURER FOR A DISTRIBUTED LOAD OF 100 PSF OR A CONCENTRATED LOAD OF 300 LBS.
4. STRUCTURAL FRAMING SHALL USE MANUFACTURER'S STANDARD SHAPES AND BE CONNECTED WITH STAINLESS STEEL HARDWARE.
5. FRP LADDER AND HANDRAIL SHALL BE DESIGNED PER ASCE 7-16 SECTION 4.5.1.
6. CONNECTION TO CONCRETE SHALL BE STAINLESS STEEL EPOXY ANCHORS DESIGNED BY MANUFACTURER. SEE SPECIFICATIONS 06 82 00 FOR ADDITIONAL REQUIREMENTS.
7. SEE SPEC SECTION 31 23 16 FOR SUBGRADE PREPARATION.
8. COAT INTERIOR OF MANHOLE PER SPECIFICATION 09 90 00.
9. OVERFLOW MANHOLE TO BE SUPPORTED BY CAST-IN-PLACE FOUNDATION SLAB AND DRILLED SHAFT. SEE SHEET 1S-506 FOR DETAILS.

no.	date	by	ckd	description
0	01/28/25	STD	JJZ	ISSUED FOR CONSTRUCTION
1	05/06/25	STD	JJZ	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	B. MIMIAGA
designed	**checked**
S. DALGLISH	J. ZEMLICKA

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

OVERFLOW MANHOLE PW-04 PLAN & SECTIONS

project	contract
135303	

drawing **2S-502** **rev.** **1**

sheet **of** **sheets**

file

COLORADO LICENSED J. ZEMLICKA 58555 PROFESSIONAL ENGINEER 05/08/2025

Scale For Microfilming
Millimeters
Inches

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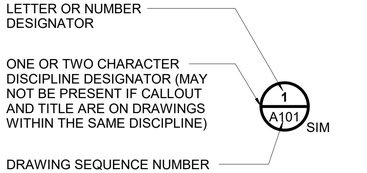
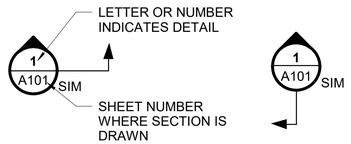
CALL OUT IDENTIFICATION

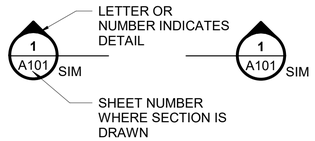
SECTION, DETAIL, AND ELEVATION SYMBOL IDENTIFIERS:



WALL SECTION CALLOUT EXAMPLE:



BUILDING SECTION CALLOUT EXAMPLE:



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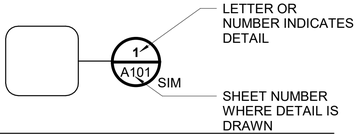
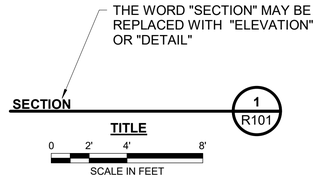
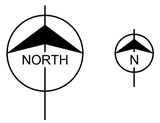


ELEVATION CALLOUT EXAMPLE:

SECTION, DETAIL, AND ELEVATION TITLE EXAMPLE:



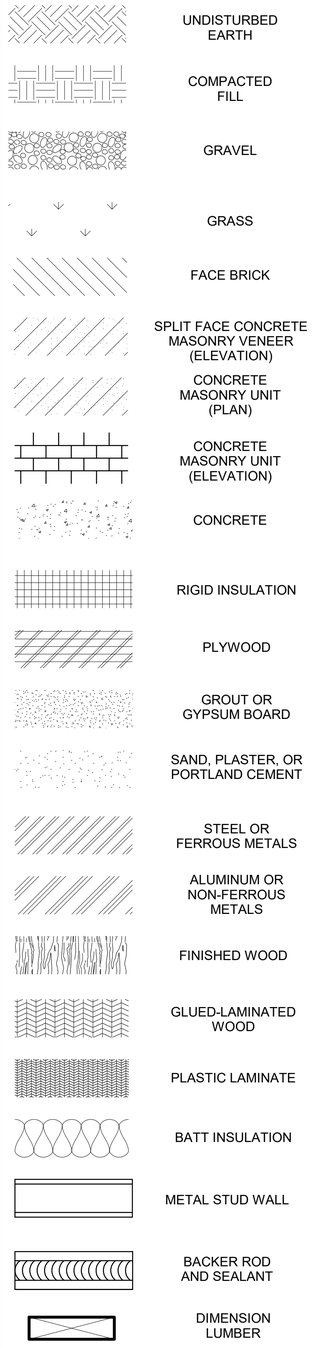
NORTH ARROW EXAMPLE:



PLAN LEGEND

PLAN LEGEND:

MATERIAL SYMBOLS



ABBREVIATIONS

	-A-
A/E	ARCHITECT/ENGINEER
ACOUST	ACOUSTICAL
ADJ	ADJACENT, ADJUSTABLE
AFF	ABOVE FINISH FLOOR
AHJ	AUTHORITY HAVING JURISDICTION
ALT	ALTERNATE
ALUM	ALUMINUM
APPROX	APPROXIMATE
ARCH	ARCHITECTURE, ARCHITECT
	-B-
BD	BOARD
BITUM	BITUMINOUS
BLDG	BUILDING
BLKG	BLOCKING
BO	BOTTOM OF, AS IN "BO STEEL"
BTWN	BETWEEN
	-C-
CAB	CABINET
CCTV	CLOSED CIRCUIT TELEVISION
CID	COMPREHENSIVE INTERIOR DESIGN
CJ	CONTROL JOINT, CONSTRUCTION JOINT
CL	CENTER LINE
CLG	CEILING
CLR	CLEAR
CMU	CONCRETE MASONRY UNIT
CO	CLEANOUT
COL	COLUMN
COMM	COMMUNICATION
CONC	CONCRETE
CONSTR	CONSTRUCTION
CONT	CONTINUOUS
CONTR	CONTRACT, CONTRACTOR
COORD	COORDINATE
CORR	CORRUGATED OR CORRIDOR
CU	CUBIC
°C	CELSIUS
	-D-
DBL	DOUBLE
DEMO	DEMOLITION
DESCR	DESCRIPTION
DET	DETAIL
DIA	DIAMETER
DIAG	DIAGONAL
DIM	DIMENSION
DN	DOWN
DR	DOOR
DS	DOWNSPOUT
DWG	DRAWING
	-E-
E	EAST
EA	EACH
EEW	EMERGENCY EYEWASH
EEWS	EMERGENCY EYEWASH & SHOWER
EF	EXHAUST FAN
EJ	EXPANSION JOINT
EL	ELEVATION, AS IN HEIGHT
ELAST	ELASTOMERIC
ELEC	ELECTRIC / ELECTRICAL
ELEV	ELEVATOR, OR ELEVATION AS IN NORTH ELEV
EQ	EQUAL
EQUIP	EQUIPMENT
ETC	AND SO FORTH (ETCETERA)
EW	EACH WAY
EWC	ELECTRIC WATER COOLER
EXH	EXHAUST
EXP	EXPANSION
EXT	EXTERIOR
	-F-
FD	FLOOR DRAIN
FDN	FOUNDATION
FE	FIRE EXTINGUISHER WITH WALL BRACKET
FEC	FIRE EXTINGUISHER CABINET
FF	FINISH FLOOR
FF&E	FURNITURE, FIXTURES & EQUIPMENT
FHC	FIRE HOSE CABINET (WITH EXTINGUISHER & BRACKET)
FHR	FIRE HOSE REEL (WITH EXTINGUISHER & BRACKET)
FIN	FINISHED, FINISH
FLR	FLOOR
FT	FEET / FOOT
FV	FIELD VERIFY
°F	FAHRENHEIT
	-G-
GA	GAUGE
GALV	GALVANIZED
GL	GIRT LINE
GRTG	GRATING
GYP	GYPSUM
GYP BD	GYPSUM BOARD
	-H-
H	HIGH
HD	HAND
HDWR	HARDWARE
HM	HOLLOW METAL
HORIZ	HORIZONTAL
HT	HEIGHT
HVAC	HEATING, VENTILATION & AIR CONDITIONING
	-I-
ID	INSIDE DIAMETER
IN	INCH
INSUL	INSULATION
INT	INTERIOR
	-J-
JAN	JANITOR'S CLOSET
	-L-
L	LEFT, LONG, LENGTH
LAB	LABORATORY
LAT	LATITUDE
LAV	LAVATORY
LB or #	POUND
LH	LEFT HAND
LONG	LONGITUDE
LVR	LOUVER
	-M-
M	METER
MACH	MACHINE
MAINT	MAINTENANCE
MAS	MASONRY
MATL	MATERIAL
MAX	MAXIMUM
MECH	MECHANICAL
MFR	MANUFACTURER
MIN	MINIMUM
MISC	MISCELLANEOUS
MJ	MOVEMENT JOINT
MM	MILLIMETER
MO	MASONRY OPENING
MTD	MOUNTED
MTL	METAL
	-N-
N	NORTH
N/A	NOT APPLICABLE
NIC	NOT IN CONTRACT
NO	NUMBER
NOM	NOMINAL
NTP	NOTICE TO PROCEED
NTS	NOT TO SCALE
	-O-
OC	ON CENTER
OD	OUTSIDE DIAMETER
OFF	OFFICE
OPNG	OPENING
OPP	OPPOSITE
	-P-
PA	PUBLIC ADDRESS
PEMB	PRE-ENGINEERED METAL BUILDING
PERIM	PERIMETER
PKG	PACKAGE
PL	PLATE
PLMB	PLUMBING
PLYWD	PLYWOOD
PROJ	PROJECT
PSF	POUNDS PER SQUARE FOOT
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
	-R-
R	RADIUS
R/A	RETURN AIR
RCP	REFLECTIVE CEILING PLAN
RD	ROOF DRAIN
RECP	RECEPTACLE
REFER	REFERENCE
REINF	REINFORCED
REQ'D	REQUIRED
REV	REVISION
RH	RIGHT HAND
RO	ROUGH OPENING
	-S-
S	SOUTH
SA	SUPPLY AIR
SCHED	SCHEDULE
SECT	SECTION
SF	SQUARE FOOT
SID	STRUCTURAL INTERIOR DESIGN
SIM	SIMILAR
SPEC	SPECIFICATION
SQ	SQUARE, AS IN "SQ FT"
STC	SOUND TRANSMISSION COEFFICIENT
STD	STANDARD
STOR	STORAGE
STRUCT	STRUCTURAL
SUPP	SUPPORT
SUSP	SUSPENDED
SYS	SYSTEM
	-T-
TD	TRENCH DRAIN
TECH	TECHNICAL
THRU	THROUGH
TLT	TOILET
TO	TOP OF, AS IN "TO STEEL"
TOR	TOP OF ROOF
TYP	TYPICAL
	-U-
UL	UNDERWRITERS LABORATORY
UNO	UNLESS NOTED OTHERWISE
UTIL	UTILITY
	-V-
VENT	VENTILATE, VENTILATOR
VERT	VERTICAL
VJ	VENEER JOINT
VOL	VOLUME
	-W-
W	WEST, WIDTH
W/	WITH
W/O	WITHOUT
WC	WATER CLOSET
WD	WOOD
WH	WATER HEATER
WT	WEIGHT

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date: MAY 2025	detailed: E. FIELDS
designed: J. DEAR	checked: R. LANG

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ARCHITECTURAL LEGEND & ABBREVIATIONS

project: 135303	contract:
drawing: **0A-001**	rev.: **1**
sheet:	of: sheets
file:	

COLORADO EDWARD LANG ARC.0010370 REGISTERED ARCHITECT 5/8/2025

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GENERAL NOTES

1. THE CONTRACTOR SHALL INCLUDE ALL WORK REQUIRED TO COMPLY WITH ALL APPLICABLE CODES AND STANDARDS AS LISTED OR REFERENCED ON LIFE SAFETY PLAN AND LIFE SAFETY CRITERIA OR AS REQUIRED BY THE AUTHORITY HAVING JURISDICTION.
2. DIMENSIONS SHALL GOVERN. DETAILS SHALL GOVERN OVER PLANS AND ELEVATIONS. LARGE SCALE DETAILS OR PLANS SHALL GOVERN OVER SMALL SCALE DETAILS OR PLANS. DO NOT SCALE DRAWINGS.
3. THE GENERAL CONTRACTOR SHALL PROVIDE AND INSTALL ALL EXIT SIGNS, EMERGENCY LIGHTING SYSTEMS, ALARM SYSTEMS AND AUTOMATIC SPRINKLER SYSTEMS AS REQUIRED BY APPLICABLE CODES AND STANDARDS OR AS REQUIRED BY THE AUTHORITY HAVING JURISDICTION.
4. THE GENERAL CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING ALL MANUFACTURER'S RECOMMENDED MAINTENANCE PROCEDURES AND SCHEDULES.
5. ANY MANUFACTURER'S OR BRAND NAME PRODUCTS INDICATED OR SPECIFIED ARE DONE SO TO ESTABLISH A MINIMUM LEVEL OF QUALITY.
6. ALL CONSTRUCTION SHALL MEET OR EXCEED LOCAL INDUSTRY STANDARDS. DETAILS ARE PROVIDED TO INDICATE MINIMUM QUALITY AND TO GIVE STANDARDS OF CONSTRUCTION. IF A CONDITION IS NOT SPECIFICALLY DETAILED, SUBMIT A SIMILAR DETAIL FOR GUIDE AND APPROVAL.
7. THE LETTERS I, O, AND Q ARE NOT USED TO INDICATE DETAILS, SECTIONS OR ELEVATIONS.
8. PROVIDE PRESERVATIVE-TREATED WOOD AT ALL LOCATIONS WHERE WOOD IS IN DIRECT CONTACT WITH CONCRETE OR MASONRY.
9. PROVIDE 3/4" FIRE-RETARDANT TREATED PLYWOOD BACKING AT ALL ELECTRICAL, PHONE, AND SECURITY SYSTEM PANELS.
10. PROVIDE FIRE-RESISTANT TREATED WOOD BLOCKING FOR SECURE ANCHORAGE OF ALL SHELVES, RUNNING TRIM, RAILINGS, SUSPENDED ITEMS, DOOR-STOPS, GRAB-BARS, AND OTHER SIMILAR WOODWORK, HARDWARE, SPECIALTIES, ACCESSORIES, FIXTURES, OR EQUIPMENT.
11. PAINT, STAIN, OR COAT ALL EXPOSED SURFACES OF CONSTRUCTION UNLESS NOTED OTHERWISE OR IF SURFACES ARE PRE-FINISHED.
12. ALL OPENING DIMENSIONS ARE NOMINAL. THE CONTRACTOR SHALL FIELD MEASURE ALL OPENINGS AND COORDINATE WITH THE APPROPRIATE SUPPLIER FOR ALL DOORS AND WINDOWS.
13. ALL CONDUITS, PLUMBING, PIPING, DUCTWORK, AND OTHER EQUIPMENT EXPOSED TO VIEW SHALL BE LOCATED PARALLEL OR PERPENDICULAR TO THE STRUCTURAL FRAMING SYSTEM.
14. PROVIDE GALVANIC PROTECTION BETWEEN DISSIMILAR MATERIALS, WHERE REQUIRED.
15. ARCHITECTURAL DETAILS ARE APPLICABLE WHERE INDICATED BY SECTION CUT, BY NOTE, OR BY DETAIL TITLE. INCORPORATE SIMILAR DETAILS AT SIMILAR CONDITIONS UNLESS NOTED OTHERWISE. THE CONTRACTOR MAY REQUEST A CLARIFICATION IF REQUIRED, OTHERWISE THE MORE STRINGENT REQUIREMENTS SHALL CONTROL.
16. SEAL ALL EXTERIOR BUILDING JOINTS AT BOTH THE EXTERIOR AND INTERIOR SURFACES AGAINST MOISTURE AND AIR INFILTRATION.
17. SEAL AROUND ALL DOOR AND WINDOW FRAMES, WALL-MOUNTED FIXTURES AND EQUIPMENT TO ADJACENT WALL SURFACES.
18. THE CONTRACTOR SHALL REVIEW THE DIMENSIONS OF ALL EQUIPMENT IN THE PROJECT REGARDLESS OF THE SOURCE AND COORDINATE ACCESS TO THE SPACE AND VERIFY CLEAR FLOOR SPACE IS PROVIDED AS REQUIRED TO ENSURE EASE OF INSTALLATION.
19. ALL WORK MUST BE OF GOOD QUALITY, FREE FROM DEFECTS, AND IN ACCORDANCE WITH THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.
20. THE CONTRACTOR IS RESPONSIBLE FOR THE COORDINATION OF ALL PENETRATIONS IN THE STRUCTURE FOR THE PROPER INSTALLATION OF THE WORK. REFER TO STRUCTURAL DRAWINGS FOR SECONDARY FRAMING AND OR REINFORCING REQUIRED AT PENETRATIONS IN STEEL, CONCRETE OR MASONRY.
21. THE CONTRACTOR SHALL PROVIDE ACCESS DOORS OR PANELS AS REQUIRED FOR SERVICING OF PIPING, DUCTWORK, CABLE TRAYS, FIRE DAMPERS AND SIMILAR APPLICATIONS. ALL PROPOSED ACCESS DOOR LOCATIONS TO BE SUBMITTED FOR APPROVAL PRIOR TO INSTALLATION.
22. PROVIDE ALL HVAC, PLUMBING, GAS OR ELECTRIC SERVICE CONNECTIONS TO CASEWORK, FIXTURES, SIGNAGE, OR EQUIPMENT INDICATED (WHETHER UNITS ARE INSTALLED BY CONTRACTOR OR BY OTHERS).
23. BRACE PARTITIONS, SOFFITS, SUSPENDED ITEMS, ETC. ONLY TO STRUCTURAL ELEMENTS ABOVE. DO NOT ANCHOR TO ROOF DECK, PLUMBING / SPRINKLER PIPES, DUCTWORK, ELECTRICAL CONDUIT OR SIMILAR ELEMENTS.
24. ALL MATERIALS USED FOR CONSTRUCTION SHALL BE NEW AND UNDAMAGED. THE CONTRACTOR SHALL SUBMIT SHOP DRAWINGS FOR ALL WORK SHOWN.
25. THE CONTRACTOR SHALL BECOME FULLY ACQUAINTED WITH CONDITIONS RELATED TO THE WORK. ANY DISCREPANCIES BETWEEN THE DRAWINGS AND THE ACTUAL CONDITIONS SHALL BE REPORTED TO THE DESIGN PROFESSIONALS FOR RESOLUTION PRIOR TO PROCEEDING WITH THE WORK.
26. DRAWINGS CONTAINED IN THIS SET SHALL NOT BE REPRODUCED FOR SHOP DRAWINGS. COPIES OF THESE DRAWINGS SUBMITTED AS SHOP DRAWINGS WILL BE REJECTED AND RETURNED TO THE CONTRACTOR.
27. EACH INSTALLER MUST EXAMINE SUBSTRATE AND/OR CONDITIONS UNDER WHICH THE WORK WILL BE INSTALLED AND REPORT TO THE CONTRACTOR IN WRITING ANY CONDITIONS DETRIMENTAL TO THE PROPER AND TIMELY EXECUTION OF THE INSTALLERS WORK. DO NOT PROCEED UNTIL UNSATISFACTORY CONDITIONS ARE CORRECTED. INSTALLATION SHALL CONSTITUTE ACCEPTANCE OF THE SUBSTRATE AND/OR CONDITIONS.
28. "TYPICAL" (TYP) AS USED IN THESE DOCUMENTS SHALL MEAN THAT THE CONDITIONS OR DIMENSION IS THE SAME OR REPRESENTATIVE FOR SIMILAR CONDITIONS THROUGHOUT.
29. CONTROL JOINTS (CJ) SHALL BE INSTALLED AT ALL PARTITIONS. CJ AT CONCRETE MASONRY UNIT PARTITIONS SHALL BE MAXIMUM 20'-0" O.C., UNLESS OTHERWISE NOTED ON DRAWINGS. REFER TO ELEVATION DRAWINGS FOR EXTERIOR CONTROL JOINT LOCATIONS. REVIEW CJ LOCATIONS WITH ARCHITECT PRIOR TO INSTALLATION.
30. NON-BEARING PARTITIONS SHALL BE ISOLATED FROM THE BUILDING STRUCTURE TO PREVENT TRANSFER OF BUILDING LOADS FROM THE STRUCTURE TO THE PARTITIONS.
31. DIMENSIONS ARE TO FACE OF WALL UNLESS NOTED OTHERWISE.

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ARCHITECTURAL GENERAL NOTES

project	contract
135303	

drawing **0A-002** — rev. **1**

sheet of sheets

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COLORADO REGISTERED ARCHITECT RYAN P. LANG ARC.0000772 5/8/2025

Millimeters
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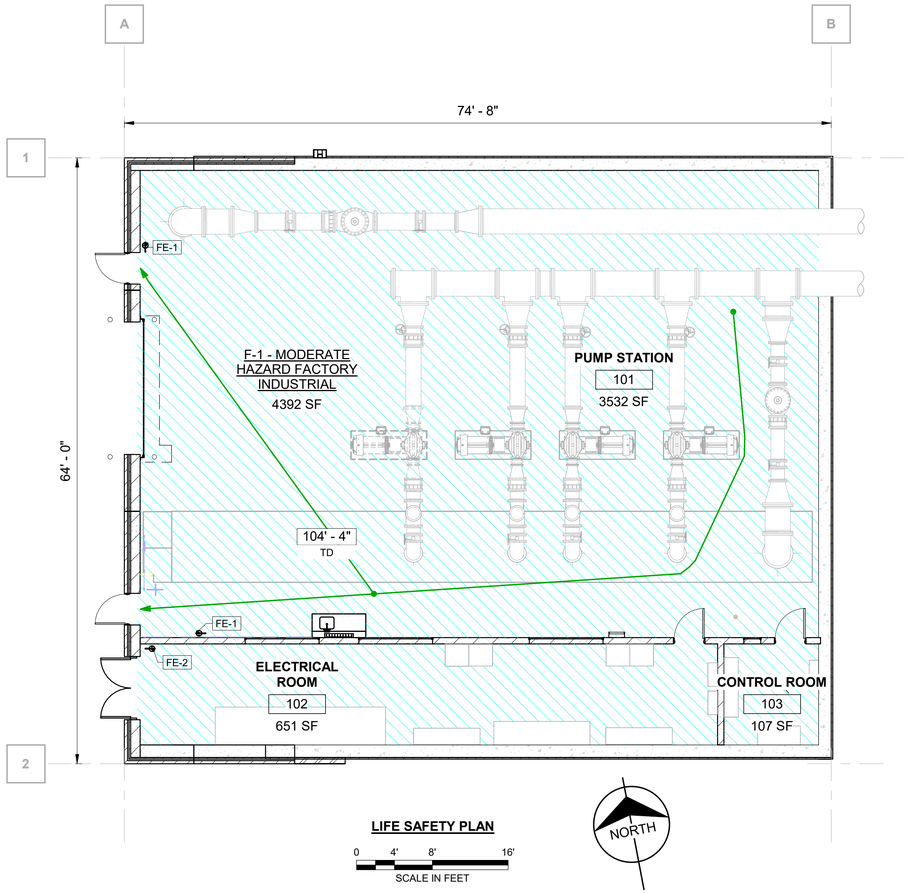

LIFE SAFETY PLAN

0 4' 8' 16'

SCALE IN FEET

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CODE REVIEW FOR THE CITY AND COUNTY OF BROOMFIELD, CO:

2021 INTERNATIONAL BUILDING CODE(IBC)
2021 INTERNATIONAL ENERGY CONSERVATION CODE(IECC)
2021 INTERNATIONAL MECHANICAL CODE(IMC)
2021 INTERNATIONAL PLUMBING CODE(IPC)
2021 INTERNATIONAL FUEL GAS CODE(IFGC)
2021 INTERNATIONAL FIRE CODE(IFC)
2023 NATIONAL ELECTRICAL CODE(NEC)

IBC CHAPTER 3 - USE AND OCCUPANCY CLASSIFICATION

OCCUPANCY TYPE	OCCUPANCY GROUP	DESCRIPTION	AREAS APPLIED
F-1	MODERATE HAZARD FACTORY INDUSTRIAL	WATER PUMP STATION	ALL

IBC CHAPTER 5 - GENERAL BUILDING HEIGHTS AND AREAS

SECTION 504 - BUILDING HEIGHT AND NUMBER OF STORIES

OCCUPANCY TYPE	ALLOWABLE BUILDING HEIGHT (FT) TABLE 504.3	ALLOWABLE NUMBER OF STORIES TABLE 504.4	ACTUAL BUILDING HEIGHT (FT)	ACTUAL NUMBER OF STORIES
F-1	55	2	20	1

SECTION 506 - BUILDING AREA - NO AREA INCREASE ALLOWED

OCCUPANCY TYPE	ALLOWABLE AREA (SF) TABLE 506.2	ACTUAL FLOOR AREA (SF)	RATIO OF ACTUAL TO ALLOWABLE AREA
F-1	15,500	4,185	0.27

IBC CHAPTER 6 - TYPES OF CONSTRUCTION

SECTION 602 - CONSTRUCTION CLASSIFICATION

CLASS	TYPE
II	B

TABLE 601 - FIRE-RESISTANCE RATING REQUIREMENTS

BUILDING ELEMENT	RATING (HOURS)
ALL	0

IBC CHAPTER 9 - FIRE PROTECTION AND LIFE SAFETY SYSTEMS

SECTION 903 - AUTOMATIC SPRINKLER SYSTEMS
SPRINKLER SYSTEM IS NOT REQUIRED IN F-1 OCCUPANCY <12,000 SF PER SECTION 903.2
SECTION 905 - STANDPIPE SYSTEMS
STANDPIPE SYSTEM IS NOT REQUIRED PER SECTION 905.3
SECTION 906 - PORTABLE FIRE EXTINGUISHERS
PORTABLE FIRE EXTINGUISHERS WILL BE INSTALLED THROUGHOUT PER SECTION 906.1
SECTION 907 - FIRE ALARM AND DETECTION SYSTEMS
MANUAL FIRE ALARM SYSTEM IS NOT REQUIRED PER SECTION 907.2.4

IBC CHAPTER 10 - MEANS OF EGRESS

SECTION 1004 -OCCUPANT LOAD

FUNCTION	OCCUPANT LOAD FACTOR	ACTUAL FLOOR AREA (SF)	MAX OCCUPANCY
INDUSTRIAL	100	4,185	42

SECTION 1005 - MEANS OF EGRESS SIZING ENTIRE BUILDING
42 OCCUPANTS*0.2IN/OCCUPANT = 8.4IN REQUIRED
MIN 32" REQUIRED FROM EACH ROOM. 36" OR 72" PROVIDED FROM EACH ROOM

SECTION 1006 - NUMBER OF EXITS AND EXITS ACCESS DOORWAYS PER SPACE

OCCUPANCY TYPE	MAXIMUM OCCUPANT LOAD PER SPACE	ACTUAL TRAVEL DISTANCE (FT)	MAXIMUM COMMON PATH OF EGRESS (FT) PER TABLE 1006.2.1	MINIMUM # OF EXITS PER TABLE 1006.2.1	MAXIMUM TRAVEL DISTANCE PER TABLE 1017.2 (FT)
F-1	49	104'-4"	75	2*	200

*NUMBER OF EXITS BASED ON TRAVEL DISTANCE REQUIREMENTS.

IBC CHAPTER 13 - ENERGY EFFICIENCY
*NUMBER OF EXITS BASED ON TRAVEL DISTANCE REQUIREMENTS. REF LIFE SAFETY PLAN.

IECC CHAPTER 4 - INSULATION REQUIREMENTS
(REF TABLE C402.1.3) (CLIMATE ZONE 5B)

COMPONENT	REQUIRED R-VALUE	INSULATION DESCRIPTION
BELOW GRADE MASS WALLS	7.5ci	CONTINUOUS RIGID INSULATION
ROOF	30ci	CONTINUOUS RIGID INSULATION ENTIRELY ABOVE ROOF DECK
ABOVE GRADE MASS WALLS	11.4ci	CONTINUOUS RIGID INSULATION
DOORS	U-0.37	OPAQUE DOORS - SWINGING
	U-0.31	OPAQUE DOORS - NON-SWINGING

AREA PLAN LEGEND

TRAVEL PATH

Length
TD
TD = TOTAL DISTANCE
CP = COMMON PATH

PORTABLE FIRE EXTINGUISHER

FE-1 — MULTI-PURPOSE DRY CHEMICAL TYPE. UL RATING 1-A:10:B:C. 5LB NOMINAL CAPACITY

FE-2 — CLEAN AGENT TYPE. UL OR FM RATING 5:B:C. 5LB NOMINAL CAPACITY

OCCUPANCY LEGEND

F-1 - MODERATE HAZARD FACTORY INDUSTRIAL

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	checked
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION LIFE SAFETY PLAN

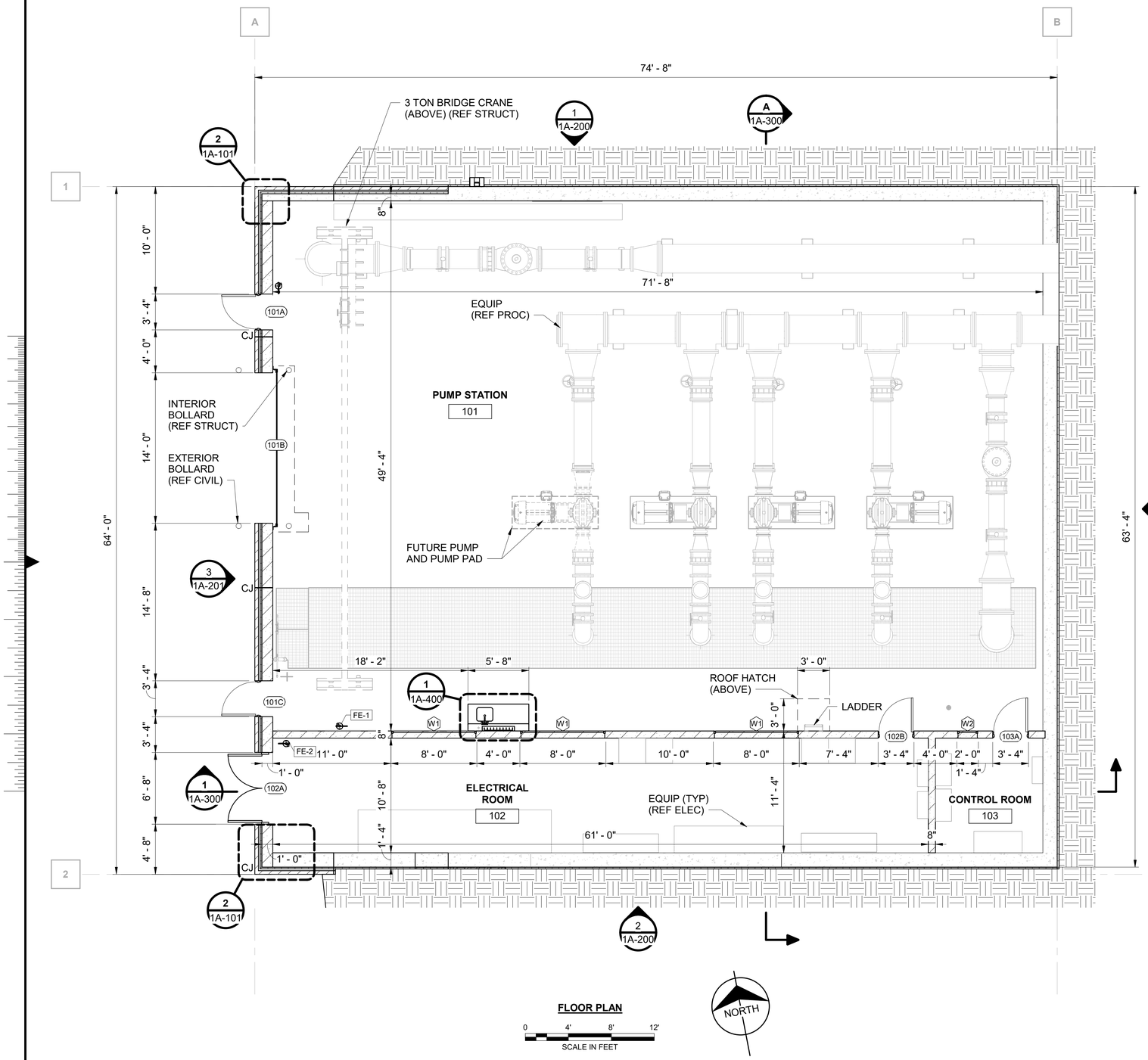
project	contract
135303	

drawing **1A-100** — rev. **1**

sheet of sheets

file

COLORADO ANNE E. LANG ARCHITECT 5/8/2025 REGISTERED ARCHITECT

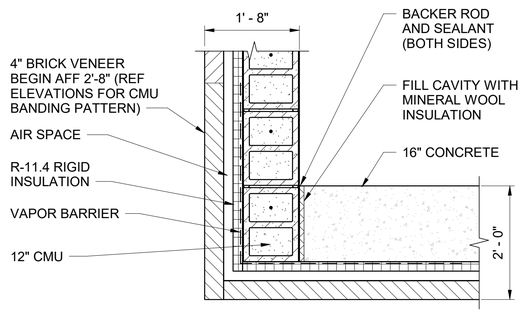


FLOOR PLAN

0 4' 8' 12'

SCALE IN FEET

NORTH



CORNER PLAN DETAIL 2 1A-101

0 1' 2' 3'

SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
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Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	checked
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD · COLORADO ·

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION FLOOR

project	contract
135303	

drawing **1A-101** — rev. **1**

sheet of sheets

file

COLORADO REGISTERED ARCHITECT ARC.00120220 5/8/2025

Scale For Microfilming: Millimeters / Inches

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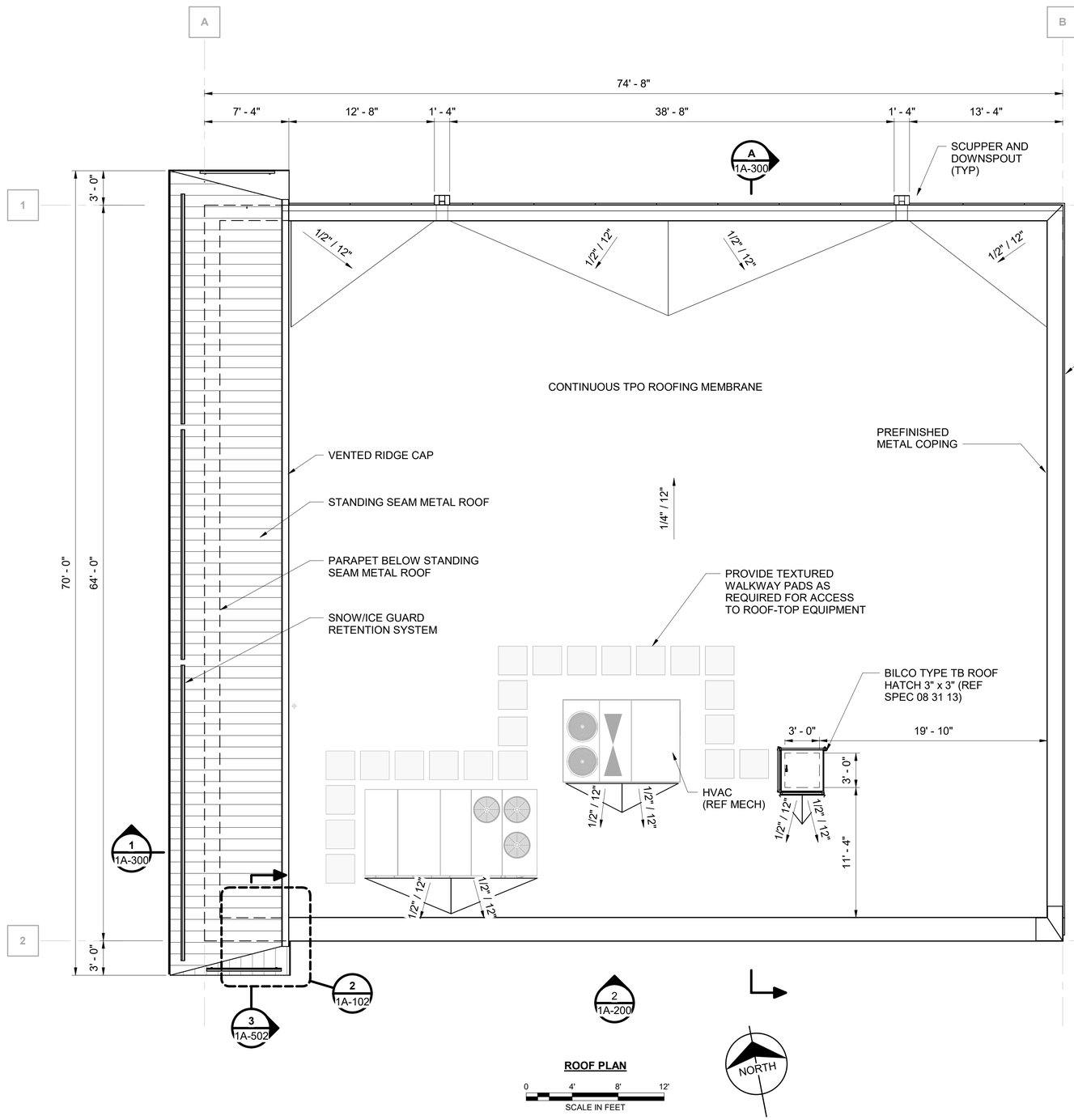
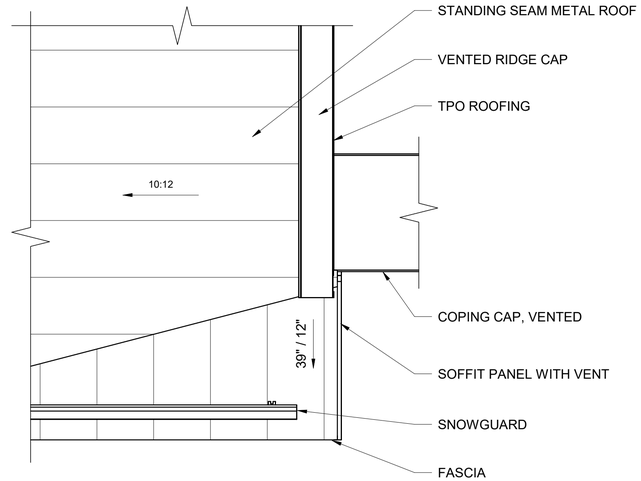
Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt



ROOF PLAN

0 4' 8' 12'

SCALE IN FEET



ROOF AT COPING DETAIL 2 1A-102

0 2' 4' 6'

SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	checked
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD · COLORADO ·

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BROOMFIELD TANKS AND PUMP STATION

PUMP STATION ROOF PLAN

project	contract
135303	

drawing **1A-102** rev. **1**

sheet of sheets

file

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Scale For Microfilming: Millimeters / Inches

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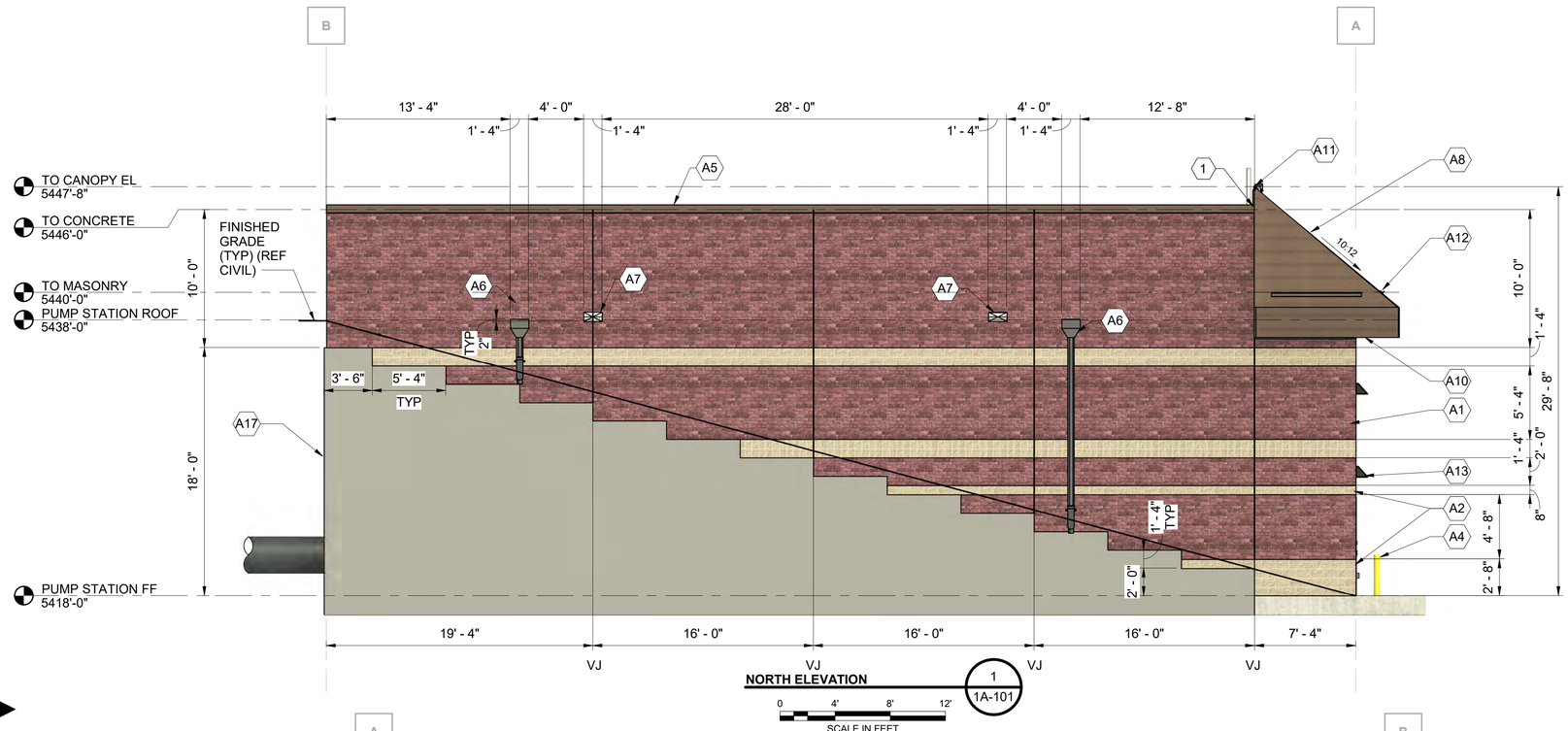
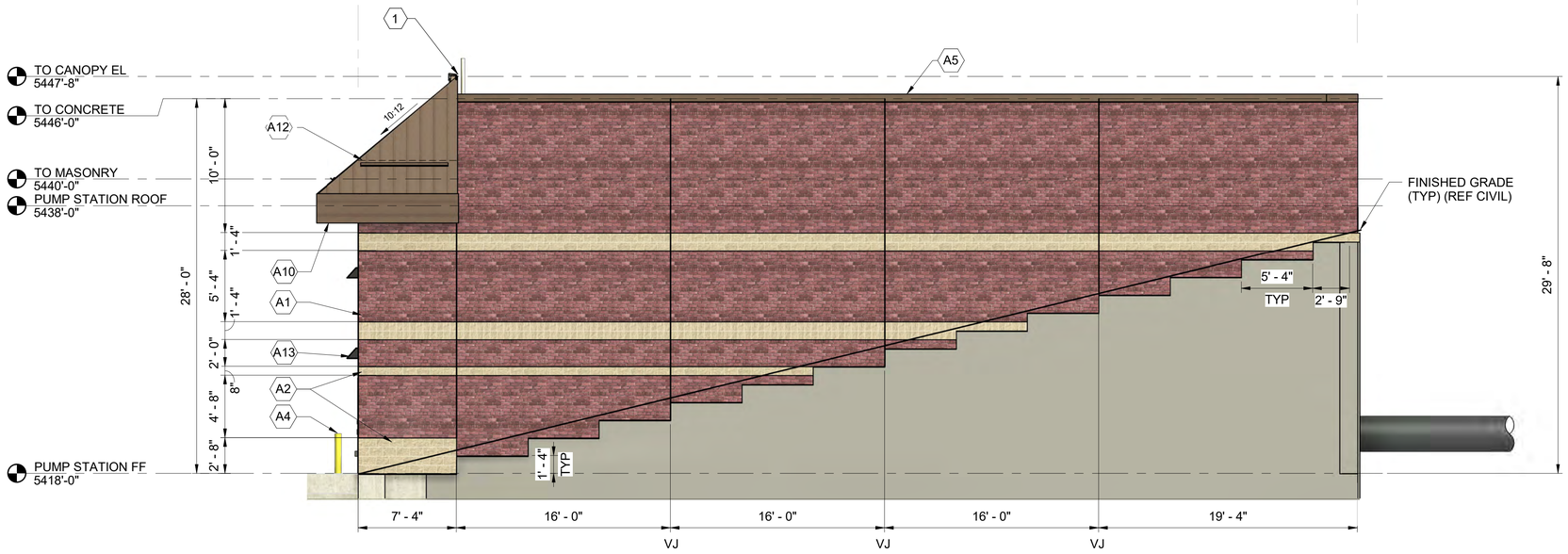


NORTH ELEVATION 1 / 1A-101

0 4' 8' 12'

SCALE IN FEET



SOUTH ELEVATION 2 / 1A-101

0 4' 8' 12'

SCALE IN FEET

GENERAL NOTE:

1. METAL ROOFING TO WRAP AROUND EAST END OF STANDING SEAM ROOF. CONTINUE TPO UNDER STANDING SEAM ROOFING AND TERMINATE AT CORNER.

KEY NOTES

- A1 BRICK – RUNNING BOND, DARK RED, INTERSTATE BRICK MONTEREY OR APPROVED EQUAL TO MATCH BROOMFIELD WTP
- A2 SPLIT FACE CMU, LIGHT TAN BASALITE 720R RUNNING BOND WITH PLAIN MORTAR OR APPROVED EQUAL TO MATCH BROOMFIELD WTP
- A4 STEEL BOLLARD. REF CIVIL
- A5 PREFINISHED METAL COPING, DARK BRONZE TO MATCH ROOF
- A6 PREFINISHED SCUPPER AND OPEN DOWNSPOUT, DARK BRONZE TO MATCH ROOF
- A7 OVERFLOW SCUPPER
- A8 STANDING SEAM METAL ROOFING, DARK BRONZE
- A10 SOFFIT PANEL WITH VENT, DARK BRONZE
- A11 RIDGE FLASHING, VENTED, DARK BRONZE
- A12 SEAM-MOUNTED, RAIL-TYPE SNOW GUARD, DARK BRONZE
- A13 LIGHT (REF ELEC) (TYP)
- A17 16" CONCRETE (REF STRUCT) WITH 2" RIGID INSULATION

no.	date	by	ckd	description
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1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION NORTH & SOUTH ELEVATIONS

project	contract
135303	

drawing 1A-200 — **rev.** 1

sheet of **sheets**

file

COLORADO REGISTERED ARCHITECT ARC.0010272 5/8/2025

Millimeters Inches Scale For Microfilming

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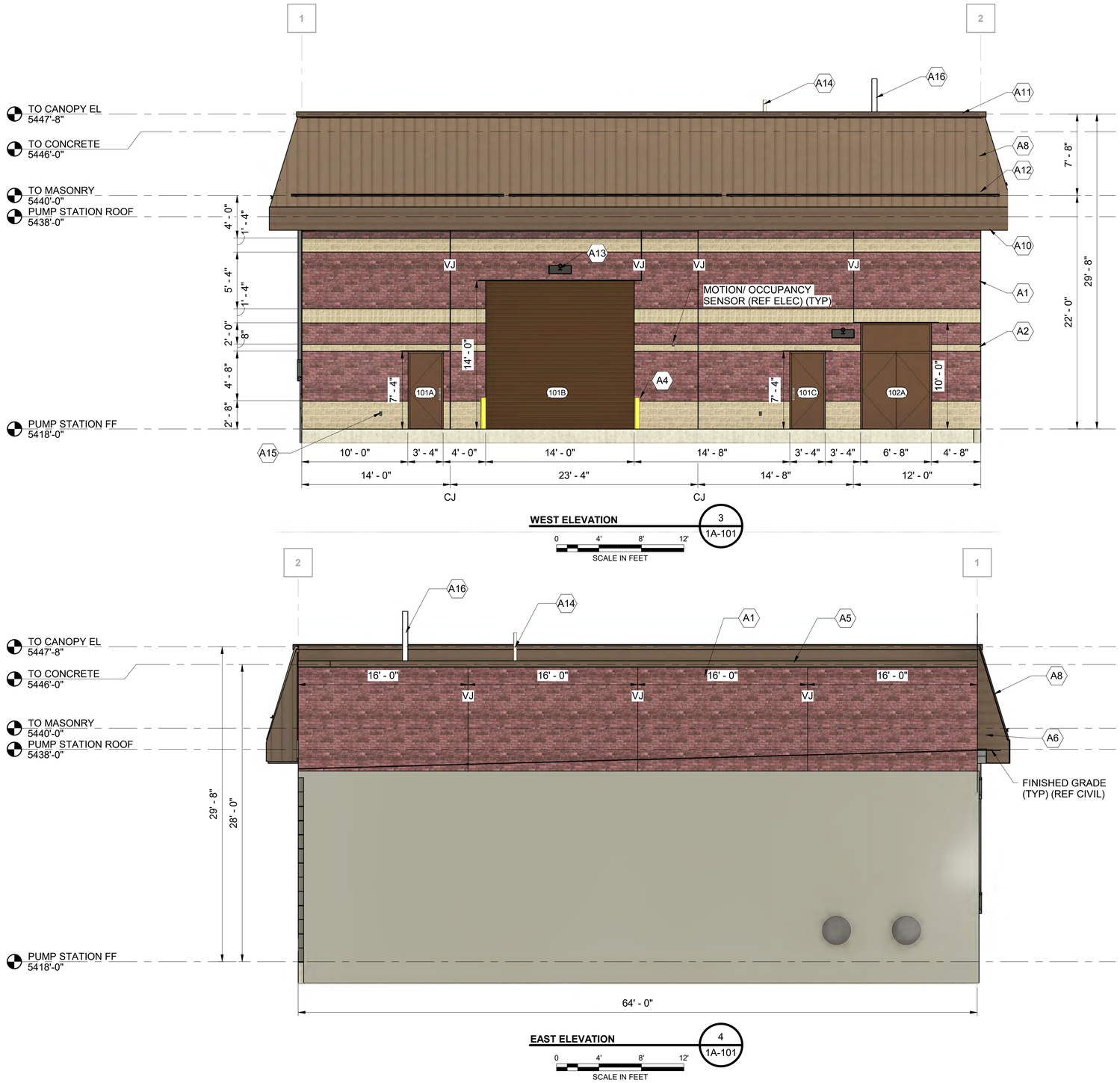

GENERAL NOTE:

1. METAL ROOFING TO WRAP AROUND EAST END OF STANDING SEAM ROOF. CONTINUE TPO UNDER STANDING SEAM ROOFING AND TERMINATE AT CORNER.

KEY NOTES

- A1 BRICK – RUNNING BOND, DARK RED, INTERSTATE BRICK MONTEREY OR APPROVED EQUAL TO MATCH BROOMFIELD WTP
- A2 SPLIT FACE CMU, LIGHT TAN BASALITE 720R RUNNING BOND WITH PLAIN MORTAR OR APPROVED EQUAL TO MATCH BROOMFIELD WTP
- A4 STEEL BOLLARD. REF CIVIL
- A5 PREFINISHED METAL COPING, DARK BRONZE TO MATCH ROOF
- A6 PREFINISHED SCUPPER AND OPEN DOWNSPOUT, DARK BRONZE TO MATCH ROOF
- A8 STANDING SEAM METAL ROOFING, DARK BRONZE
- A10 SOFFIT PANEL WITH VENT, DARK BRONZE
- A11 RIDGE FLASHING, VENTED, DARK BRONZE
- A12 SEAM-MOUNTED, RAIL-TYPE SNOW GUARD, DARK BRONZE
- A13 LIGHT (REF ELEC) (TYP)
- A14 VENT (REF MECH) (TYP)
- A15 RECEPTACLE (REF ELEC) (TYP)
- A16 ANTENNA ESTIMATED AT 5FT (+/-) TALL (TYP)

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION EAST & WEST ELEVATIONS

project	contract
135303	

drawing **1A-201** — **rev.** **1**

sheet **of** **sheets**

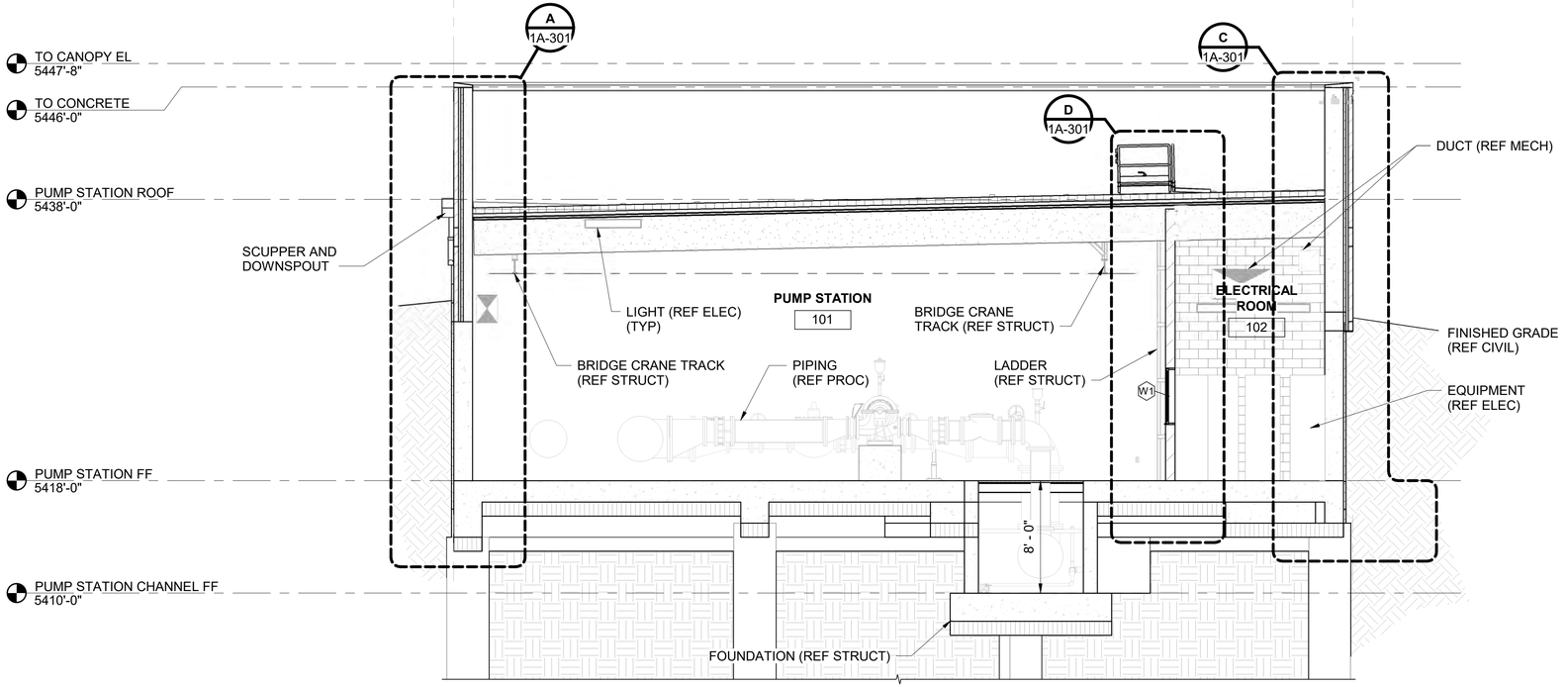
file

COLORADO RYAN S. LANG ARCHITECT 5/8/2025 REGISTERED ARCHITECT

Scale For Microfilming
Millimeters
Inches

5/8/2025 11:58:34 AM

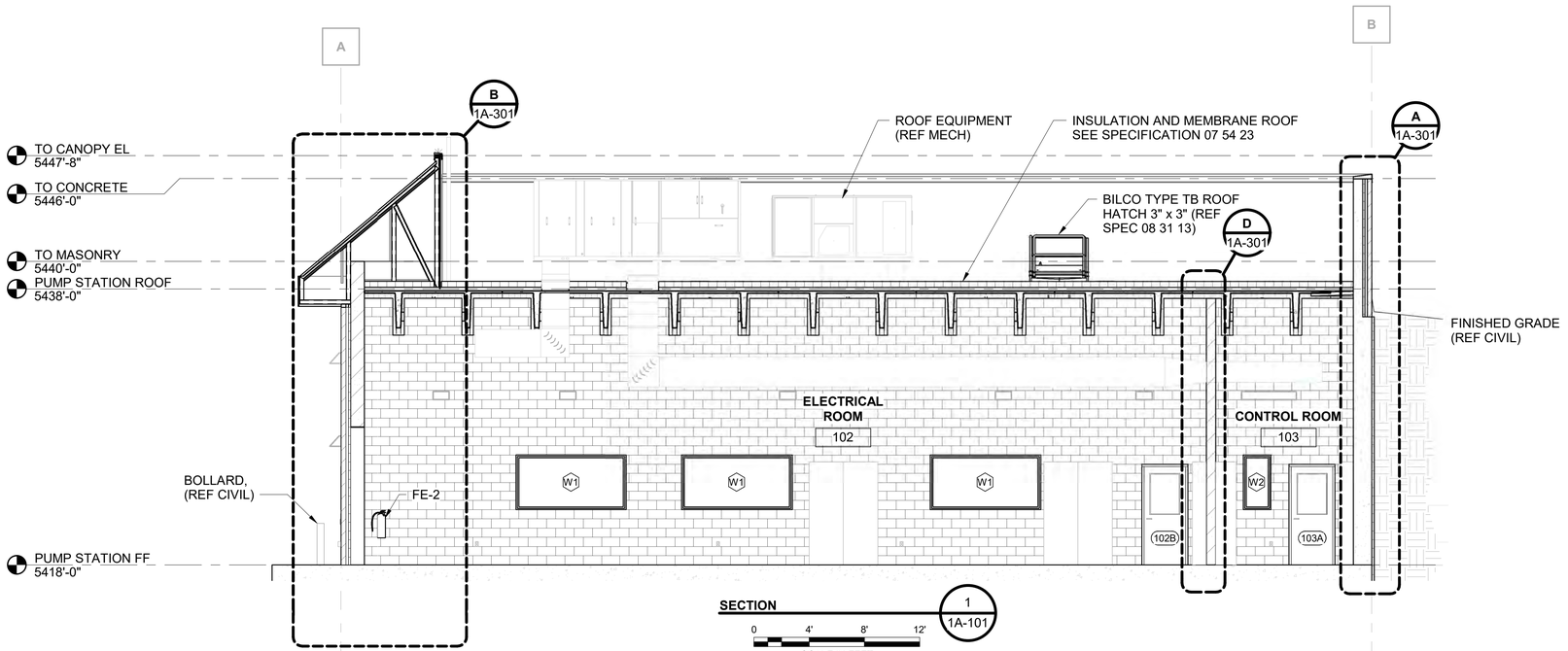
Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt



SECTION A 1A-101

0 4' 8' 12'

SCALE IN FEET



SECTION 1 1A-101

0 4' 8' 12'

SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION BUILDING SECTIONS

project	contract
135303	

drawing **1A-300** — rev. **1**

sheet of sheets

file

COLORADO · RYAN LANG · REGISTERED ARCHITECT · ARC.0010373 · 5/8/2025

Millimeters

Scale For Microfilming

Inches

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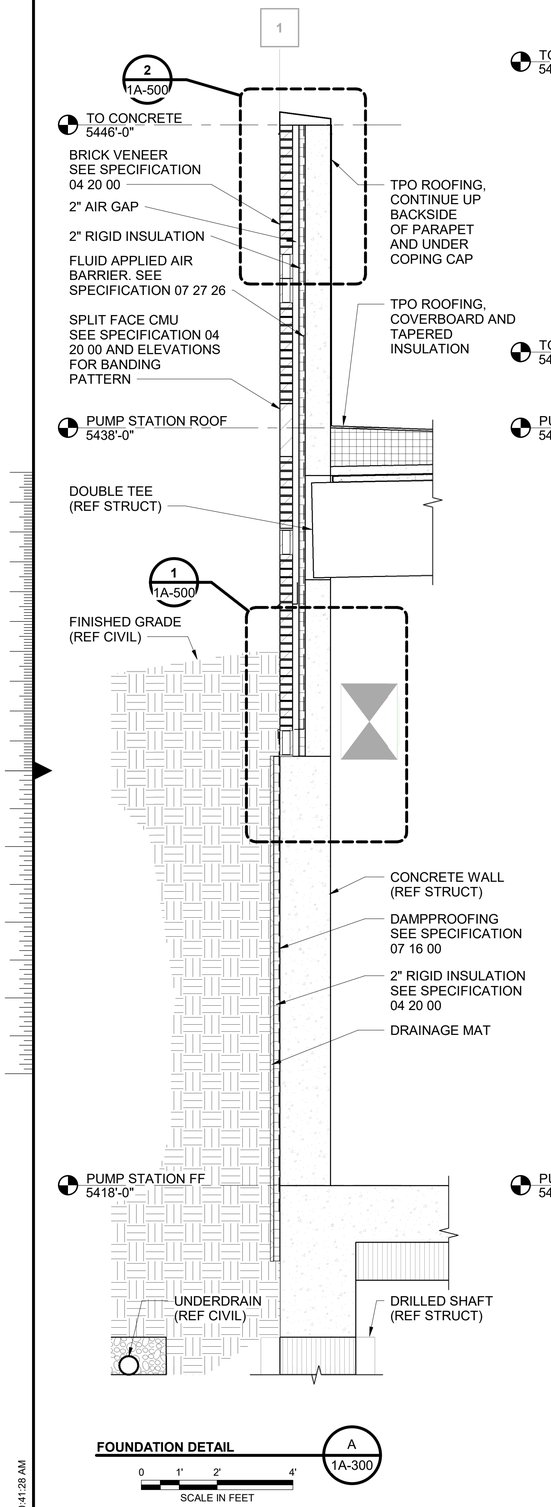
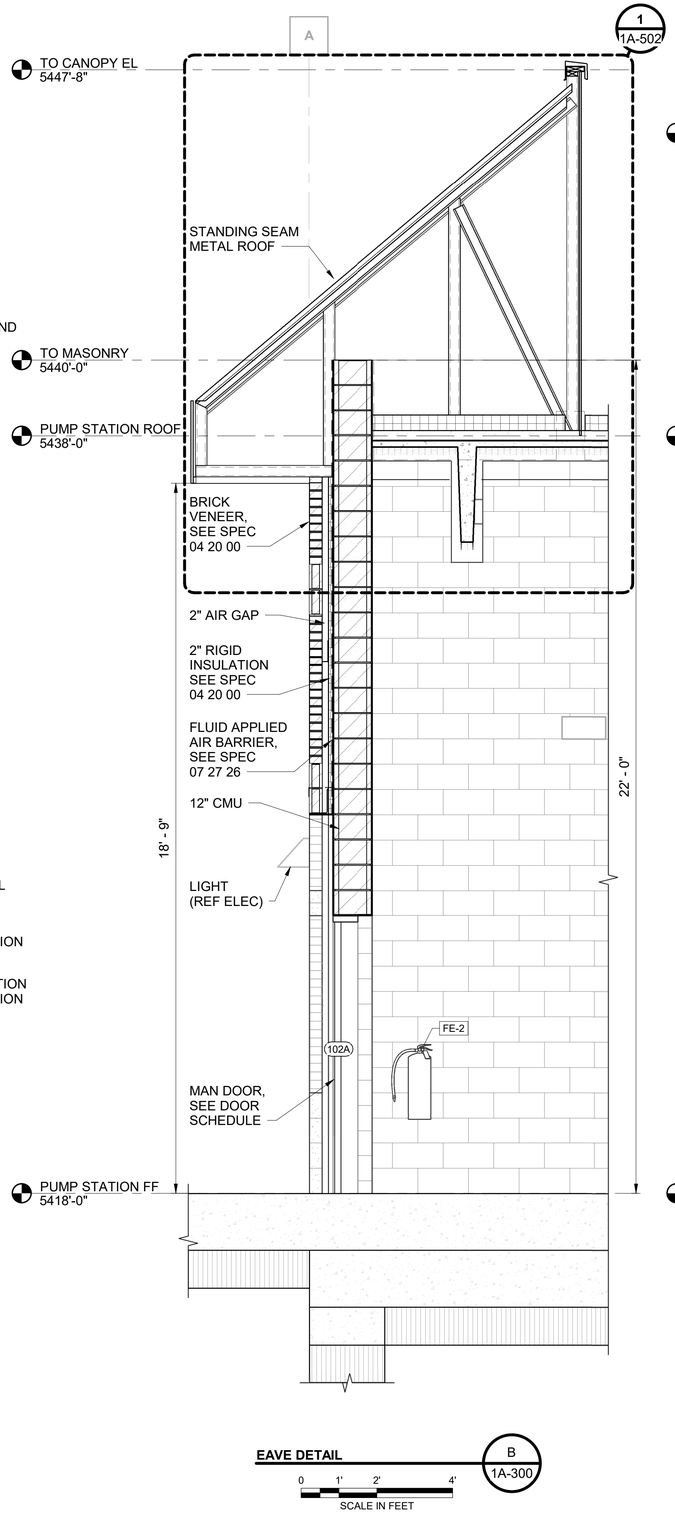


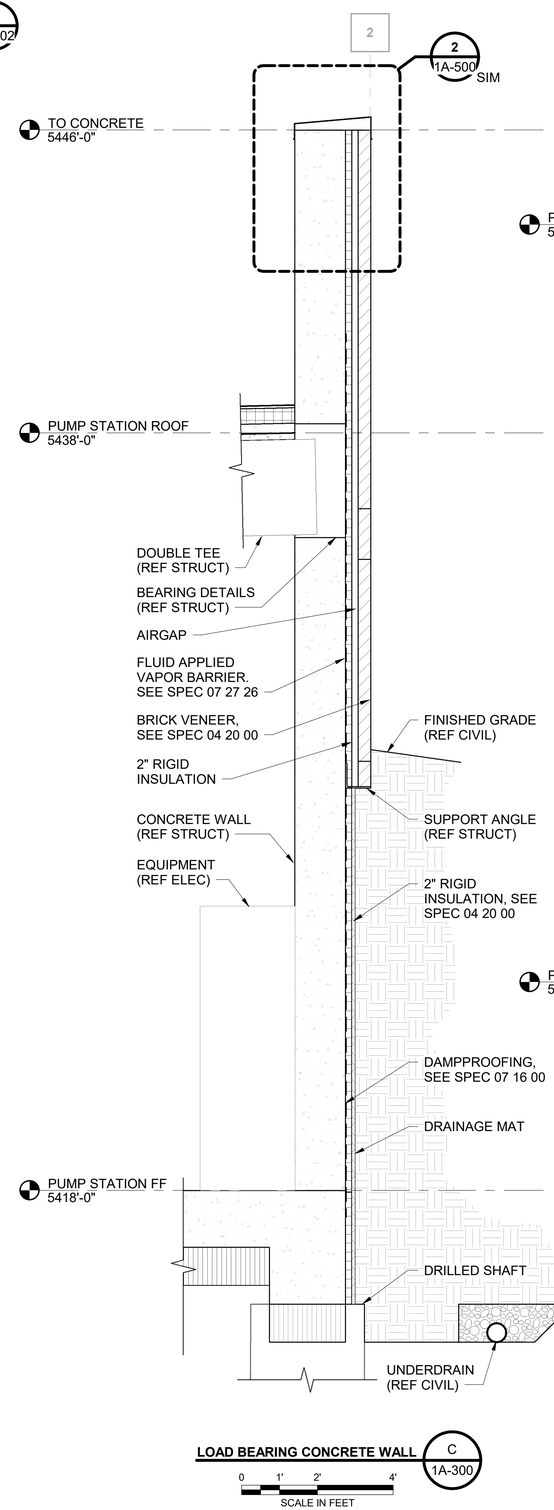
FOUNDATION DETAIL A 1A-300

0 1' 2' 4'
SCALE IN FEET



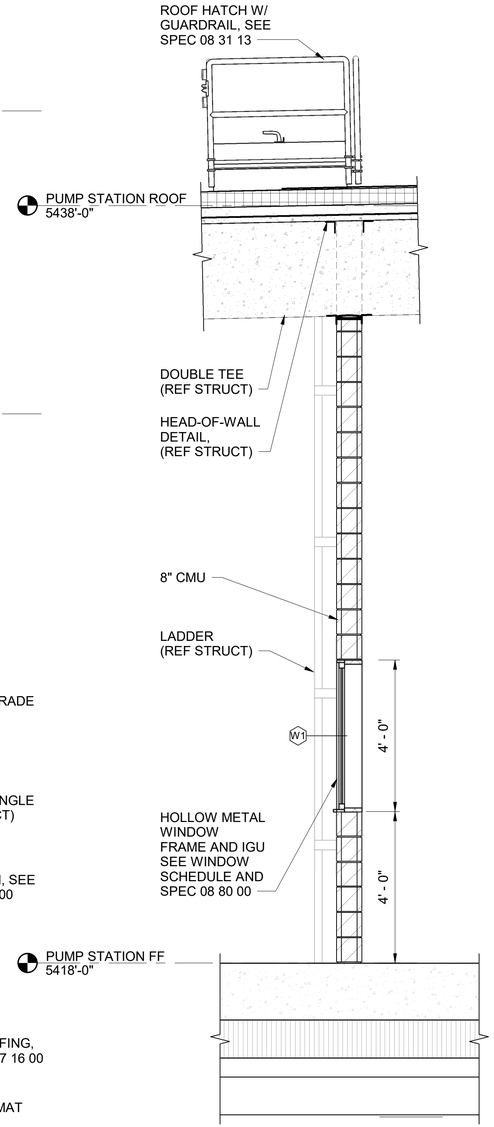
EAVE DETAIL B 1A-300

0 1' 2' 4'
SCALE IN FEET



LOAD BEARING CONCRETE WALL C 1A-300

0 1' 2' 4'
SCALE IN FEET



NON-LOAD BEARING CMU WALL D 1A-300

0 1' 2' 4'
SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	checked
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION WALL SECTIONS

project	contract
135303	

drawing **1A-301** — rev. **1**

sheet of sheets
file

COLORADO · BRIAN S. LANG · ARCHITECT · ARC.0000279 · 5/8/2025 · REGISTERED ARCHITECT

Scale For Microfilming: Millimeters / Inches

5/8/2025 10:41:28 AM

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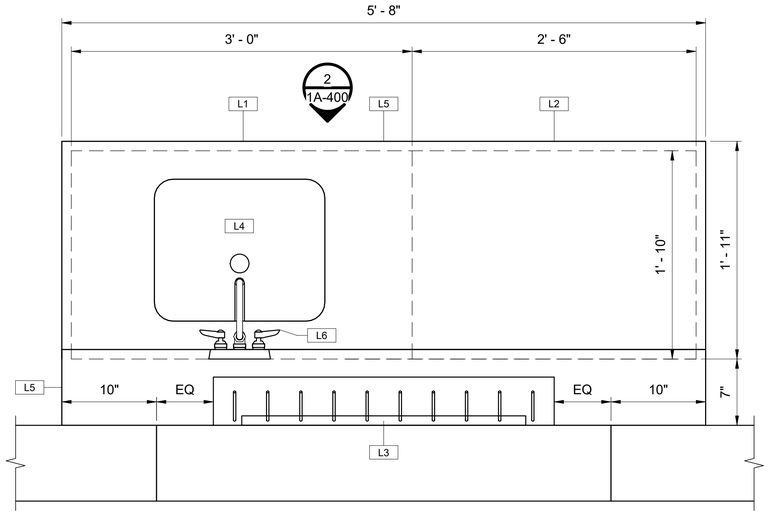
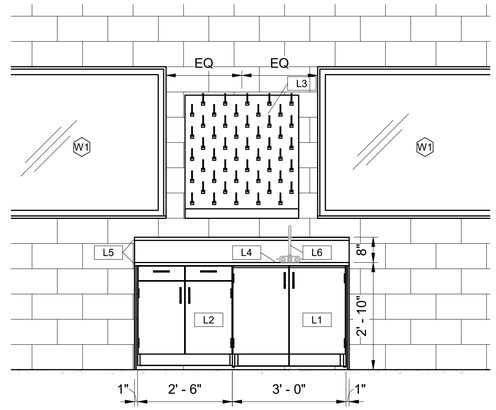


ENLARGED SINK PLAN — 1 / 1A-101

0 1/2' 1' 1 1/2'

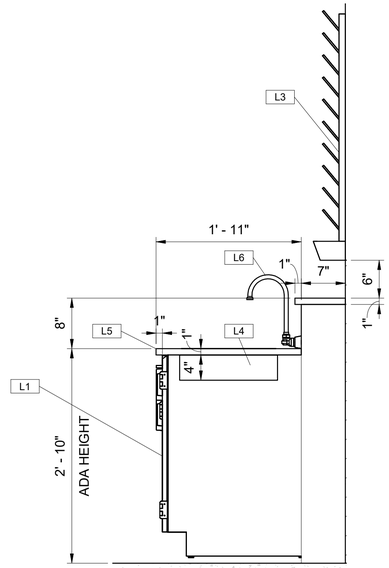
SCALE IN FEET



INTERIOR SINK ELEVATION — 2 / 1A-400

0 1' 2' 4'

SCALE IN FEET



ADA LAB SINK SECTION

0 1" 2"

SCALE IN FEET

FURNITURE SCHEDULE

MARK	AMOUNT	DESCRIPTION	WIDTH	DEPTH	HEIGHT	MODEL	MFR	REMARKS
L1	1	ADA HEIGHT SINK CABINET W/ 2 DOORS	3'-0"	1'-10"	2'-10"	G03C322236	KEWAUNEE	
L2	1	SOLID BASE DOUBLE DOOR W/ 2 DRAWERS	2'-6"	1'-10"	2'-10"	E41C322230	KEWAUNEE	
L3	1	PEGBOARD W/ DRIP TROUGH	2'-8"	0'-1"	2'-6"	X-020017-GR	KEWAUNEE	
L4	1	ADA DEPTH SINK BASIN	2'-1"	0'-4"	1'-3"	1005-ADA-DI-BK	KEWAUNEE	DROP-IN TYPE, EPOXY RESIN, ANTI-SIPHON PANEL MOUNTED FAUCET (REF MECH)
L5	2	ADA HEIGHT COUNTERTOP		1'-11"	2'-10"		KEWAUNEE	1" EPOXY RESIN
L6	1	LAB FAUCET				B-1146	T&S BRASS AND BRONZE WORKS, INC.	PANEL MOUNTED W/ PADDLE HANDLES (REF MECH)

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD · COLORADO ·

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ENLARGED PLAN AND INTERIOR ELEVATIONS

project	contract
135303	

drawing 1A-400 — **rev.** 1

sheet **of** **sheets**

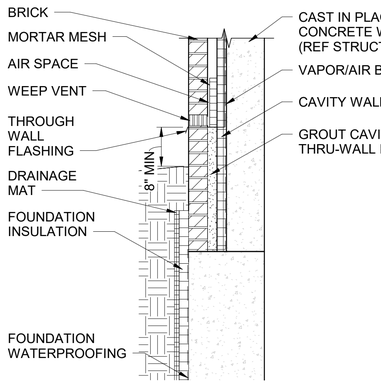
file

COLORADO · RYAN S. LANG · REGISTERED ARCHITECT · 5/8/2025

Scale For Microfilming
Millimeters
Inches

5/8/2025 10:42:10 AM

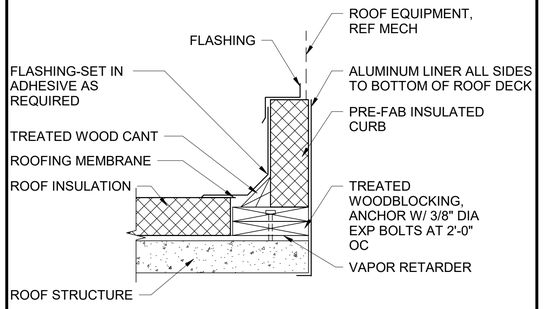
Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt



FOUNDATION DETAIL — 1 / 1A-301

0 1' 2' 3'

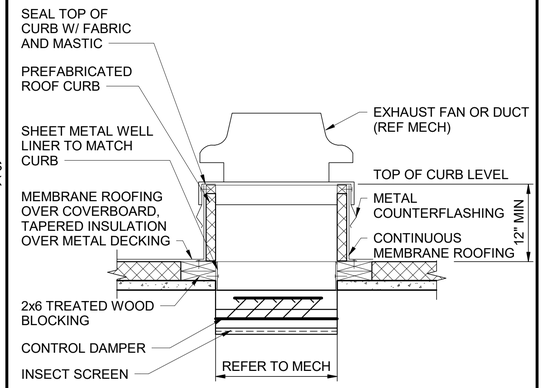
SCALE IN FEET



ROOF CURB

0 1/2' 1' 1 1/2'

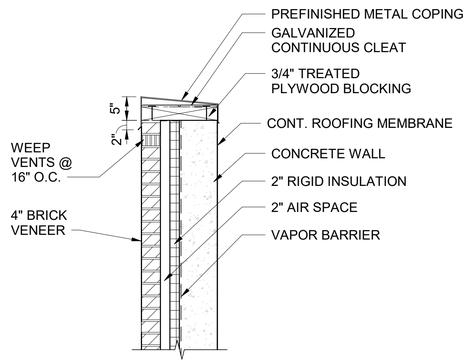
SCALE IN FEET



ROOF EXHAUST FAN DETAIL

0 1/2' 1' 1 1/2'

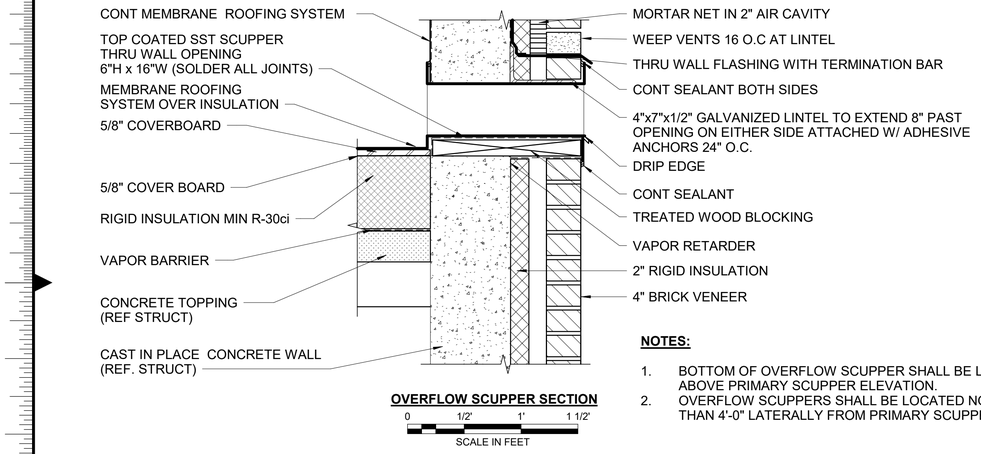
SCALE IN FEET



COPING DETAIL — 2 / 1A-301

0 1' 2' 3'

SCALE IN FEET



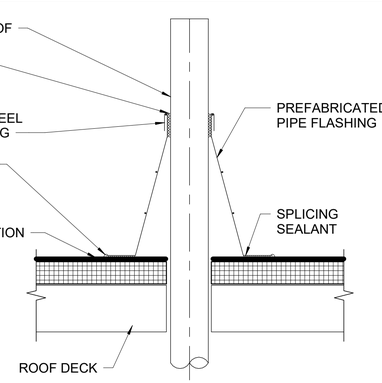
OVERFLOW SCUPPER SECTION

0 1/2' 1' 1 1/2'

SCALE IN FEET

NOTES:

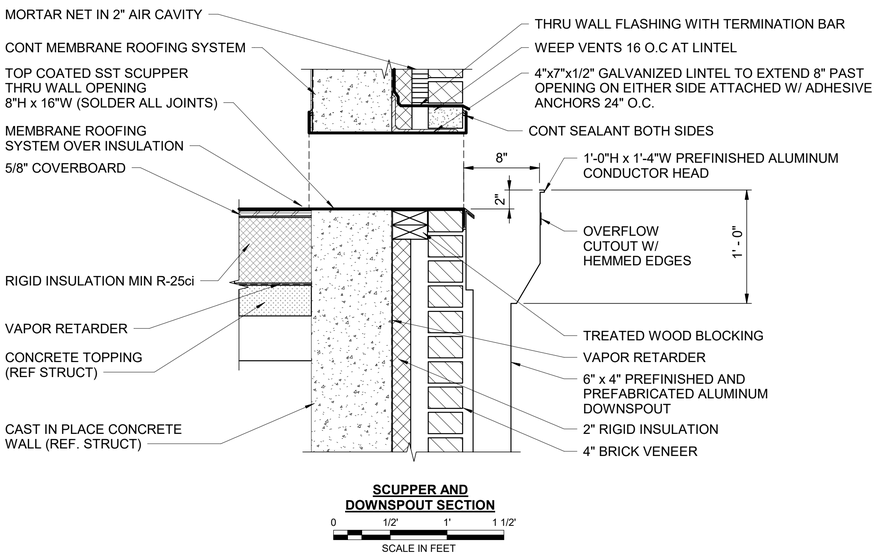
1. BOTTOM OF OVERFLOW SCUPPER SHALL BE LOCATED 2" ABOVE PRIMARY SCUPPER ELEVATION.
2. OVERFLOW SCUPPERS SHALL BE LOCATED NOT LESS THAN 4'-0" LATERALLY FROM PRIMARY SCUPPERS.



VENT THRU MEMBRANE ROOF

0 1/2' 1' 1 1/2'

SCALE IN FEET



SCUPPER AND DOWNSPOUT SECTION

0 1/2' 1' 1 1/2'

SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements. **THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."**

City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION ARCHITECTURAL DETAILS I

project	contract
135303	

drawing **1A-500** — rev. **1**

sheet of sheets

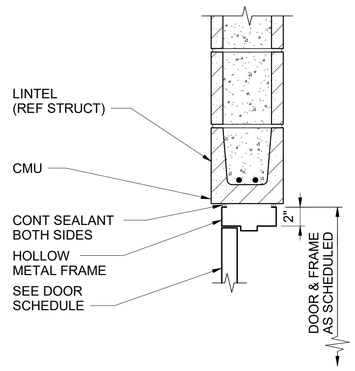
file

COLORADO REGISTERED ARCHITECT ARC.0000272 5/8/2025

Scale For Microfilming: Millimeters / Inches

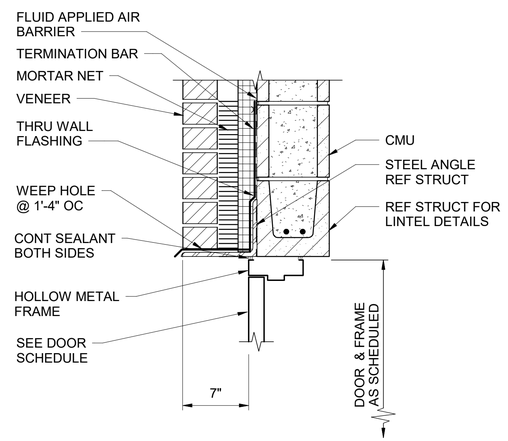
5/8/2025 10:44:32 AM

Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt



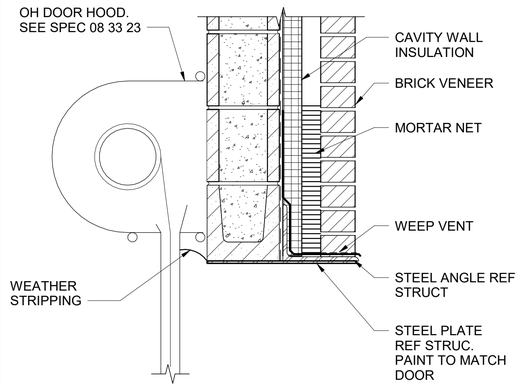
CMU - DOOR HEAD 4

0 1/2' 1' 1 1/2'
SCALE IN FEET



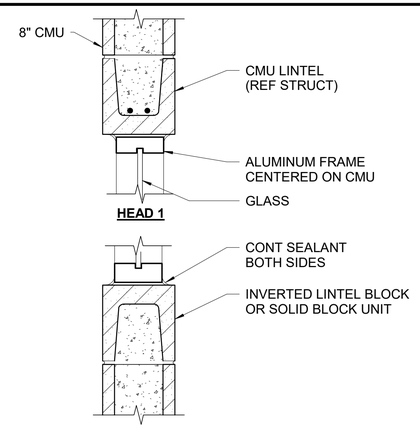
CMU W/ VENEER
DOOR HEAD 1

0 1/2' 1' 1 1/2'
SCALE IN FEET



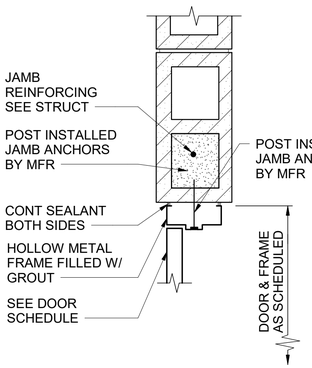
DOOR HEAD 7

0 1/2' 1' 1 1/2'
SCALE IN FEET



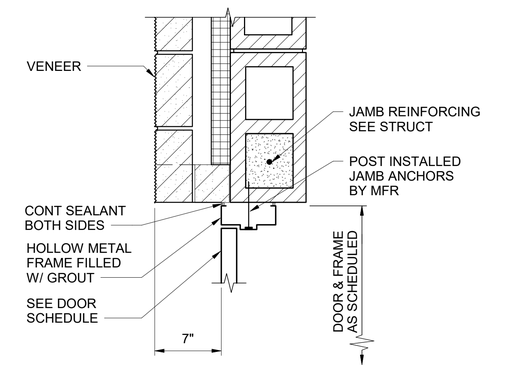
WINDOW @ CMU WALL

0 1/2' 1' 1 1/2'
SCALE IN FEET



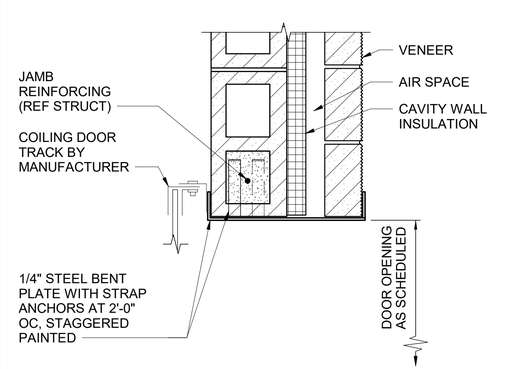
CMU - DOOR JAMB 10

0 1/2' 1' 1 1/2'
SCALE IN FEET



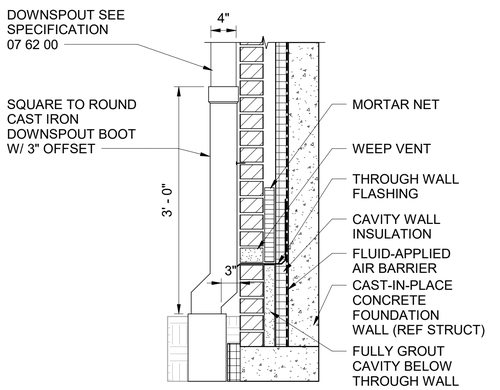
CMU W/ VENEER
DOOR JAMB 9

0 1/2' 1' 1 1/2'
SCALE IN FEET



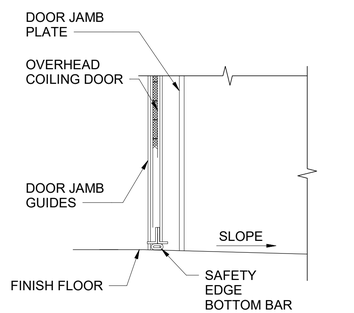
CMU W/ VENEER
DOOR JAMB 8

0 1/2' 1' 1 1/2'
SCALE IN FEET



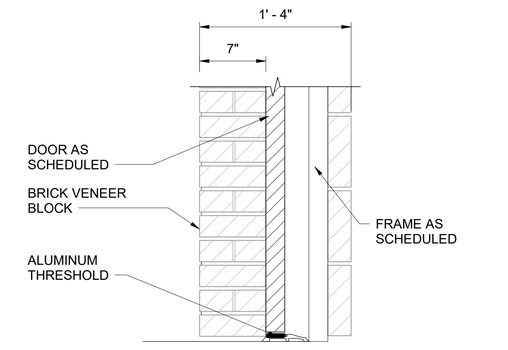
DOWNSPOUT DETAIL

0 1/2' 1' 1 1/2'
SCALE IN FEET



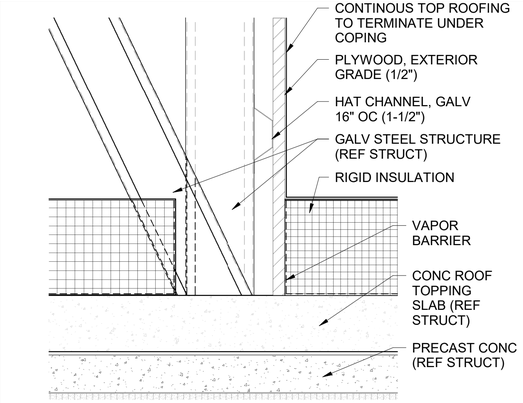
OH DOOR - DOOR SILL 2

0 1/2' 1' 1 1/2'
SCALE IN FEET



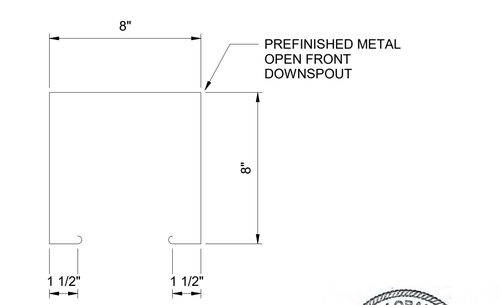
CMU W/ VENEER
DOOR SILL 1

0 1/2' 1' 1 1/2'
SCALE IN FEET



MANSARD ROOF CONNECTION 1 / 1A-502

0 3" 6" 9"
SCALE IN FEET



TYP. DOWNSPOUT DETAIL

0 3" 6" 9"
SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
A. LEYVA	R. LANG

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION ARCHITECTURAL DETAILS II

project	contract
135303	

drawing 1A-501 **rev.** 1

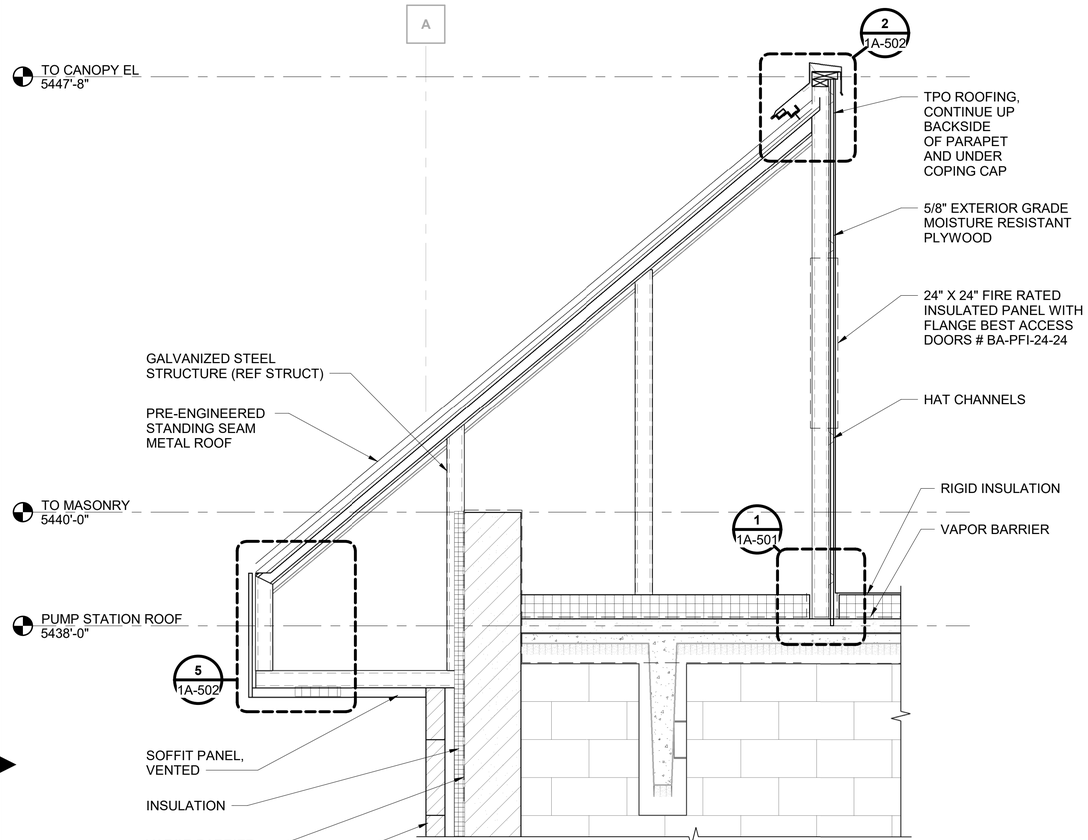
sheet of **sheets**

file

COLORADO REGISTERED ARCHITECT RYAN LANG ARC.00403270 5/8/2025

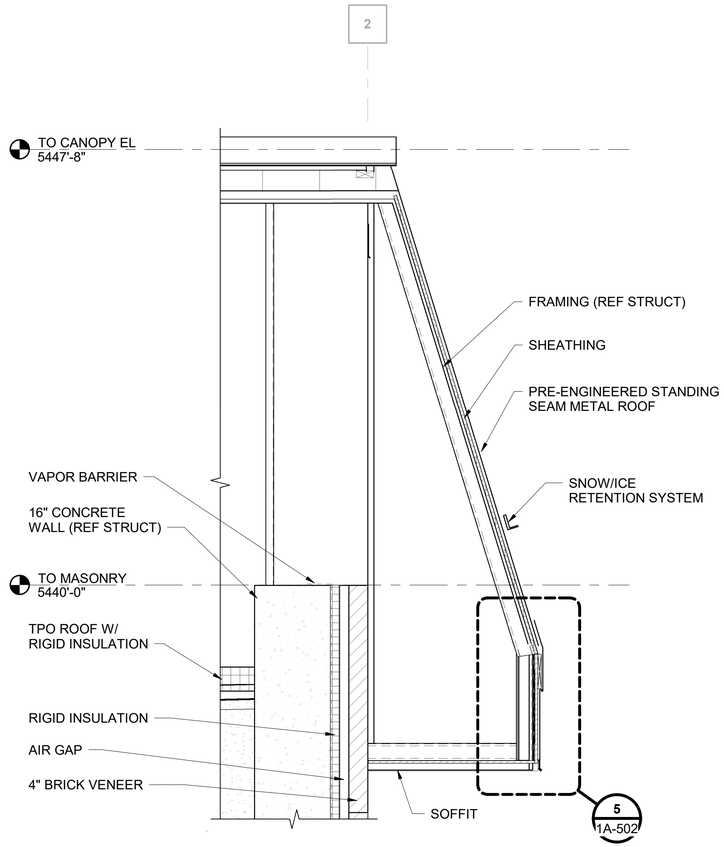
Scale For Microfilming
Millimeters
Inches
5/8/2025 11:49:25 AM

Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt



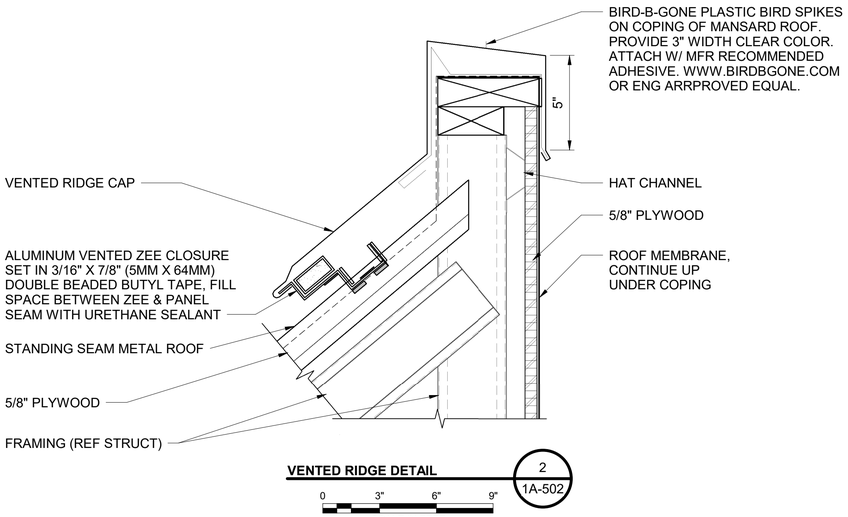
DETAIL 1 / 1A-301

SCALE IN FEET: 0, 1', 2', 3'



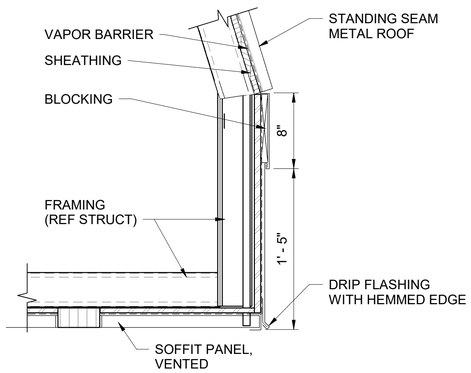
DETAIL 3 / 1A-102

SCALE IN FEET: 0, 1', 2', 3'



VENTED RIDGE DETAIL 2 / 1A-502

SCALE IN FEET: 0, 3", 6", 9"



FASCIA DETAIL 5 / 1A-502

SCALE IN FEET: 0, 1/2', 1', 1 1/2'

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date: MAY 2025	detailed: E. FIELDS
designed: J. DEAR	checked: R. LANG

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION ARCHITECTURAL DETAILS III

project: 135303	contract:
drawing: 1A-502	rev.: 1
sheet:	of: sheets
file:	

COLORADO · CHARLIE R. LANG · REGISTERED ARCHITECT · ARC.00103273 · 5/8/2025

Scale For Microfilming: Millimeters / Inches

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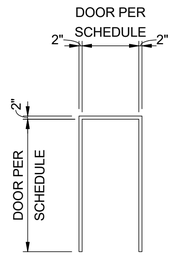
DOOR SCHEDULE

DOOR NUMBER	PAIR	DOOR SIZE WIDTH	DOOR SIZE HEIGHT	DOOR TYPE	DOOR MATERIAL	DOOR FINISH	FRAME	FRAME MATERIAL	FRAME FINISH	DETAIL HEAD	DETAIL JAMB	DETAIL SILL	HARDWARE SET	REMARKS
101A		3'-2"	7'-2"	F	HM	PAINT	1	HM	PAINT	1	9	1	1	
101B		14'-0"	14'-0"	OH-C	STEEL	PAINT	1	HM	PAINT	7	8	2	MFR	REF ELEC FOR POWER
101C		3'-2"	7'-2"	F	HM	PAINT	1	HM	PAINT	1	9	1	3	
102A	X	6'-4"	7'-2"	F	HM	PAINT	2	HM	PAINT	1	9	1	2	
102B		3'-2"	7'-2"	HG	HM	PAINT	1	HM	PAINT	4	10	1	4	
103A		3'-2"	7'-2"	HG	HM	PAINT	1	HM	PAINT	4	10	2	5	



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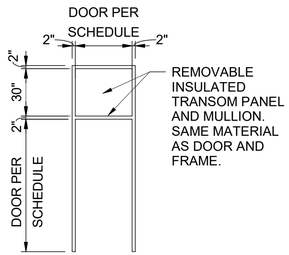

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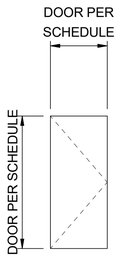

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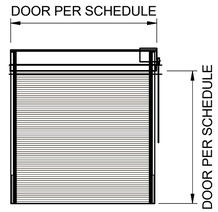


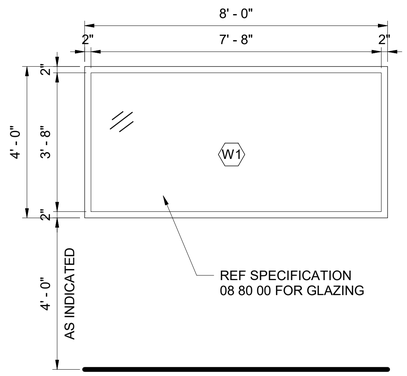
OH-C

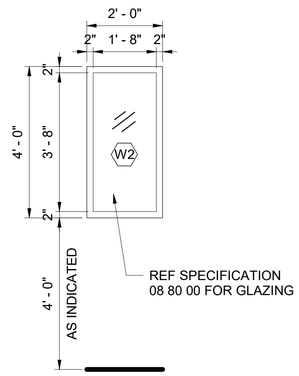
DOOR FRAMES AND TYPES

0 2' 4' 8'
SCALE IN FEET

WINDOW SCHEDULE

QUANITY	TYPE	SIZE HEIGHT	SIZE WIDTH	SILL HEIGHT AFF	DETAIL HEAD	DETAIL JAMB	DETAIL SILL	REMARKS
3	W1	4'-0"	8'-0"	4'-0"	1	1	1	
1	W2	4'-0"	2'-0"	4'-0"	1	1	1	





FIXED GLASS WINDOW DETAILS

0 1' 2' 4'
SCALE IN FEET

ROOM FINISH SCHEDULE

ROOM NUMBER	NAME	FLOOR FINISH	BASE FINISH	WALLS NORTH	WALLS SOUTH	WALLS EAST	WALLS WEST	CEILING
101	PUMP STATION	10	20	30	30	30	30	40
102	ELECTRICAL ROOM	10	20	30	30	30	30	40
103	CONTROL ROOM	10	20	30	30	30	30	40

FLOOR:
10-CONCRETE HARDENER

BASE:
20-NO BASE

WALLS:
30-PAINTED CMU/CONCRETE

CEILING:
40-NO FINISH

no.	date	by	ckd	description
0	01/28/25	AEL	RPL	ISSUED FOR CONSTRUCTION
1	05/06/25	JRD	RPL	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Architecture, P.C.

date	detailed
MAY 2025	E. FIELDS
designed	**checked**
J. DEAR	R. LANG

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION ARCHITECTURAL SCHEDULES & DETAILS

project	contract
135303	

drawing 1A-600 — **rev.** 1

sheet of **sheets**

file

COLORADO · RYAN S. LANG · ARC.0000279 · 5/8/2025 · REGISTERED ARCHITECT

Scale For Microfilming
Millimeters
Inches
5/8/2025 10:44:52 AM

Autodesk Docs://135303_TanksProject/135303_01_SA_PSTN.rvt

PIPE LINE ACCESSORIES

- GATE VALVE
- OS&Y OUTSIDE SCREW & YOKE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- 2-WAY VALVE
- 3-WAY VALVE
- BALL VALVE
- M MOTORIZED CONTROL VALVE
- GLOBE VALVE
- PLUG VALVE
- ANGLE VALVE
- SELF CONTAINED PRESSURE REDUCING (REGULATING) VALVE
- FLEX CONNECTION
- PUMP
- THERMOMETER
- BFP BACKFLOW PREVENTION ASSEMBLY
- PRESSURE GUAGE
- Y-TYPE STRAINER
- REMOVABLE CAP
- REMOVABLE PLUG
- REDUCER (CONCENTRIC)
- UNION
- M METER
- FLOW ARROW

PIPE LINE DESIGNATIONS

V	VENT
S	STORM (ABOVE GRADE)
S	STORM (BELOW GRADE)
OD	STORM OVERFLOW
DCW	DOMESTIC COLD WATER
DHW	DOMESTIC HOT WATER
DHWR	DOMESTIC HOT WATER RECIRCULATION
SS	SANITARY SEWER (ABOVE GRADE)
SS	SANITARY SEWER (BELOW GRADE)
COND	CONDENSATE DRAIN
NG	NATURAL GAS
CO	CLEANOUT IN RISER
WCO	CLEANOUT IN WALL
FCO	CLEANOUT IN FLOOR

PLUMBING ABBREVIATIONS

AFF	ABOVE FINISHED FLOOR
AG	AIR GAP
CONC	CONCENTRIC
CPVC	CHLORINATED POLYVINYL CHLORIDE
D	DRAIN
DN	DOWN
DWH	DOMESTIC WATER HEATER
EXIST	EXISTING
FD	FLOOR DRAIN
FM	FLOW METER
HD	HUB DRAIN
I.E.	INVERT ELEVATION
IF	INSULATED FLANGE
LC	LOCK CLOSED
LO	LOCK OPEN
PSIA	POUNDS PER SQUARE INCH ABSOLUTE
PSIG	POUNDS PER SQUARE INCH GAUGE
PVC	POLYVINYL CHLORIDE
SCH	SCHEDULE
TD	TRENCH DRAIN
TP	TRAP PRIMER
TYP	TYPICAL
VTR	VENT THROUGH ROOF

GENERAL NOTES:

1. UNLESS NOTED OTHERWISE, THE CIVIL AND MECHANICAL INTERFACE POINT IS 5 FEET OUTSIDE OF THE BUILDING WALL.
2. COORDINATE ALL PIPE SLEEVE REQUIREMENTS WITH FOUNDATION SUBCONTRACTOR.
3. LOCATE ALL PLUMBING EQUIPMENT FOR UNOBSTRUCTED ACCESS TO UNIT ACCESS PANELS, CONTROLS, AND VALVING.
4. LEGEND IS GENERAL IN NATURE AND NOT ALL ITEMS SHOWN MAY BE USED ON THIS PROJECT.
5. INSTALL SANITARY PIPING WITH 2% SLOPE DOWNWARD IN DIRECTION OF FLOW. INSTALL VENT PIPING WITH 1% SLOPE DOWNWARD TOWARD FIXTURE OR STACK.
6. ALL FIXTURES SHALL HAVE A P-TRAP INSTALLED(UNLESS OTHERWISE NOTED).
7. PROVIDE ALL MATERIALS, VALVES, HANGERS, ETC. AND EQUIPMENT AND PERFORM ALL LABOR REQUIRED TO INSTALL COMPLETE AND OPERABLE PLUMBING SYSTEMS AS INDICATED ON THE DRAWINGS, AS SPECIFIED AND AS REQUIRED BY CODE.
8. INSTALL ALL PLUMBING FIXTURES, EQUIPMENT AND APPURTENANCES IN ACCORDANCE WITH MANUFACTURER'S RECOMMENDATIONS, CONTRACT DOCUMENTS, AND APPLICABLE CODES AND REGULATIONS.
9. COORDINATE CONSTRUCTION OF ALL PLUMBING WORK WITH STRUCTURAL, CIVIL, ELECTRICAL WORK ETC., SHOWN ON OTHER CONTRACT DOCUMENT DRAWINGS.
10. VERIFY DIMENSIONS AND CONNECTION SIZE WITH FURNISHED EQUIPMENT.

no.	date	by	ckd	description
0	01/28/25	DLO	CG	ISSUED FOR CONSTRUCTION
1	05/06/25	DLO	CG	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

PLUMBING SYMBOLS LEGEND

	EEWS-1	EMERGENCY EYEWASH / SHOWER
	4" FD-A	SIZE - FLOOR DRAIN
	HB	HOSE BIBB
	WH	WALL HYDRANT

RISER DIAGRAM LEGEND

- CO — CLEANOUT (CO) IN RISER
- FCO — CLEANOUT (FCO) IN FLOOR
- VENT THRU ROOF (VTR)
- FLOOR OR WALL PENETRATION
- PLUMBING FIXTURE TRAP
- FLOOR DRAIN / EQUIPMENT DRAIN
- WHA-A — WATER HAMMER ARRESTOR
- WCO — WALL CLEANOUT (WCO)
- UP / DN — ISOMETRIC DIRECTION ARROW

PIPE SYMBOLS

- PIPE ELBOW
- PIPE DOWN
- PIPE UP
- PIPE CONTINUATION

COLORADO REGISTERED DAVID L. OLSEN 44374 PROFESSIONAL ENGINEER
5/7/2025

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: D. OLSEN
designed: D. OLSEN	checked: C. GUERRA

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PLUMBING GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS

project: 135303	contract:
drawing: 0P-001	rev.: 1
sheet	of sheets
file	

Millimeters
Inches
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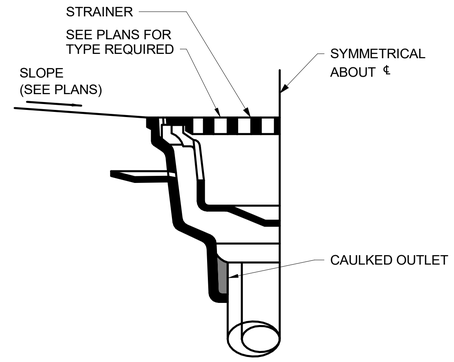

FLOOR DRAIN INSTALLED IN GROUND FLOOR
NOT TO SCALE

BACKFLOW PREVENTER SCHEDULE

TAG NO.	TYPE	BASIS OF DESIGN MFR	BASIS OF DESIGN MODEL	SYSTEM	SIZE	DESIGN FLOW (GPM)	REMARKS
BFP-1	REDUCED PRESSURE ZONE ASSEMBLIES	WATTS	009	DCW	3/4"	25	

PUMP SCHEDULE

TAG	TYPE	LOCATION	DESIGN MINIMUM CAPACITY: CAPACITY (GPM)	DESIGN MINIMUM CAPACITY: PUMP HEAD (FT)	DISCHARGE SIZE	MOTOR HP	VOLTS	PHASE	BASIS OF DESIGN: MANUFACURER	BASIS OF DESIGN: MODEL	REMARKS
P-131	SUMP PUMP	POTABLE PUMP STATION	96	10	2"	0.5	200	1	ZOELLER	I282	1

NOTES:
1. PROVIDE CONTROL PANEL WITH HOA, AUDIO ALARM AND DRY CONTACTS TO SEND ALARMS TO SCADA (HIGH WATER, CONTINOUS PUMP RUN AND FAULT). PROVIDE THREE FLOAT SWITCHES, FLOAT SWITCH BRACKET, CHECK VALVES, SHUT OFF VALVE, DISCONNECT RAIL SYSTEM AND LIFTING BAIL.

DRAIN SCHEDULE

TAG NO.	DESCRIPTION	BASIS OF DESIGN: MFGR	BASIS OF DESIGN: MODEL NUMBER	OUTLET SIZE	TYPE	STRAINER	REMARKS
FD-1	CAST IRON, TWO PIECE BODY, INTEGRAL CLAMPING COLLAR, TRAP SEAL	JAY R. SMITH	2005-A	4"	FLOOR DRAIN - ROUND	5"ø ADJUSTABLE, NICKEL-BRONZE	

PLUMBING FIXTURE SCHEDULE

TAG	FIXTURE: BOD MFGR	FIXTURE: BOD MODEL	FIXTURE: TYPE	FITTING: BOD MFGR	FITTING: BOD MODEL	FITTING: TYPE	TRAP	CARRIER	MOUNTING HEIGHT	CONNECTION SIZE: DCW	CONNECTION SIZE: DHW	CONNECTION SIZE: WASTE	REMARKS
HB-1			INTERIOR HOSE BIBB	WOODFORD	24	BRASS W/ANTI-SIPHON VACUUM BREAKER, TEE KEY HANDLE, AND HOSE CONNECTION	N/A	N/A	36" AFF	3/4"	N/A	N/A	WALL MOUNTED WITH POLISHED CHROME FINISH
SK-1			SEE ARCHITECTURAL DRAWINGS, COUNTER TOP WITH INTEGRAL SINK.	DELTA	W6601-8-J	SINGLE HOLE SINGLE TEMPURATURE FAUCET, SWIVEL SPOUT AND SINGLE METAL LEVER HANDLE	1-1/2"	N/A	HT. SET BY COUNTER TOP	1/2"	1/2"	2	PROVIDE SS BASKET STRAINER AND PLASTIC TRAP, COODINATE WITH SINK FOR REQUIRMENTS FOR COMPLETE INSTALLATION.

no.	date	by	ckd	description
0	01/28/25	DLO	CG	ISSUED FOR CONSTRUCTION
1	05/06/25	DLO	CG	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	D. OLSEN
designed	**checked**
D. OLSEN	C. GUERRA

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PLUMBING DETAILS AND SCHEDULES

project	contract
135303	
drawing	**rev.**
0P-002	1
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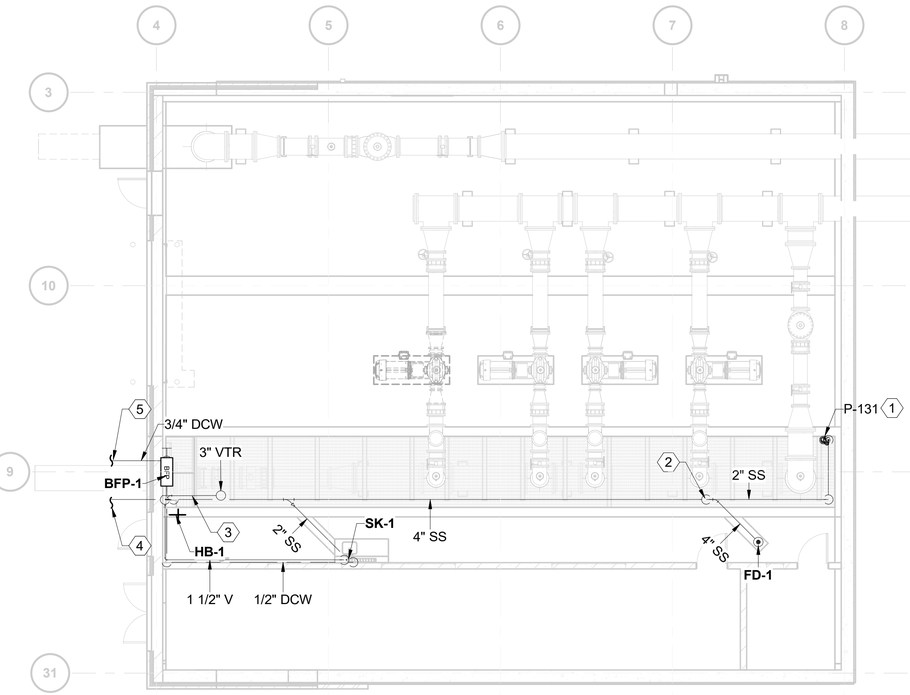

PUMP STATION FF PLUMBING

0 4' 8' 16'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. FIELD ROUTE STORM DRAIN COORDINATING WITH OTHER DISCIPLINES FOR FINAL ELEVATIONS AND ROUTING TO MAINTAIN SLOPE.

KEYED NOTES: (#)

1. INSTALL SUMP PUMP IN SUMP PIT IN PIPE GALLERY BELOW FLOOR, COORDINATE WITH STRUCTURAL FOR EXACT LOCATION. ROUTE 2" DISCHARGE UP THE WALL OF THE TRENCH AND ROUTE ALONG WALL OF TRENCH.
2. CONNECT 2" DISCHARGE FROM SUMP PUMP INTO TOP OF 4" SS PIPING BELOW FLOOR FROM FLOOR DRAIN, ROUTED ALONG PIPE GALLERY WALL.
3. ROUTE 3" VENT THROUGH ROOF INSIDE OF ROOF SCREENING ALONG OUTSIDE WALL WITH REQUIRED OFFSETS.
4. COORDINATE WITH PROCESS DRAWINGS FOR CONTINUATION OF PIPING TO CONNECT TO SS IN STREET.
5. NEW 3/4" DCW TO CONNECT TO DCW MAIN IN THE YARD, COORDINATE WITH PROCESS DRAWINGS FOR LOCATION OF PIPING IN YARD. COORDINATE WITH THE CITY FOR SPECIFIC REQUIREMENTS.

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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	D. OLSEN
designed	**checked**
D. OLSEN	C. GUERRA

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PLUMBING PLAN

project	contract
135303	

drawing **0P-100** — rev. **1**

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SINGLE LINE PIPING

- 18" — PIPE SIZE AND DIRECTION OF FLOW
- GATE VALVE (GV) OR MUD VALVE (MV)
- GLOBE VALVE
- BUTTERFLY VALVE (BFV)
- CHECK VALVE (CV)
- STOP CHECK VALVE
- PLUG VALVE (PV)
- 3-WAY VALVE
- ANGLE VALVE
- RELIEF OR BACKPRESSURE VALVE
- HOSE GATE DRAIN VALVE
- PINCH VALVE
- NEEDLE VALVE
- DIAPHRAGM VALVE
- BALL VALVE (BV)
- P — SELF-CONTAINED PRESSURE REDUCING (REGULATING VALVE)
- S — SOLENOID VALVE
- BP — BACKFLOW PREVENTER
- VB — VACUUM BREAKER
- MS — MOISTURE SEPARATOR
- T — IN-LINE TOTALIZING FLOW METER
- LOCKED OPEN
- LOCKED CLOSED
- NO — NORMALLY OPEN
- NC — NORMALLY CLOSED
- FLEXIBLE HOSE
- EXPANSION ELEMENT (JOINT)
- FLEXIBLE BALL JOINT
- BASKET TYPE STRAINER
- TEE TYPE STRAINER
- Y-TYPE STRAINER
- FLANGED COUPLING ADAPTER (FCA)
- RETAINER FLANGE
- DRAINER ASSEMBLY
- INSULATING FLANGE (I.F.)
- RESTRICTING ORIFICE
- SIGHT FLOW INDICATOR
- ELBOW TURNING DOWN
- ELBOW TURNING UP
- TYPICAL PIPE BREAK
- PIPES IN SECTION
- TEE TURNING DOWN
- TEE TURNING UP
- ABOVE / PIPES CROSSING / BELOW
- ABOVE / PIPES CROSSING WITH BREAK-OUT TO SHOW PIPES OR EQUIPMENT BELOW / BELOW

- M — IN-LINE FLOW METER
- CLEANOUT (CO)
- DISCHARGE ELBOW ASSEMBLY
- STRAIGHTENING VANE
- REMOVABLE PLUG
- REMOVABLE CAP
- WELDED CAP
- BF — BLIND FLANGE
- DRIP POCKET ASSEMBLY
- STEAM TRAP ASSEMBLY
- AC — AIR COCK
- HB — HOSE BIBB
- WH — WALL HYDRANT
- PIPE ANCHOR
- PIPE GUIDE
- REDUCER
- UNION
- QUICK DISCONNECT COUPLING
- VENT THROUGH ROOF
- INJECTOR
- CENTRIFUGAL PUMP
- PROGRESSIVE CAVITY PUMP
- BLOWER
- POSITIVE DISPLACEMENT BLOWER
- FAN
- DIAPHRAGM METERING PUMP
- V — VACUUM TRAP
- WATER SURFACE (WS)
- PULSATION DAMPENER W/ ISOLATION BALL VALVE
- STATIC MIXER
- GAUGE SEAL
- DIAPHRAGM PROTECTED PRESSURE SWITCH
- PC — CHEMICAL APPLICATION POINT
- PIPE SUPPORT LOCATION
- PRV — PRESSURE REDUCING VALVE
- AIR RELEASE VALVE

DOUBLE LINE PIPING

- GATE VALVE
- BUTTERFLY VALVE
- FLANGED COUPLING ADAPTOR
- REDUCER
- FLANGED PIPING
- DOUBLE BOLTED SLEEVE COUPLING
- EXPANSION JOINT
- MECHANICAL JOINT PIPING
- HARNESSED SLEEVE COUPLING
- CHECK VALVE
- BALL VALVE
- A/O — AIR/OIL CYLINDER
- PLUG VALVE
- INLINE STRAINER
- DISMANTLING JOINT
- ELBOW TURNING DOWN
- ELBOW TURNING UP
- ABOVE / PIPES CROSSING / BELOW
- TYPICAL PIPE BREAK
- ABOVE / PIPES CROSSING WITH BREAK-OUT TO SHOW PIPES OR EQUIPMENT BELOW / BELOW
- PIPES IN SECTION

- AIR VAC
- GLOBE VALVE
- STRAINER
- MAG METER
- BLIND FLANGE
- WALL PIPE PENETRATION

LINETYPES

- EXISTING
- NEW CONSTRUCTION
- FUTURE CONSTRUCTION

MARKER

- XX — EQUIPMENT MARKER
- XX — VALVE MARKER

PROCESS TAGGING SYSTEM:

AREA EQUIPMENT LOOP NUMBER

XXXX-XXXX-####

LOOP NUMBER:

SYSTEM TRAIN QUANTITY/SEQUENCE

#

GENERAL ABBREVIATIONS

AAG	ABOVE AT GRADE
AFF	ABOVE FINISHED FLOOR
AFG	ABOVE FINISHED GRADE
BD	BLOWDOWN
BOC	BOTTOM OF CONCRETE
BOW	BOTTOM OF WEIR
CI	CAST IRON
CL	CENTERLINE
CO	CLEANOUT
DIA	DIAMETER
DIP	DUCTILE IRON PIPE
DR	DRAIN
DV	DRAIN VALVE
EL	ELEVATION
FCA	FLANGED COUPLING ADAPTER
FF	FINISHED FLOOR
FM	FORCE MAIN
FP	FIRE PROTECTION
FRP	FIBER REINFORCED PLASTIC
HGL	HYDRAULIC GRADE LINE
HWL	HIGH WATER LEVEL
ID	INNER DIAMETER
IE	INVERT ELEVATION
INV	INVERT
LWL	LOWER WATER LEVEL
MAX	MAXIMUM
MG	MILLION GALLONS
MGD	MILLION GALLONS PER DAY
MIN	MINIMUM
NG	NATURAL GAS
NIC	NOT IN CONTRACT
OC	ON CENTER
OVE	OVERHEAD ELECTRIC
OVF	OVERFLOW
PCW	POTABLE COLD WATER
PD	PROCESS DRAIN
PS	PIPE SUPPORT
PSI	POUNDS PER SQUARE INCH
PV	PLUG VALVE
RED	REDUCER
SS	SANITARY SEWER
SCH	SCHEDULE
SQ	SQUARE
SST	STAINLESS STEEL
TBD	TO BE DETERMINED
TBR	TO BE REMOVED
TEMP	TEMPORARY
THRU	THROUGH
TOC	TOP OF CONCRETE
TOS	TOP OF STEEL
TOW	TOP OF WALL
UGE	UNDERGROUND ELECTRIC
UGT	UNDERGROUND TELEPHONE
UNO	UNLESS NOTED OTHERWISE
VT	VERTICAL TURBINE
W	WATER SUPPLY LINE
WS	WATER SURFACE

PROCESS PIPE IDENTIFICATION:

AIR	AIR PIPING
FA	FOUL AIR
BFF	BIOFILTER FILTRATE
CA	COMPRESSED AIR
DS	DIGESTED SOLIDS
DF	DEWATERING FEED
FCI	FINAL CLARIFIER INFLUENT
FCU	FINAL CLARIFIER UNDERFLOW
FEFF	FINAL EFFLUENT
GINF	GRIT INFLUENT
GR	GRIT RETURN
INF	PLANT INFLUENT
IRW	IRRIGATION WATER
ML	MIXED LIQUOR
NPW	NON-POTABLE WATER
POS	POLYMER SOLUTION
PR	PRESSATE RETURN
PW	POTABLE WATER
RAS	RETURN ACTIVATED SLUDGE
SC	SCUM
SEFF	SECONDARY EFFLUENT
SINF	SECONDARY INFLUENT
SNT	SUPERNATANT
SSW	SANITARY SEWER
UR	UV RETURN STREAM
WAS	WASTE ACTIVATED SLUDGE
WSC	COMBINED WAS AND SCUM

PROCESS AREA IDENTIFICATION:

AB	AERATION BASIN
ADMN	ADMINISTRATION BUILDING
BLWR	BLOWER BUILDING
BIOF	BIOFILTER
GEN	BACKUP GENERATOR SYSTEM
DIG	DIGESTOR
EFFL	EFFLUENT STRUCTURE
SITE	GENERAL SITE
HDWK	HEADWORKS BUILDING
INFL	INFLUENT LIFT STATION
OD	OXIDATION DITCH
PCLR	PRIMARY CLARIFIER
SCLR	SECONDARY CLARIFICIER
SB	STORAGE BUILDING
SLDS	SOLIDS HANDLING AND DEWATERING BUILDING
SPB	SLUDGE PUMPING BUILDING
UV	UV BUILDING
WHLD	WAS HOLDING TANK

PROCESS SYSTEM IDENTIFICATION:

1 = CFS	COARSE AND FINE SCREEN
2 = GR	GRIT REMOVAL
3 = INF	INFLUENT CONTROL
4 = PC	PRIMARY CLARIFICATION
5 = AB	AERATION BASIN
6 = OD	OXIDATION DITCH
7 = SC	SECONDARY CLARIFICATION
8 = DIS	UV DISINFECTION
9 = AER	AEROBIC DIGESTION
10 = RAS	RETURN ACTIVATED SLUDGE
11 = WAS	WASTE ACTIVED SLUDGE
12 = SCR	SCUM REMOVAL
13 = SR	SLUDGE THICKENING
14 = DW	DEWATERING
15 = EL	ELECTRICAL
16 = HVAC	HEATING, VENTILATION, AND AIR CONDITIONING

PROCESS EQUIPMENT IDENTIFICATION:

AER	AERATOR
AC	AIR COMPRESSOR
AR	AIR RECIEVER
ARV	AIR RELEASE VALVE
ATS	AUTOMATIC TRANSFER SWITCH
AVR	AIR VACUUM RELIEF VALVE
BDP	BIOFILTER DRAIN PUMP
BST	BASKET STRAINER
BFV	BUTTERFLY VALVE
BNK	UV BANK
BT	BLADDER TANK
BV	BALL VALVE
CP	PROCESS CONTROL PANEL
CV	CHECK VALVE
FT	FLOCCULATION TANK
FE	FLOW ELEMENT
G	GENERATOR
GV	GATE VALVE
GR	GRINDER
HCS	HYDRAUILIC CLEANING SYSTEM
LP	208/120V POWER DISTRIBUTION
M	MOTOR
MCC	MOTOR CONTROL CENTER
MIX	MIXER
PP	480 V POWER DISTRIBUTION
PDC	POWER DISTRIBUTION CENTER
P	PUMP
PRV	PRESSURE REDUCING VALVE
PV	PLUG VALVE
RDR	RADAR
RTU	REMOTE TERMINAL UNIT WIT OIT
SG	SLIDE GATE
SP	STOP PLATE
SV	SURGE RELIEF VALVE
UF	UNIVERSAL AIR FILTER
VFD	VARIABLE FREQUENCY DRIVE
WG	WEIR GATE
XFM	TRANSFORMER

NOTES:

1. THIS IS A STANDARD PROCESS LEGEND AND NOT ALL ITEMS OR EQUIPMENT AS DESIGNATED HEREON ARE USED ON THIS PROJECT.
2. THIS SHEET APPLIES TO PROCESS DRAWINGS LABELED DXXX AND PROCESS AND INSTRUMENTATION DRAWINGS LABLED IXXX.

COLORADO LICENSED — CHRISTOPHER K. RACHELSON — 47887 — 05/08/2025 — PROFESSIONAL ENGINEER

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0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: J. DAVIS
designed: J. DAVIS	checked: N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PROCESS GENERAL NOTES, LEGEND, AND ABBREVIATIONS

project: 135303	contract:
drawing: 0D-001	rev.: 1
sheet:	of: sheets
file:	

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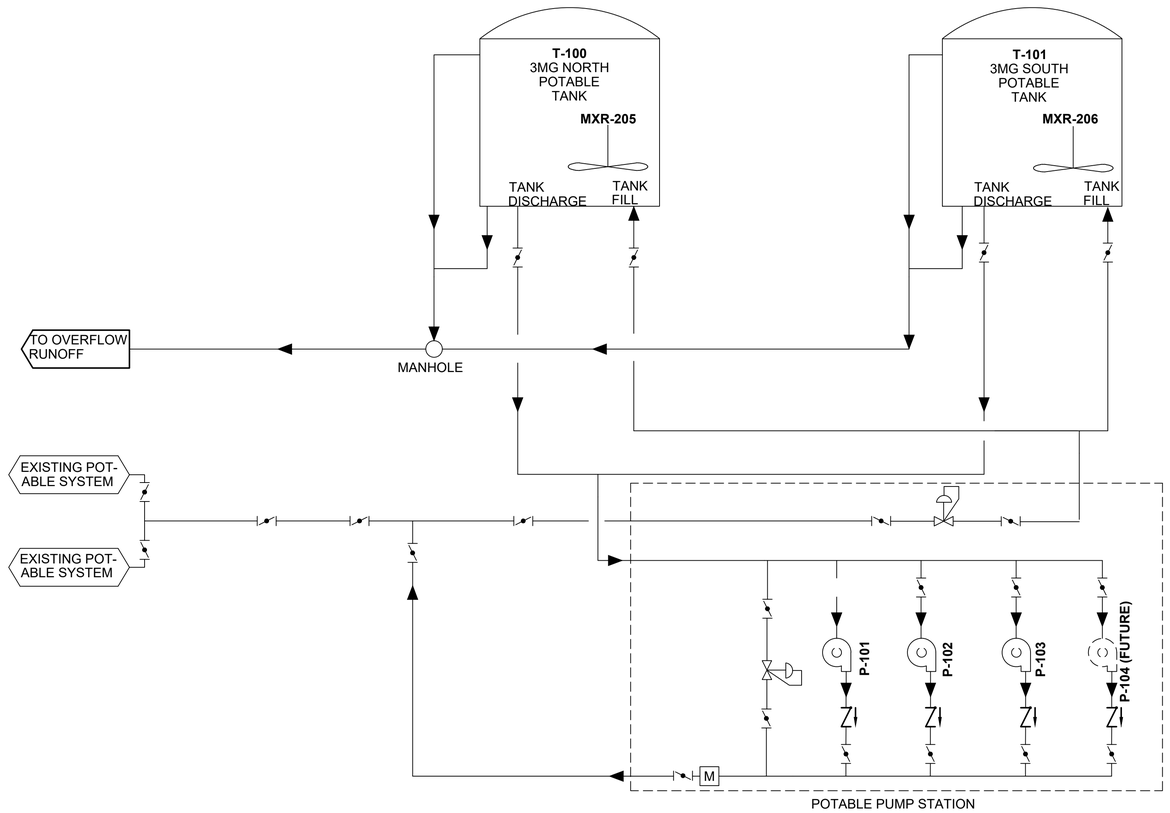
POTABLE PUMP STATION DESIGN CRITERIA		
COMPONENT	**CURRENT DESIGN VALUE**	**FUTURE DESIGN VALUE**
CAPACITY (NO REDUNDANCY)	17.1 MGD	22.7 MGD
FIRM CAPACITY	11.4 MGD	17 MGD
LOW FLOW	5.7 MGD	5.7 MGD
NUMBER OF PUMPS	3 (2 DUTY + 1 STANDBY)	4 (3 DUTY + 1 STANDBY)
CAPACITY PER PUMP	5.7 MGD	5.7 MGD
MAXIMUM TOTAL DYNAMIC HEAD	187 FEET	187 FEET
PUMP DISCHARGE VALVE	NON-SLAM SWING CHECK VALVE	NON-SLAM SWING CHECK VALVE
PUMP CONTROL MECHANISM	VARIABLE FREQUENCY DRIVE	VARIABLE FREQUENCY DRIVE
MOTOR HORSEPOWER	3 @ 300 HP EACH	4 @ 300 HP EACH



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ENGLEWOOD, CO 80112
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date	detailed by
MAY 2025	M. WILLIS
designed by	**checked by**
J. DAVIS	N. RACHELSON

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PROCESS FLOW DIAGRAM

project	contract
135303	

drawing **0D-002** rev. **1**

sheet of sheets

file 0D-002 - PROCESS FLOW DIAGRAM.dwg

COLORADO LICENSED
NATHAN E. RACHELSON
47887
05/08/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches

EQUIPMENT SCHEDULE			#
NO.	EQUIPMENT DESCRIPTION	EQUIPMENT TAG	SPECIFICATION SECTION
1	POTABLE WATER PUMP	P-101	33 12 40
2	POTABLE WATER PUMP	P-102	33 12 40
3	POTABLE WATER PUMP	P-103	33 12 40
4	POTABLE WATER PUMP (FUTURE)	P-104 (FUTURE)	FUTURE
5	24" MAGNETIC METER	FE-121	40 70 00
6	NORTH POTABLE TANK MIXER	MXR-105	46 41 23
7	SOUTH POTABLE TANK MIXER	MXR-106	46 41 23

VAULT SCHEDULE			
VAULT TAG	TYPE	SERVICE	FOUNDATION TYPE
PW-01	VAULT	POTABLE TANK BI-DIRECTIONAL VAULT	DRILLED PIERS
PW-02	VAULT	POTABLE TANK FILL VAULT	DRILLED PIERS
PW-03	VAULT	POTABLE TANK DISCHARGE VAULT	DRILLED PIERS
PW-04	MANHOLE	POTABLE DRAIN/OVERFLOW MANHOLE	DRILLED PIERS
SW-02	MANHOLE	COMBINED OVERFLOW/DRAIN MANHOLE B	DRILLED PIERS
SW-03	MANHOLE	COMBINED OVERFLOW/DRAIN MANHOLE C	DRILLED PIERS
SW-04	MANHOLE	COMBINED OVERFLOW/DRAIN MANHOLE D	DRILLED PIERS
SW-05	MANHOLE	COMBINED OVERFLOW/DRAIN MANHOLE E	DRILLED PIERS

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COLORADO LICENSED — NICOLE N. RACHELSON — 47887 — 05/06/2025 — PROFESSIONAL ENGINEER

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ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	J. DAVIS
designed	**checked**
J. DAVIS	N. RACHELSON

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

EQUIPMENT AND VAULT SCHEDULE

project	contract
135303	

drawing **0D-003** — rev. **1**

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VALVE SCHEDULE I

NO.	TAG	SIZE	TYPE	PRESSURE CLASS	END CONNECTION	WORKING PRESSURE	PIPE SYSTEM	ACTUATOR	LINE ORIENTATION	SERVICE	LOCATION	NOTES
1	BV-104	24"	BUTTERFLY	150	FLG X FLG	100	POTABLE PUMP DISCHARGE HEADER	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
2	BV-128	16"	BUTTERFLY	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
3	BV-126	16"	BUTTERFLY	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
4	BV-124	16"	BUTTERFLY	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
5	BV-122	16"	BUTTERFLY	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
6	BV-112	16"	BUTTERFLY	150	FLG X FLG	100	POTABLE SURGE SYSTEM	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
7	BV-116	18"	BUTTERFLY	150	FLG X FLG	15	POTABLE PUMP SUCTION	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
8	BV-115	18"	BUTTERFLY	150	FLG X FLG	15	POTABLE PUMP SUCTION	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
9	BV-114	18"	BUTTERFLY	150	FLG X FLG	15	POTABLE PUMP SUCTION	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
10	BV-113	18"	BUTTERFLY	150	FLG X FLG	15	POTABLE PUMP SUCTION	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
11	BV-111	16"	BUTTERFLY	150	FLG X FLG	100	POTABLE SURGE SYSTEM	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
12	CV-127	16"	CHECK VALVE	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	N/A	HORIZONTAL	N/A	LOCATED IN POTABLE PUMP STATION	
13	CV-125	16"	CHECK VALVE	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	N/A	HORIZONTAL	N/A	LOCATED IN POTABLE PUMP STATION	
14	CV-123	16"	CHECK VALVE	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	N/A	HORIZONTAL	N/A	LOCATED IN POTABLE PUMP STATION	
15	CV-121	16"	CHECK VALVE	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	N/A	HORIZONTAL	N/A	LOCATED IN POTABLE PUMP STATION	
16	FCV-100	20"	GLOBE VALVE	150	FLG X FLG	70	POTABLE TANK FILL	PILOT	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
17	FCV-134	16"	GLOBE VALVE	150	FLG X FLG	100	POTABLE SURGE VALVE	PILOT	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
18	BV-136	20"	BUTTERFLY	150	FLG X FLG	70	POTABLE TANK FILL	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
19	BV-135	20"	BUTTERFLY	150	FLG X FLG	70	POTABLE TANK FILL	ELECTRIC MOTOR	HORIZONTAL	OPEN/CLOSE	LOCATED IN POTABLE PUMP STATION	
20	BV-107	30"	BUTTERFLY	150	FLG X FLG	70	POTABLE NORTH TANK FILL ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
21	BV-109	30"	BUTTERFLY	150	FLG X FLG	70	POTABLE SOUTH TANK FILL ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
22	BV-106	30"	BUTTERFLY	150	FLG X FLG	15	POTABLE NORTH TANK DISCHARGE ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
23	BV-108	30"	BUTTERFLY	150	FLG X FLG	15	POTABLE SOUTH TANK DISCHARGE ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
24	BV-103	30"	BUTTERFLY	150	FLG X FLG	70	POTABLE TANK FILL	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
25	BV-102	30"	BUTTERFLY	150	FLG X FLG	100	POTABLE PUMP DISCHARGE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
26	BV-132	30"	BUTTERFLY	150	FLG X FLG	70	POTABLE DISTRIBUTION SYSTEM	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN VALVE VAULT	
27	BV-133	20"	BUTTERFLY	150	MJ X MJ	70	POTABLE DISTRIBUTION ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN YARD PIPING	DIRECT BURIED
28	BV-139	24"	BUTTERFLY	150	MJ X MJ	70	POTABLE DISTRIBUTION ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	LOCATED IN YARD PIPING	DIRECT BURIED
29	FUTURE	1/2"	AIR RELEASE	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	FUTURE
30		1/2"	AIR RELEASE	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
31		1/2"	AIR RELEASE	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
32		1/2"	AIR RELEASE	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
33		3"	CONTROLLED VENTING VAC RELIEF	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
34		3"	CONTROLLED VENTING VAC RELIEF	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
35		3"	CONTROLLED VENTING VAC RELIEF	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
36		3"	CONTROLLED VENTING VAC RELIEF	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
37		1/2"	AIR/VAC VALVE ASSEMBLY	150	NPT	100	POTABLE BI-DIRECTIONAL VALVE	N/A	VERTICAL	N/A	LOCATED IN POTABLE TANK BI-DIRECTIONAL VAULT	
38		3"	CONTROLLED VENTING VAC RELIEF	150	NPT	100	POTABLE PUMP	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
39	BV-151	20"	BUTTERFLY	150	MJ X MJ	70	POTABLE DISTRIBUTION ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	TIE-INTO EXISTING PIPING	DIRECT BURIED
40	BV-150	20"	BUTTERFLY	150	MJ X MJ	70	POTABLE DISTRIBUTION ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	TIE-INTO EXISTING PIPING	DIRECT BURIED
41	BV-152	24"	BUTTERFLY	150	MJ X MJ	70	POTABLE DISTRIBUTION ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	TIE-INTO EXISTING PIPING	DIRECT BURIED
42	BV-153	24"	BUTTERFLY	150	MJ X MJ	70	POTABLE DISTRIBUTION ISOLATION VALVE	MANUAL	HORIZONTAL	OPEN/CLOSE	TIE-INTO EXISTING PIPING	DIRECT BURIED
43		1/4"	AIR RELEASE	150	NPT	70	POTABLE TANK FILL	N/A	VERTICAL	N/A	LOCATED IN POTABLE PUMP STATION	
44	BV-138	18"	BUTTERFLY	150	FLG X FLG	15	POTABLE SOUTH TANK DRAIN ISOLATION VALVE	MANUAL	VERTICAL	OPEN/CLOSE	LOCATED IN YARD PIPING	VALVE STEM EXTENSION
45	BV-137	18"	BUTTERFLY	150	FLG X FLG	15	POTABLE NORTH TANK DRAIN ISOLATION VALVE	MANUAL	VERTICAL	OPEN/CLOSE	LOCATED IN YARD PIPING	VALVE STEM EXTENSION

NOTE: GENERALLY, VALVES 2 1/2-INCHES AND LARGER ARE INDICATED ON THE VALVE SCHEDULE. GENERALLY, VALVES 2-INCHES AND SMALLER ARE INDICATED ON THE PROCESS AND INSTRUMENTATION DRAWINGS. ADDITIONAL VALVES MAY BE SHOWN ON THE DRAWINGS THAT ARE NOT INCLUDED IN THE VALVE SCHEDULE.

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: M. WILLIS
designed: J. DAVIS	checked: N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

VALVE SCHEDULE

project: 135303	contract:
drawing: 0D-004	rev.: 1
sheet:	of: sheets:
file:	

COLORADO LICENSED NICOLE E. RACHELSON 47887 05/06/2025 PROFESSIONAL ENGINEER

Scale For Microfilming: Millimeters / Inches

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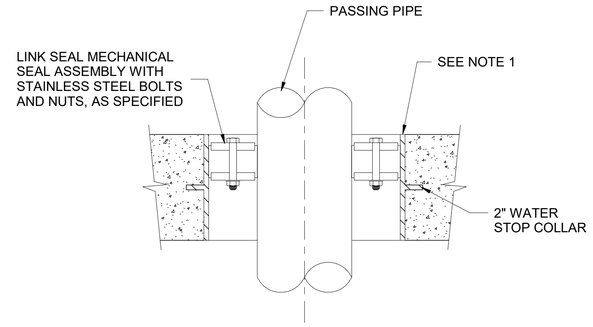
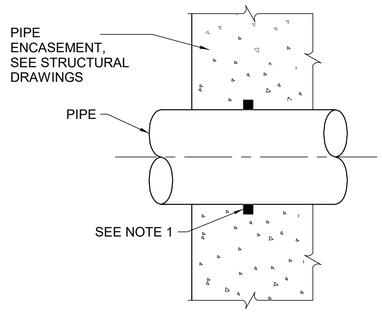


NOTES:

1. CENTURY LINE MODEL CS HDPE SLEEVE FOR PIPE SIZES LESS THAN 12". PIPING GREATER THAN OR EQUAL TO 12" SHALL UTILIZE A STAINLESS STEEL SLEEVE. ALL SLEEVES SHALL BE PER LINK SEAL MANUFACTURER'S RECOMMENDATIONS.

FLOOR PENETRATION
NOT TO SCALE

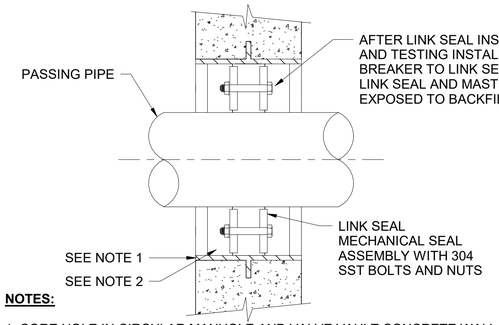


NOTES:

1. Rx WATERSTOP FOR DUCTILE IRON PIPE, SYNCO FLEX WATERSTOP FOR HDPE PIPE. INSTALL PER MANUFACTURER'S RECOMMENDATIONS. FOR STEEL PIPE, PROVIDE 2" COLLAR WELDED TO PIPE.
2. PROVIDE WATERSTOP ON PIPE AT EACH END OF ENCASEMENT

ENCASED PIPE WATERSTOP DETAIL
NOT TO SCALE

GENERAL NOTES:
1. REFER TO CCOB STANDARD DETAILS.

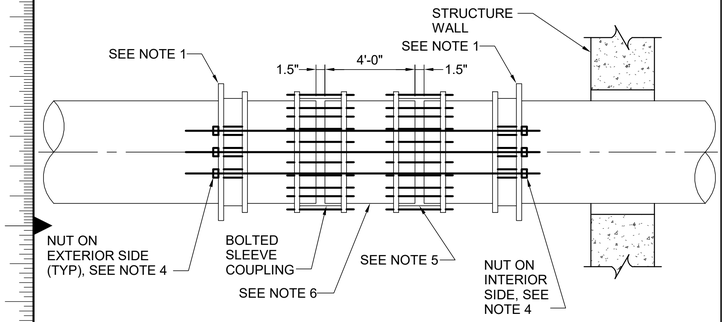


NOTES:

1. CORE HOLE IN CIRCULAR MANHOLE AND VALVE VAULT CONCRETE WALL. FOR NEW WALLS, PROVIDE CONCRETE OPENING REINFORCEMENT FOR PLANNED OPENING PRIOR TO CONCRETE PLACEMENT.

2. PROVIDE SOLID BLOCK TO TRANSMIT THE WEIGHT OF THE PIPE TO THE SOLID BLOCK AND NOT THE LINK SEAL. THE BLOCK SHALL BE MOUNTED UNDERNEATH THE PIPE FOR 90 DEG CENTERED IN THE MIDDLE OF THE PIPE.

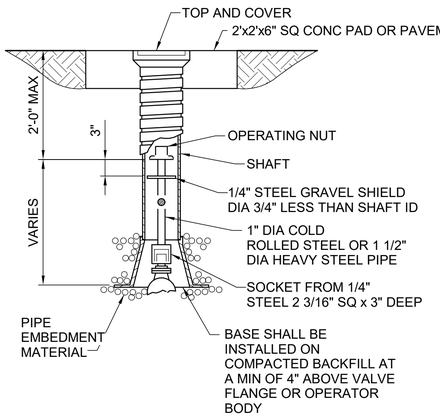
SINGLE LINK SEAL
NOT TO SCALE



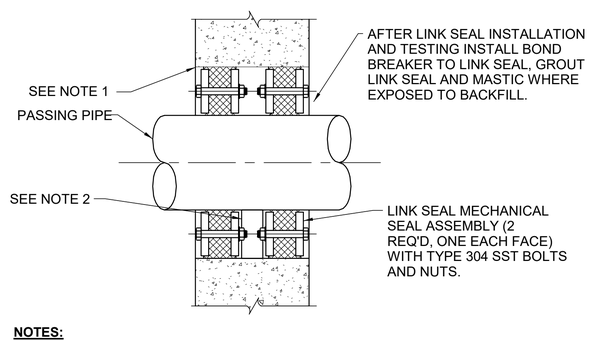
NOTES:

1. RESTRAINT CONNECTION TO PIPE VARIES BY PIPE MATERIAL
   - STEEL PIPE: PROVIDE AWWA M-11 HARNESS
   - PVC PIPE: PROVIDE ROMAC 470 SERIES RESTRAINT
   - DIP: PROVIDE MECHANICAL JOINT RESTRAINT WITH FLANGE LUGS
   - HDPE: PROVIDE ROMAC ALPHA SERIES RESTRAINT
2. LUG TYPE, TIE BOLT DIAMETER, NUMBER OF RODS AND ROD ORIENTATION VARIES BY PIPE DIAMETER.
3. TIE RODS TO BE CENTERED ON PIPE SPRINGLINE, CONFORM TO AWWA M-11 (5TH ED) APPENDIX C. PROVIDE DOG EAR STYLE LUGS WHERE REQUIRED TO MATCH HARNESS BOLT LOCATION.
4. PROVIDE ISOLATION KIT WHERE INTERIOR AND EXTERIOR PIPES ARE DISSIMILAR METAL OR WHERE REQUIRED TO ISOLATE CATHODIC PROTECTION SYSTEM FROM INTERIOR PIPE.
5. BOLTED SLEEVE COUPLING. USE TRANSITION COUPLING WHERE EXTERIOR AND INTERIOR PIPE OUTSIDE DIAMETERS DO NOT MATCH. COUPLING SHALL BE INSULATING TYPE WHERE INTERIOR AND EXTERIOR PIPES ARE DISSIMILAR MATERIALS OR WHERE REQUIRED TO ISOLATE CATHODIC PROTECTION SYSTEM FROM INTERIOR PIPE.
6. PLAIN END x PLAIN END SPOOL PIECE MATERIAL SHALL MATCH THAT OF THE EXTERIOR YARD PIPING.

DOUBLE BOLTED SLEEVE COUPLING DETAIL
NOT TO SCALE



SCREW SHAFT TYPE VALVE BOX
NOT TO SCALE



NOTES:

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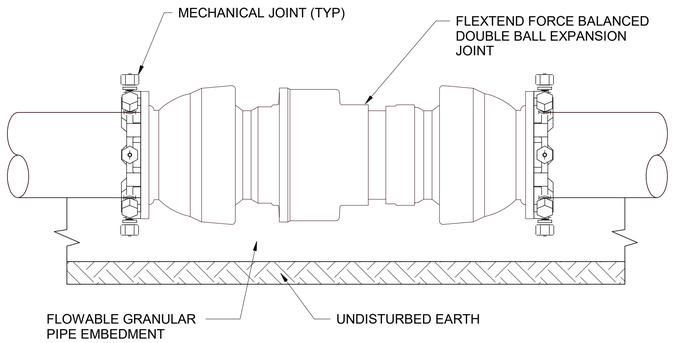
2. PROVIDE SOLID BLOCK TO TRANSMIT THE WEIGHT OF THE PIPE TO THE SOLID BLOCK AND NOT THE LINK SEAL. THE BLOCK SHALL BE MOUNTED UNDERNEATH THE PIPE FOR 90 DEG CENTERED IN THE MIDDLE OF THE PIPE.

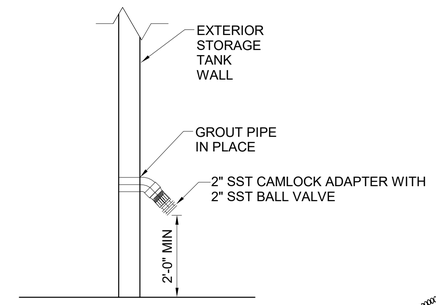
DOUBLE LINK SEAL DETAIL
NOT TO SCALE



NOTES:

1. LINED AND COATED WITH FUSION BONDED EPOXY, APPLIED AND TESTED IN ACCORDANCE WITH AWWA C213.

FLEXIBLE COUPLING DETAIL
NOT TO SCALE



WATER STORAGE TANK SAMPLE SPIGOT
NOT TO SCALE

COLORADO LICENSED
NATHAN RACHELSON
47887
05/08/2025
PROFESSIONAL ENGINEER

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	M. WILLIS
designed	**checked**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PROCESS DETAILS

project	contract
135303	
drawing	**rev.**
0D-005	1
sheet	**of** **sheets**
file	

Scale For Microfilming: Millimeters / Inches

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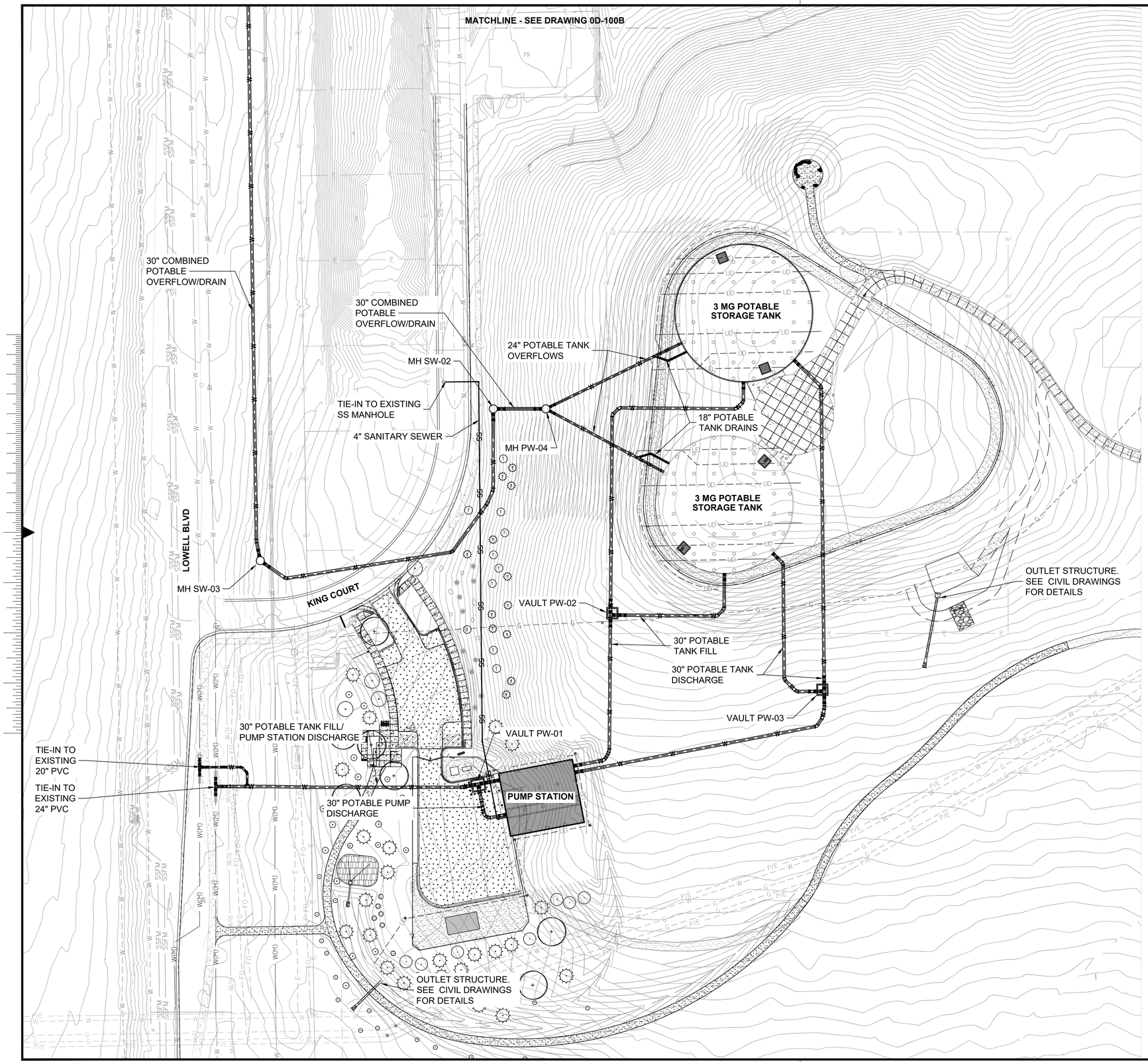

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date: MAY 2025	detailed by: M. WILLIS
designed by: J. DAVIS	checked by: N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

YARD PIPING PLAN I

project: 135303	contract:
drawing: **0D-100A**	rev.: **1**
sheet	of sheets
file 0D-100 - YARD PIPING.dwg	

COLORADO LICENSED
NICOLE K. RACHELSON
47887
PROFESSIONAL ENGINEER
05/06/2025

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NORTH

0 50' 100'
SCALE IN FEET

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NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	M. WILLIS
designed by	**checked by**
J. DAVIS	N. RACHELSON

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BROOMFIELD TANKS AND PUMP STATION

YARD PIPING PLAN II

project	contract
135303	

drawing **0D-100B** rev. **1**

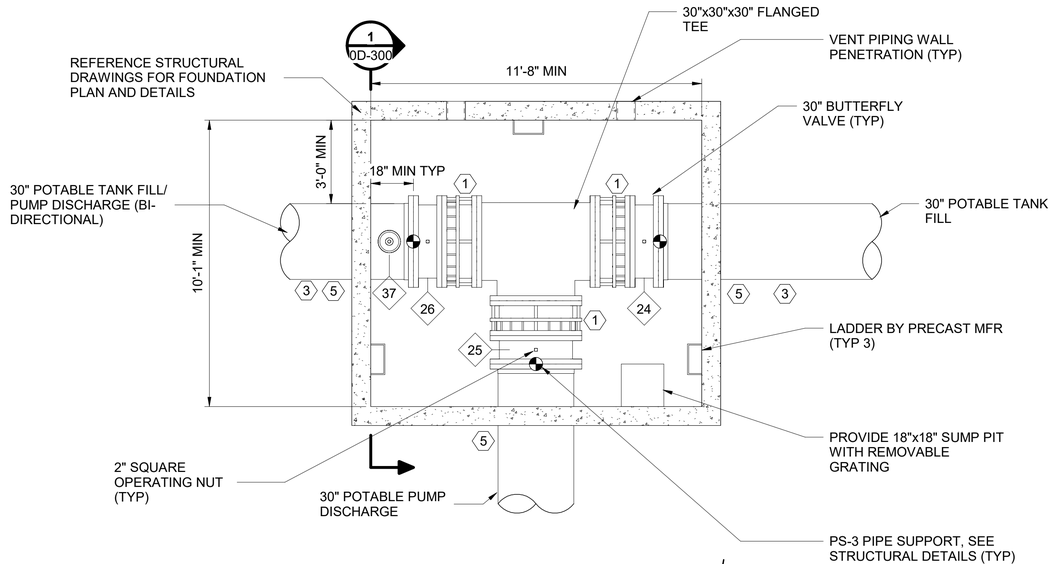
sheet of sheets

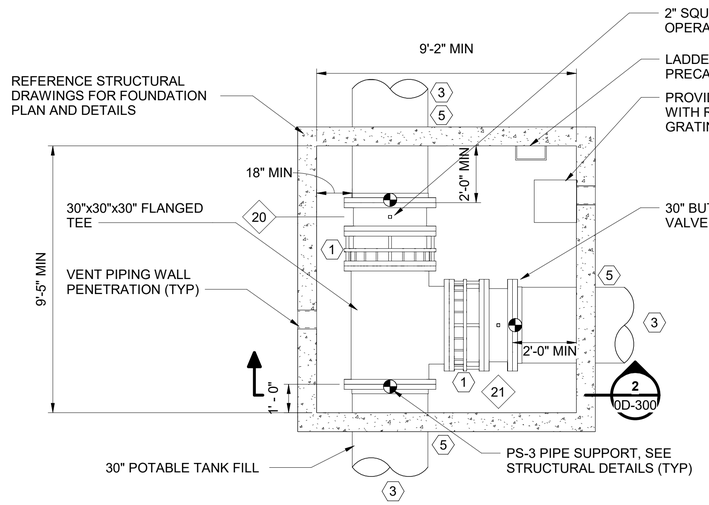
file 0D-100 - YARD PIPING.dwg

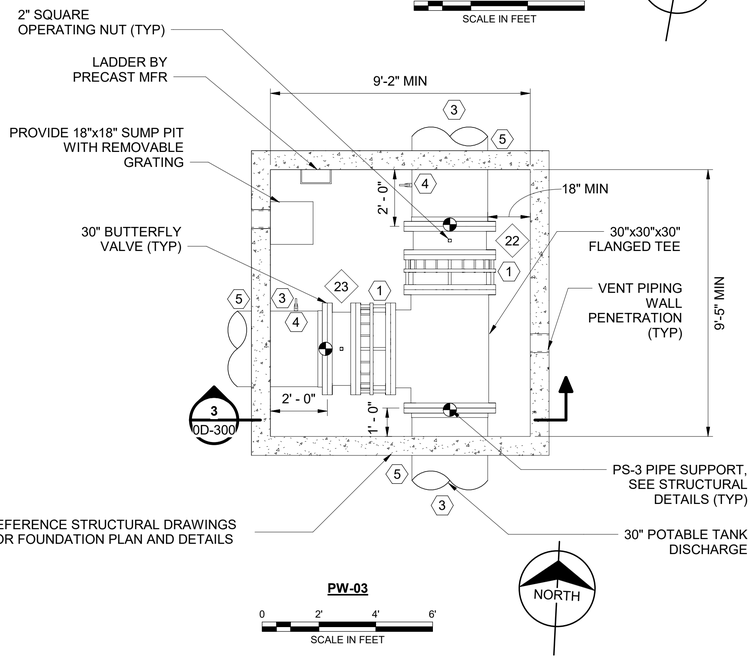
NOTES:
1. ALL PIPING AND APPURTENANCES TO BE FULLY RESTRAINED.
2. PRE-CAST VAULT STRUCTURE TO BE DESIGNED AND STAMPED BY A PROFESSIONAL ENGINEER IN THE STATE OF COLORADO.
3. STRUCTURES SHALL CONFORM TO CRITERIA ON STRUCTURAL GENERAL NOTES SHEET, 0S-003.

KEYED NOTES:

1. 30" DISMANTLING JOINT.
2. 18" DISMANTLING JOINT.
3. INSTALL FLEXIBLE COUPLING FOR ALL VAULT CONNECTIONS. SEE PROCESS DETAILS.
4. SAMPLE TAP OFF SIDE OF PIPE WITH 3/4" STEEL BALL VALVE.
5. SINGLE LINK SEAL FOR PIPE PENETRATIONS. SEE PROCESS DETAILS.







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MAY 2025	J. DAVIS
designed	**checked**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

VALVE VAULT PLANS

project	contract
135303	

drawing **0D-101** — rev. **1**

sheet of sheets

file

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NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

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Inches

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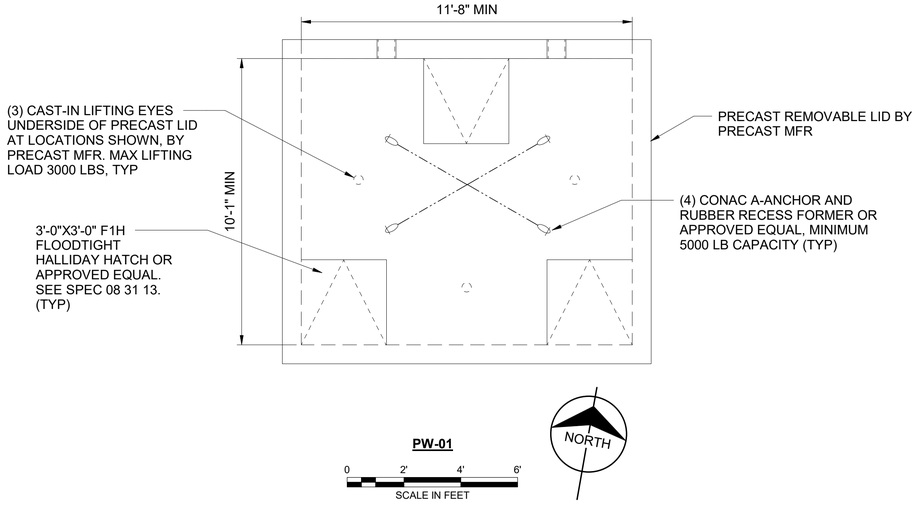
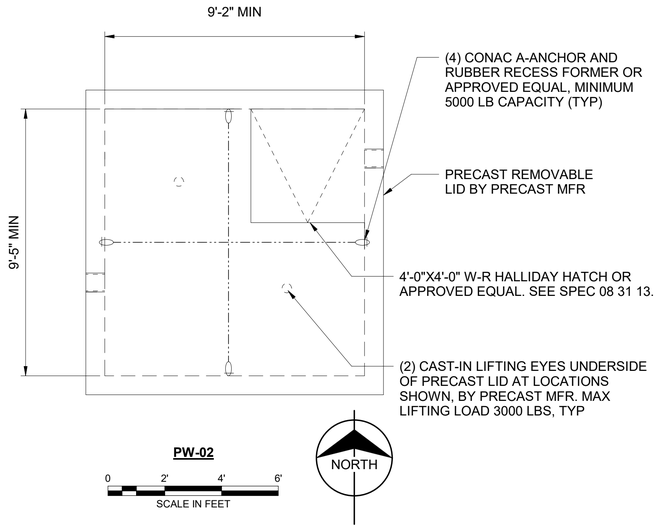
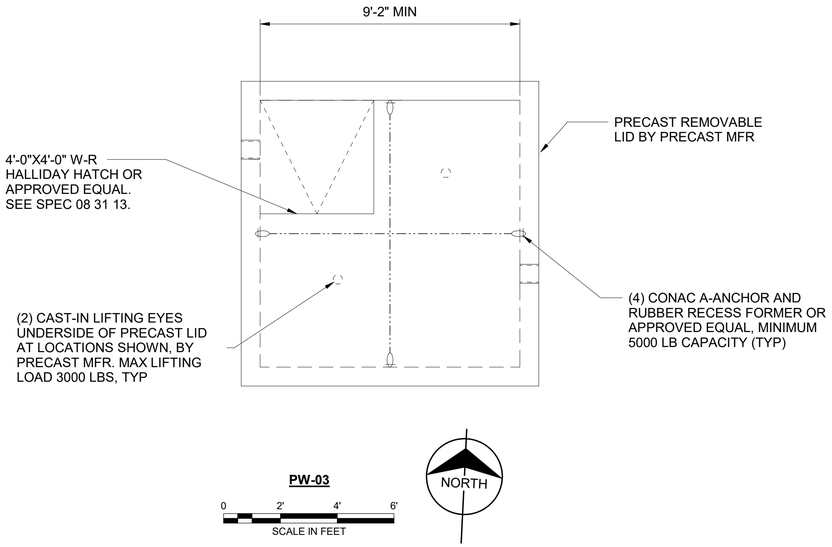


PW-01



PW-02



PW-03

NOTES:
1. VAULT AND MANHOLE LIDS SHALL BE LABELED WITH 'CONFINED SPACE'.

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date: MAY 2025	detailed: J. DAVIS
designed: J. DAVIS	checked: N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

VALVE VAULT ROOF PLANS

project: 135303	contract:
drawing: 0D-102	rev.: 1
sheet	of sheets
file	

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NICOLE K. RACHELSON
47887
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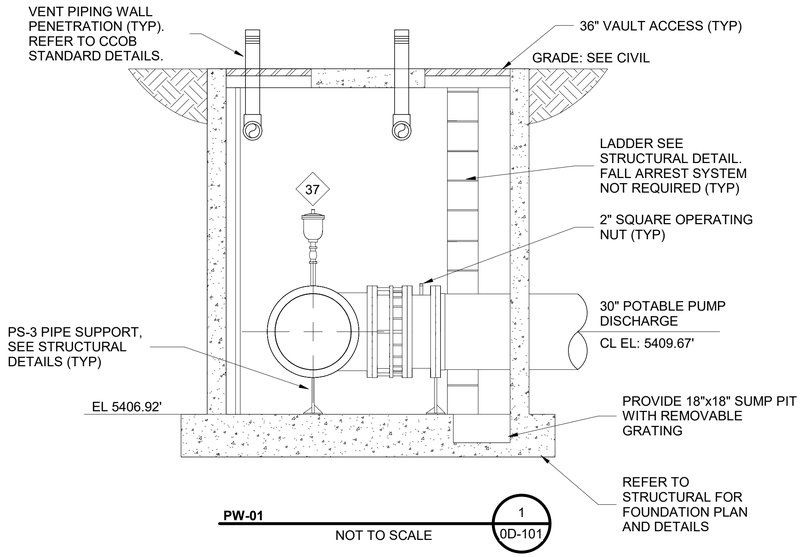
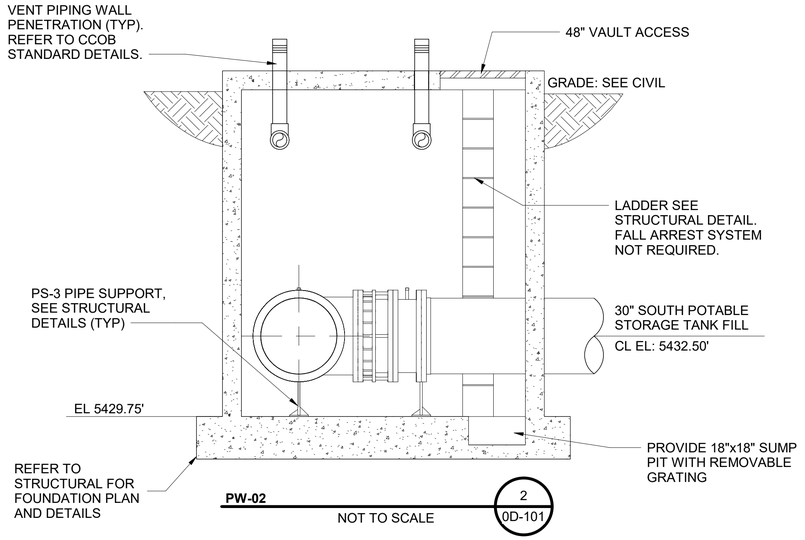
Inches

5/6/2025 11:13:02 AM

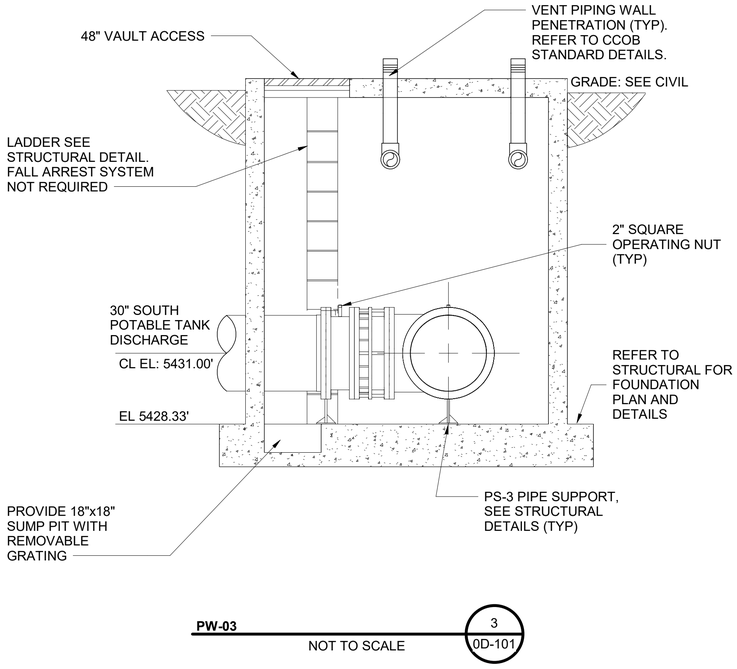
Autodesk Docs://135303_TanksProject/135303_D_POT_ONLY.rvt.rvt



PW-01 — NOT TO SCALE — 1 / 0D-101



PW-02 — NOT TO SCALE — 2 / 0D-101



PW-03 — NOT TO SCALE — 3 / 0D-101

NOTES:

1. SEE VAULT AND MANHOLE FLOOR AND RIM ELEVATIONS ON PLAN AND PROFILE DRAWINGS.
2. VENT DEPTH IN VAULTS TO BE STAGGERED FOR AIR FLOW.

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements. **THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."**

City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date MAY 2025	**detailed** M. WILLIS
designed J. DAVIS	**checked** N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

VALVE VAULT SECTIONS

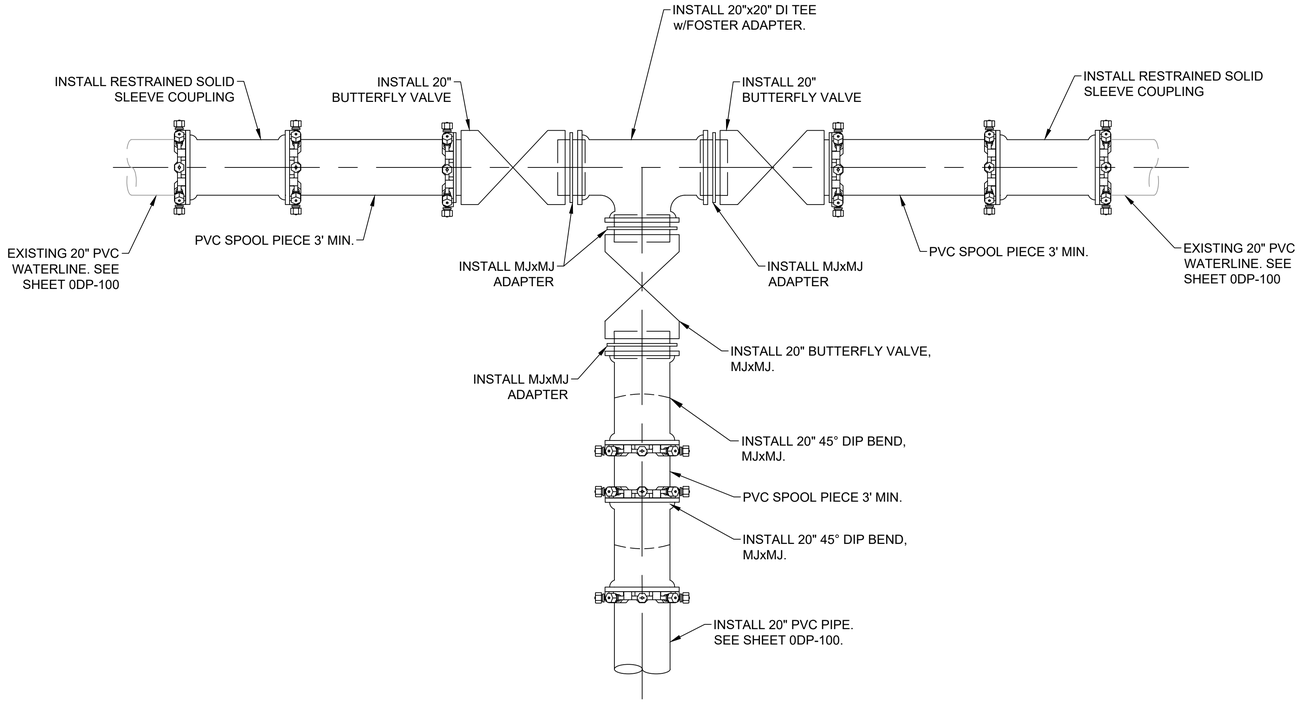
project 135303	**contract**
drawing 0D-300	**rev.** 1
sheet	**of** **sheets**
file	

COLORADO LICENSED — NICHOLAS K. RACHELSON — 47887 — 05/06/2025 — PROFESSIONAL ENGINEER

Scale For Microfilming: Millimeters / Inches

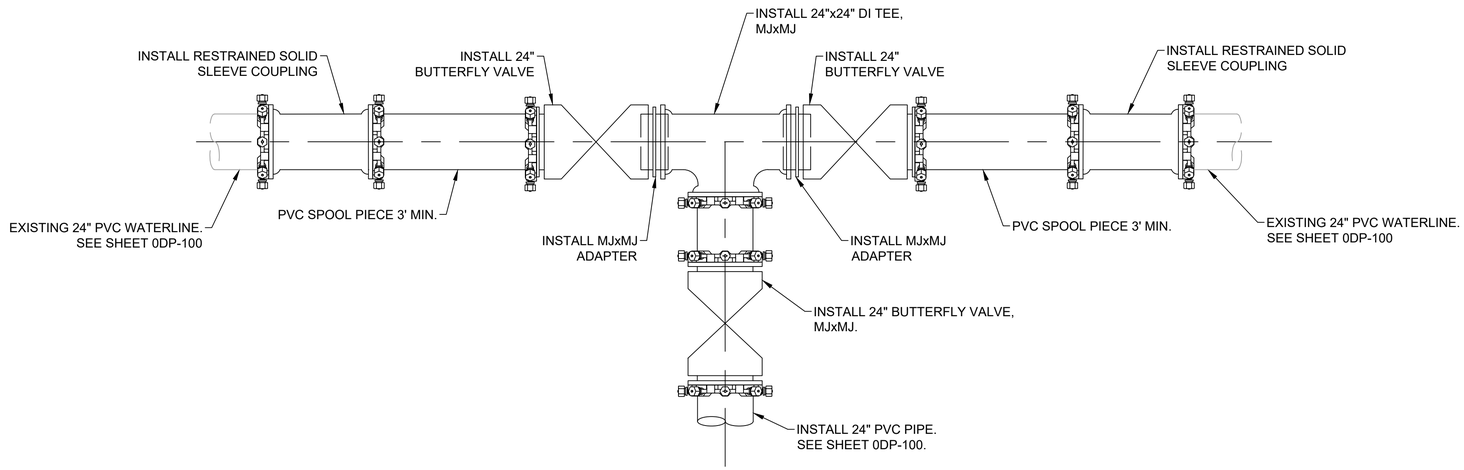
5/6/2025 11:13:03 AM

Autodesk Docs://135303_TanksProject/135303_D_POT_ONLY.rvt.rvt



TYPICAL CONNECTION DETAIL FOR 20" PVC CONNECTION (1 / 0DP-100)

NOT TO SCALE



TYPICAL CONNECTION DETAIL FOR 24" PVC CONNECTION (2 / 0DP-100)

NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	J. DAVIS
designed by	**checked by**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

YARD PIPING DETAILS I

project	contract
135303	

drawing rev.

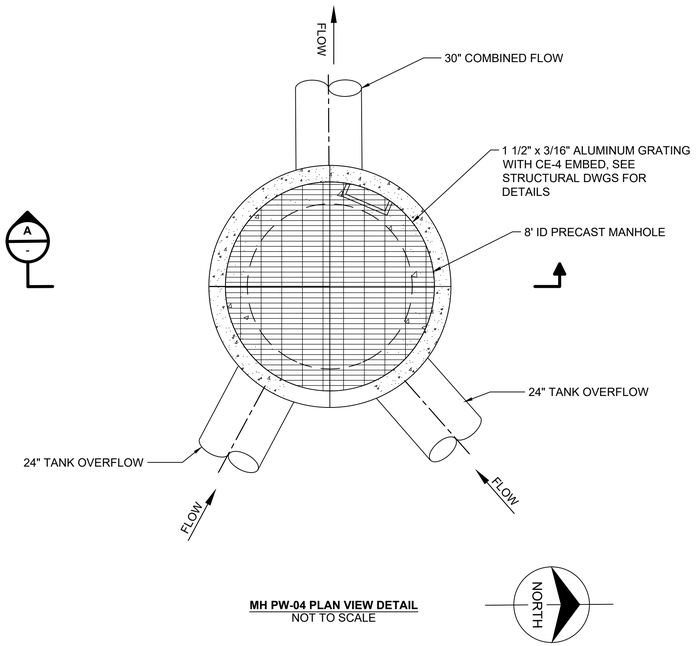
0D-500 — 1

sheet of sheets

file 135303_0D-500.dwg

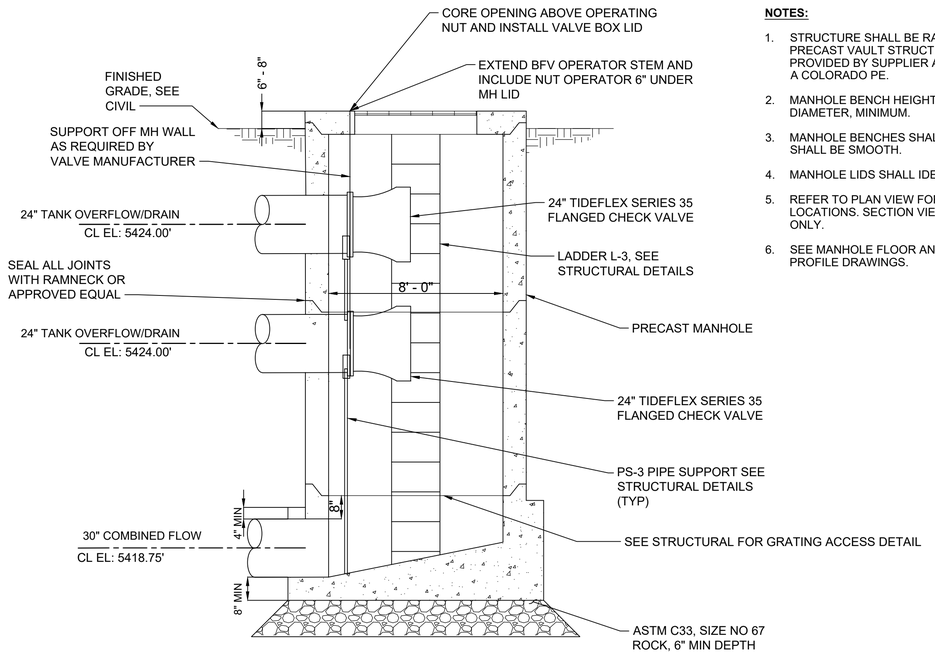
COLORADO LICENSED NATHAN D. RACHELSON 47887 05/06/2025 PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches



MH PW-04 PLAN VIEW DETAIL
NOT TO SCALE

NORTH



MH PW-04
SECTION VIEW DETAIL
NOT TO SCALE

A
-

NOTES:

1. STRUCTURE SHALL BE RATED FOR H20 LOADING. PRECAST VAULT STRUCTURAL CALCULATIONS TO BE PROVIDED BY SUPPLIER AND DESIGNED AND STAMPED BY A COLORADO PE.
2. MANHOLE BENCH HEIGHT SHALL EQUAL 1/2 PIPE DIAMETER, MINIMUM.
3. MANHOLE BENCHES SHALL BE BRUSHED AND INVERTS SHALL BE SMOOTH.
4. MANHOLE LIDS SHALL IDENTIFY ENCLOSED SPACE.
5. REFER TO PLAN VIEW FOR INTENDED PIPE PENETRATION LOCATIONS. SECTION VIEW DETAIL IS FOR ELEVATION ONLY.
6. SEE MANHOLE FLOOR AND RIM ELEVATIONS ON PLAN AND PROFILE DRAWINGS.

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date MAY 2025	**detailed by** J. DAVIS
designed by J. DAVIS	**checked by** N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO
BROOMFIELD TANKS AND PUMP STATION

YARD PIPING DETAILS II

project	contract
135303	

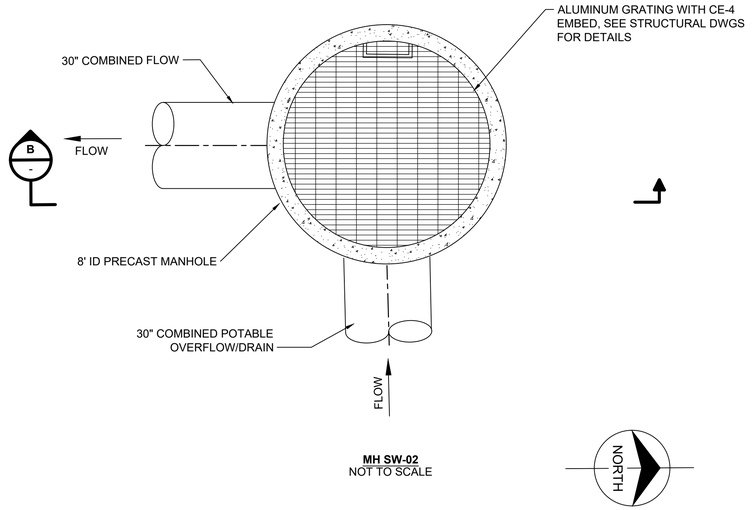
drawing **0D-501** rev. **1**

sheet of sheets

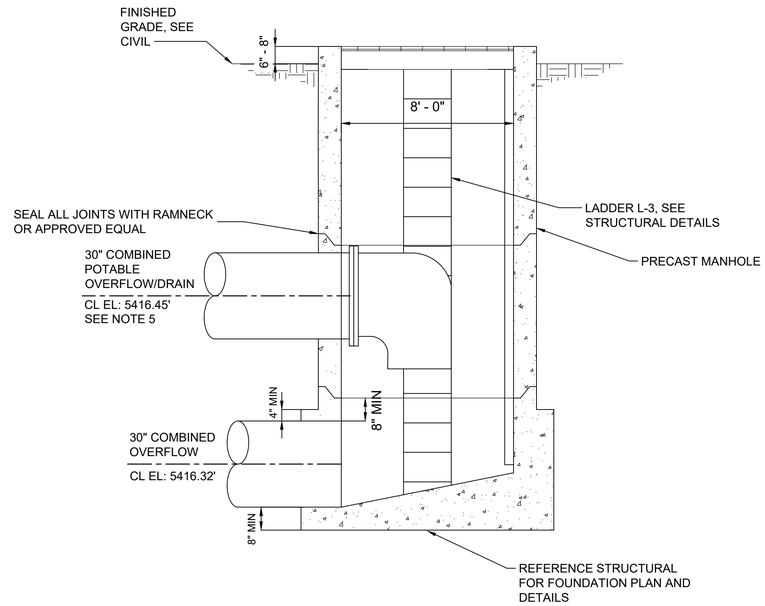
file 135303_0D-500.dwg

COLORADO LICENSED
NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

Millimeters
Inches
Scale For Microfilming



MH SW-02
NOT TO SCALE



MH SW-02 SECTION VIEW DETAIL (B / -)
NOT TO SCALE

NOTES:

1. STRUCTURE SHALL BE RATED FOR H2O LOADING. PRECAST VAULT STRUCTURAL CALCULATIONS TO BE PROVIDED BY SUPPLIER AND DESIGNED AND STAMPED BY A COLORADO PE.
2. MANHOLE BENCH HEIGHT SHALL EQUAL 1/2 PIPE DIAMETER, MINIMUM.
3. MANHOLE BENCHES SHALL BE BRUSHED AND INVERTS SHALL BE SMOOTH.
4. MANHOLE LIDS SHALL IDENTIFY ENCLOSED SPACE.
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6. SEE MANHOLE FLOOR AND RIM ELEVATIONS ON PLAN AND PROFILE DRAWINGS.

no.	date	by	ckd	description
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1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date MAY 2025	**detailed by** J. DAVIS
designed by J. DAVIS	**checked by** N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

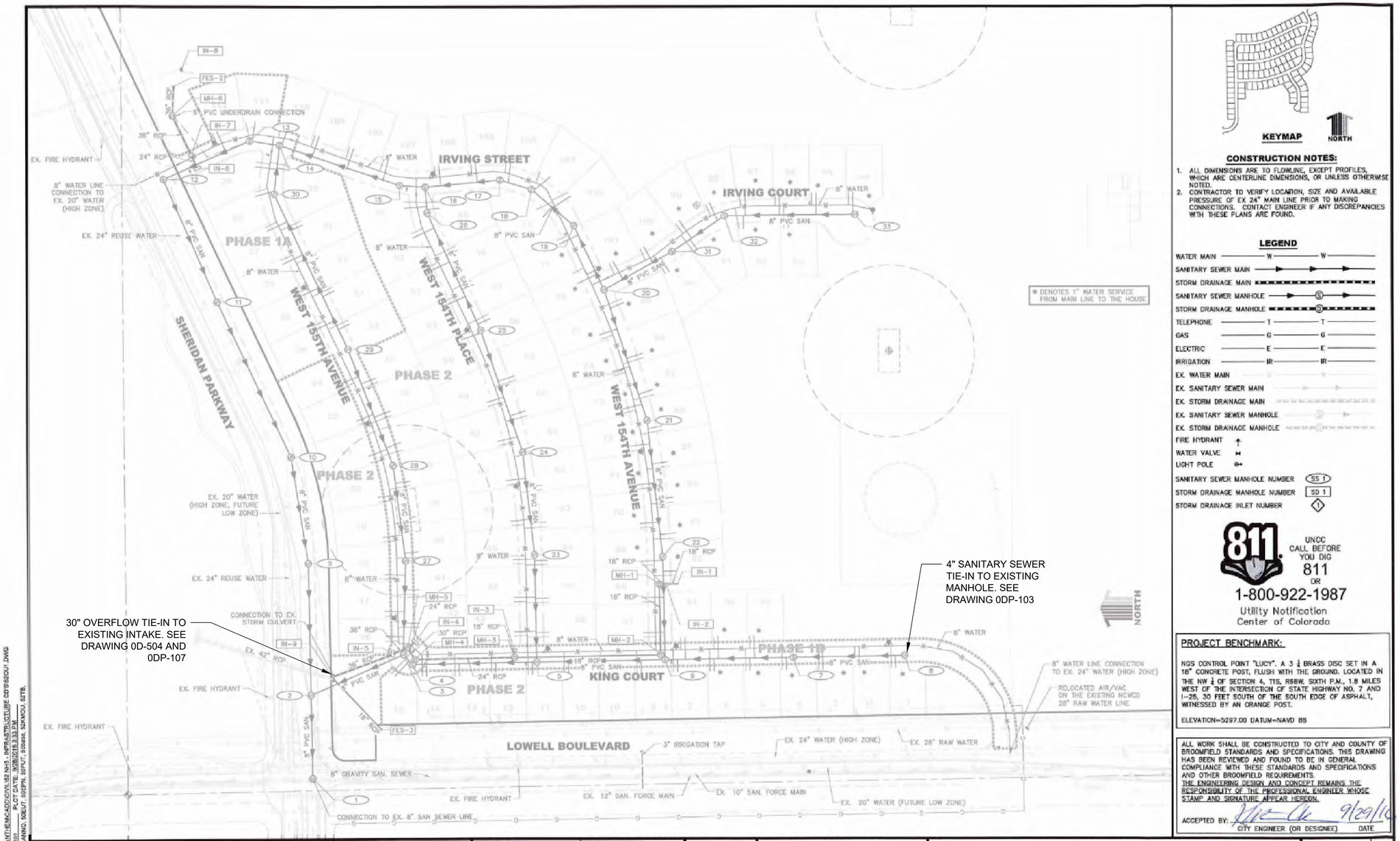
BROOMFIELD TANKS AND PUMP STATION

YARD PIPING DETAILS III

project 135303	contract
drawing **0D-502**	rev. **1**
sheet	of sheets
file 135303_0D-500.dwg	

COLORADO LICENSED
NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches



KEYMAP

NORTH

CONSTRUCTION NOTES:

1. ALL DIMENSIONS ARE TO FLOWLINE, EXCEPT PROFILES, WHICH ARE CENTERLINE DIMENSIONS, OR UNLESS OTHERWISE NOTED.
2. CONTRACTOR TO VERIFY LOCATION, SIZE AND AVAILABLE PRESSURE OF EX 24" MAIN LINE PRIOR TO MAKING CONNECTIONS. CONTACT ENGINEER IF ANY DISCREPANCIES WITH THESE PLANS ARE FOUND.

LEGEND

- WATER MAIN
- SANITARY SEWER MAIN
- STORM DRAINAGE MAIN
- SANITARY SEWER MANHOLE
- STORM DRAINAGE MANHOLE
- TELEPHONE
- GAS
- ELECTRIC
- IRRIGATION
- EX. WATER MAIN
- EX. SANITARY SEWER MAIN
- EX. STORM DRAINAGE MAIN
- EX. SANITARY SEWER MANHOLE
- EX. STORM DRAINAGE MANHOLE
- FIRE HYDRANT
- WATER VALVE
- LIGHT POLE
- SANITARY SEWER MANHOLE NUMBER (SS 1)
- STORM DRAINAGE MANHOLE NUMBER (SD 1)
- STORM DRAINAGE INLET NUMBER

811 UNCC CALL BEFORE YOU DIG 811 OR 1-800-922-1987 Utility Notification Center of Colorado

PROJECT BENCHMARK:

NGS CONTROL POINT "LUCY". A 3 ¼ BRASS DISC SET IN A 18" CONCRETE POST, FLUSH WITH THE GROUND. LOCATED IN THE NW ¼ OF SECTION 4, T1S, R68W, SIXTH P.M., 1.8 MILES WEST OF THE INTERSECTION OF STATE HIGHWAY NO. 7 AND I-25, 30 FEET SOUTH OF THE SOUTH EDGE OF ASPHALT, WITNESSED BY AN ORANGE POST.

ELEVATION=5297.00 DATUM=NAVD 88

ALL WORK SHALL BE CONSTRUCTED TO CITY AND COUNTY OF BROOMFIELD STANDARDS AND SPECIFICATIONS. THIS DRAWING HAS BEEN REVIEWED AND FOUND TO BE IN GENERAL COMPLIANCE WITH THESE STANDARDS AND SPECIFICATIONS AND OTHER BROOMFIELD REQUIREMENTS. THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON.

ACCEPTED BY: _____ 9/29/16
CITY ENGINEER (OR DESIGNEE) DATE

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	J. DAVIS
designed by	**checked by**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

YARD PIPING DETAILS IV

project	contract
135303	

drawing **0D-503** rev. **1**

sheet of sheets

file 135303_0D-500.dwg

COLORADO LICENSED — 47887 — 05/06/2025 — PROFESSIONAL ENGINEER

DATE	REVISION DESCRIPTION
1	
2	
3	
4	
5	

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PLOTTED BY: Rod Stamps PLOT DATE: 3/28/2016 3:33 PM
XREFS: pastamps, SIANNO, 5BUT, XREPN, SUTU1, SIGSSA, S2XMOU, S2TB

52OU1.dwg	0 50 100 200		
WHEELOCK ANTHEM	1 inch = 100 ft. Horizontal		
WS-ACB DEVELOPMENT, LLC	RLS	RLS	TAJ

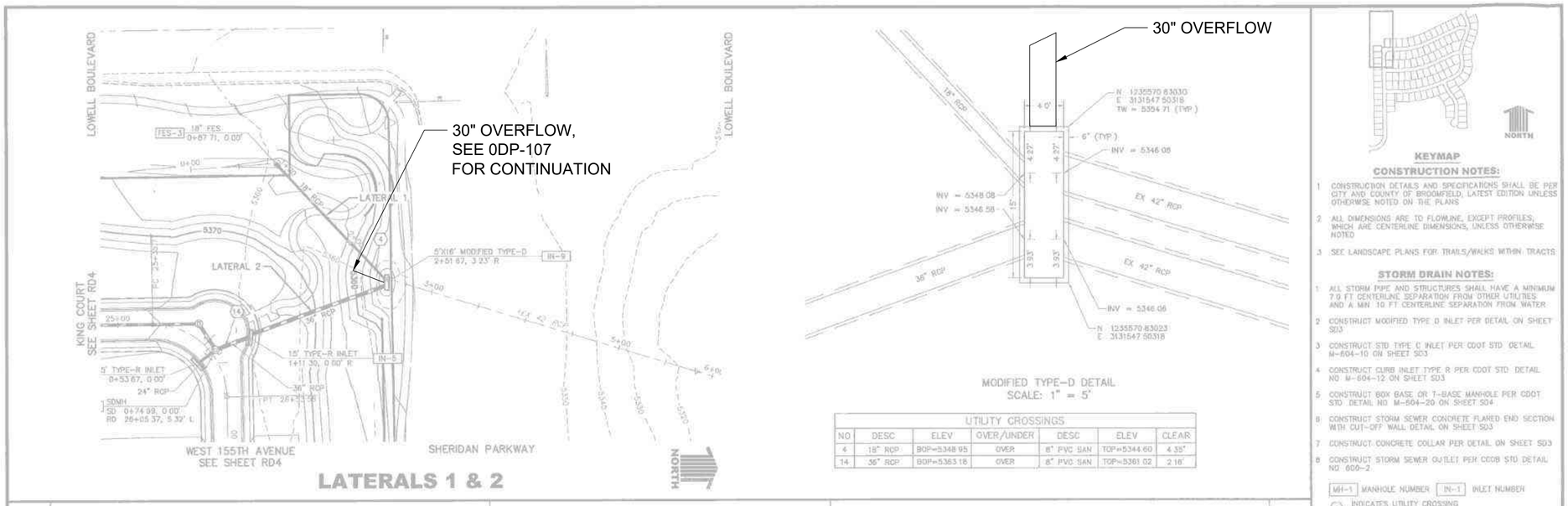
Calibre — Construction Management Civil Engineering Surveying

ANTHEM FILING NO. 24
NEIGHBORHOOD 5
OVERALL UTILITY PLAN

Sheet OU1 4 of 33

Date SEPTEMBER 14, 2016

Scale For Microfilming: Millimeters / Inches



MODIFIED TYPE-D DETAIL
SCALE: 1" = 5'

UTILITY CROSSINGS

NO	DESC	ELEV	OVER/UNDER	DESC	ELEV	CLEAR
4	18" RCP	BOP=5348.95	OVER	8" PVC SAN	TOP=5344.60	4.35'
14	36" RCP	BOP=5363.18	OVER	8" PVC SAN	TOP=5361.02	2.16'

KEYMAP

CONSTRUCTION NOTES:

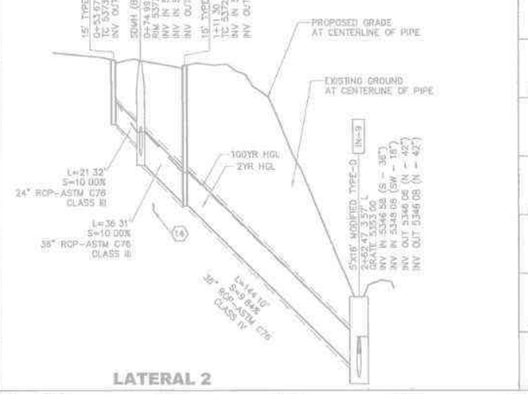
1. CONSTRUCTION DETAILS AND SPECIFICATIONS SHALL BE PER CITY AND COUNTY OF BROOMFIELD, LATEST EDITION UNLESS OTHERWISE NOTED ON THE PLANS
2. ALL DIMENSIONS ARE TO FLOWLINE, EXCEPT PROFILES, WHICH ARE CENTERLINE DIMENSIONS, UNLESS OTHERWISE NOTED
3. SEE LANDSCAPE PLANS FOR TRAILS/WALKS WITHIN TRACTS

STORM DRAIN NOTES:

1. ALL STORM PIPE AND STRUCTURES SHALL HAVE A MINIMUM 7.0 FT CENTERLINE SEPARATION FROM OTHER UTILITIES AND A MIN. 10 FT CENTERLINE SEPARATION FROM WATER
2. CONSTRUCT MODIFIED TYPE D INLET PER DETAIL ON SHEET SD3
3. CONSTRUCT STD TYPE C INLET PER CDOT STD. DETAIL M-604-10 ON SHEET SD3
4. CONSTRUCT CURB INLET TYPE R PER CDOT STD. DETAIL NO M-604-12 ON SHEET SD3
5. CONSTRUCT BOX BASE OR T-BASE MANHOLE PER CDOT STD. DETAIL NO M-604-20 ON SHEET SD4
6. CONSTRUCT STORM SEWER CONCRETE FLARED END SECTION WITH CUT-OFF WALL DETAIL ON SHEET SD3
7. CONSTRUCT CONCRETE COLLAR PER DETAIL ON SHEET SD3
8. CONSTRUCT STORM SEWER OUTLET PER CCOB STD DETAIL NO. 609-2

MH-1 MANHOLE NUMBER | IN-1 INLET NUMBER

(1) INDICATES UTILITY CROSSING (SEE TABLE ON THIS SHEET)



COLORADO LICENSED
TODD A. JOHNSON
37860
09-14-16
PROFESSIONAL ENGINEER

811 UNCC
CALL BEFORE YOU DIG
811
OR
1-800-922-1987
Utility Notification Center of Colorado

PROJECT BENCHMARK:

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ELEVATION=5297.00 DATUM=NAVD 88

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CITY ENGINEER (OR DESIGNEE) — DATE 9/04/16

PATH: P:\WEBLOCK ANTHEM\CADD\SHEETS\52SD1.DWG, 1:1, JHPRASTRUCTURE CO PASSPORT TWO
PLOTTED BY: Rod Bigman — PLOT DATE: 9/12/2016 10:39 AM
XREFS: pstamps SDMD SDPP1 SDPP2 SSRAGE ADMND TRIGT MSDPLAT18

DATE	REVISION DESCRIPTION

52SD1.dwg
WHEELOCK ANTHEM
WS ACB DEVELOPMENT, LLC

0 25 50 100
1 inch = 50 ft Horizontal
1 inch = 5 ft Vertical

MAS | MAS | TAJ

Calibre
Construction Management Civil Engineering Surveying

ANTHEM FILING NO. 24
NEIGHBORHOOD 5
STORM PLAN AND PROFILE

SD1 | 14 | 33

SEPTEMBER 14, 2016

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	J. DAVIS
designed by	**checked by**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

YARD PIPING DETAILS V

project	contract
135303	

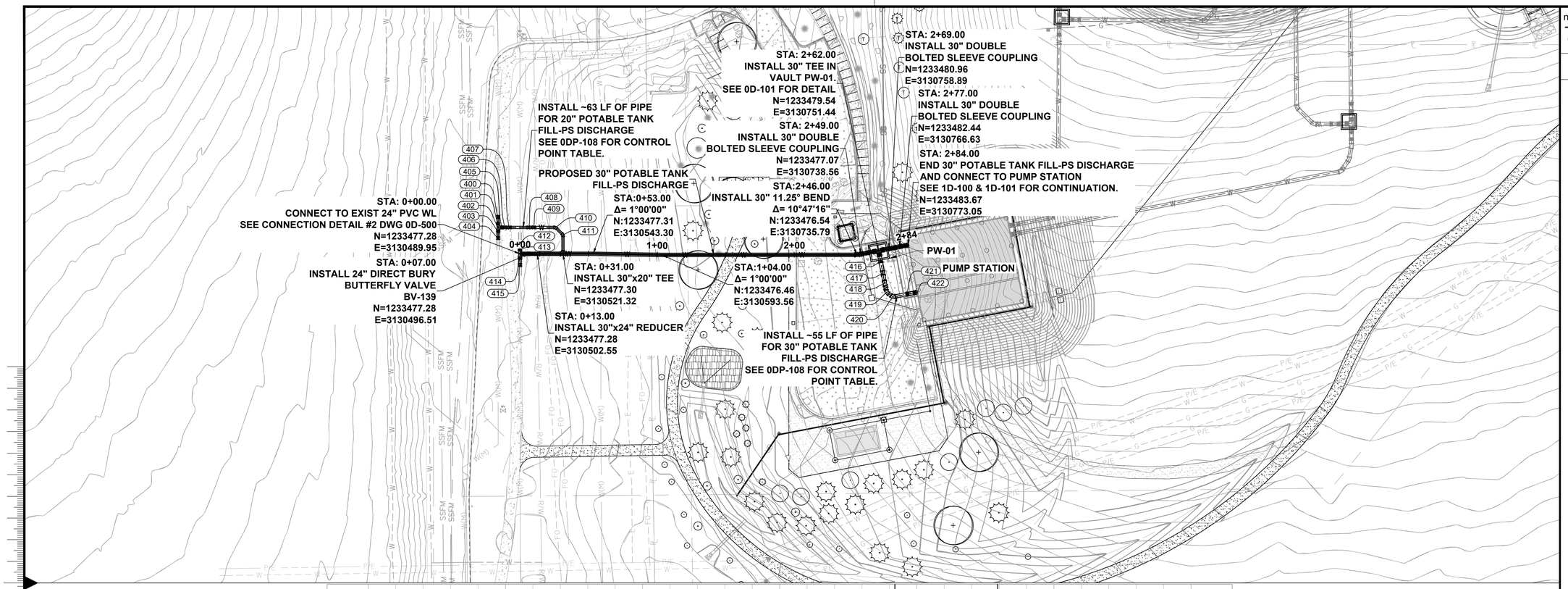
drawing **0D-504** rev. **1**

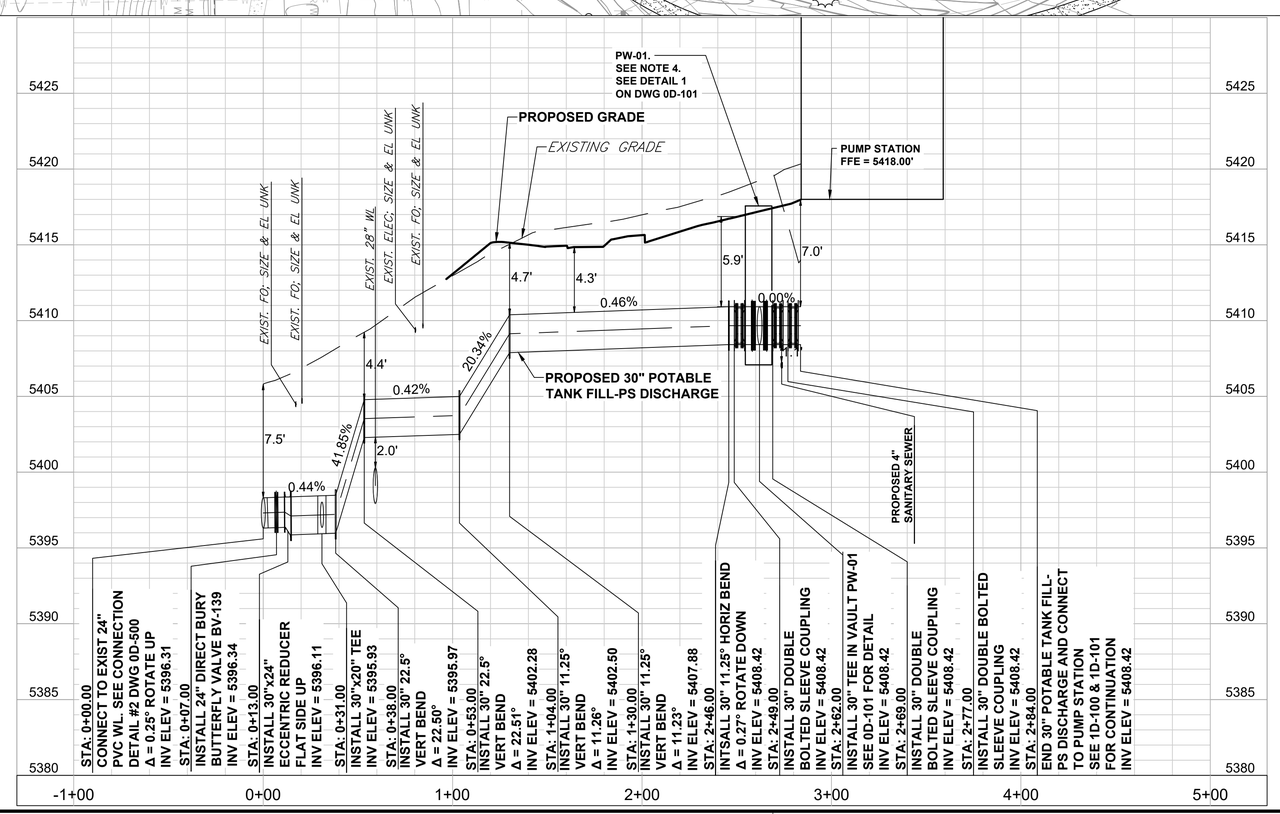
sheet of sheets

file 135303_0D-500.dwg

COLORADO LICENSED
NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches





NOTES:

1. **RESTRAIN ALL PIPING.**
2. **CONTRACTOR SHALL CONFIRM ALL CROSSING AND CONNECTION POINTS.**
3. **DR 25 PVC PIPE SHALL BE EMBEDDED IN CLSM 20-FEET BELOW GRADE OR DEEPER. DR 18 PVC PIPE SHALL BE EMBEDDED IN CLSM 30-FEET BELOW GRADE OR DEEPER.**
4. **CONTRACTOR TO BUILD UP GRADE AROUND VAULT AS NEEDED.**

no.	date	by	ckd	description
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1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	checked by
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
30" POTABLE TANK FILL/PS DISCHARGE
STA. 00+00 TO STA. 02+84

project	contract
135303	

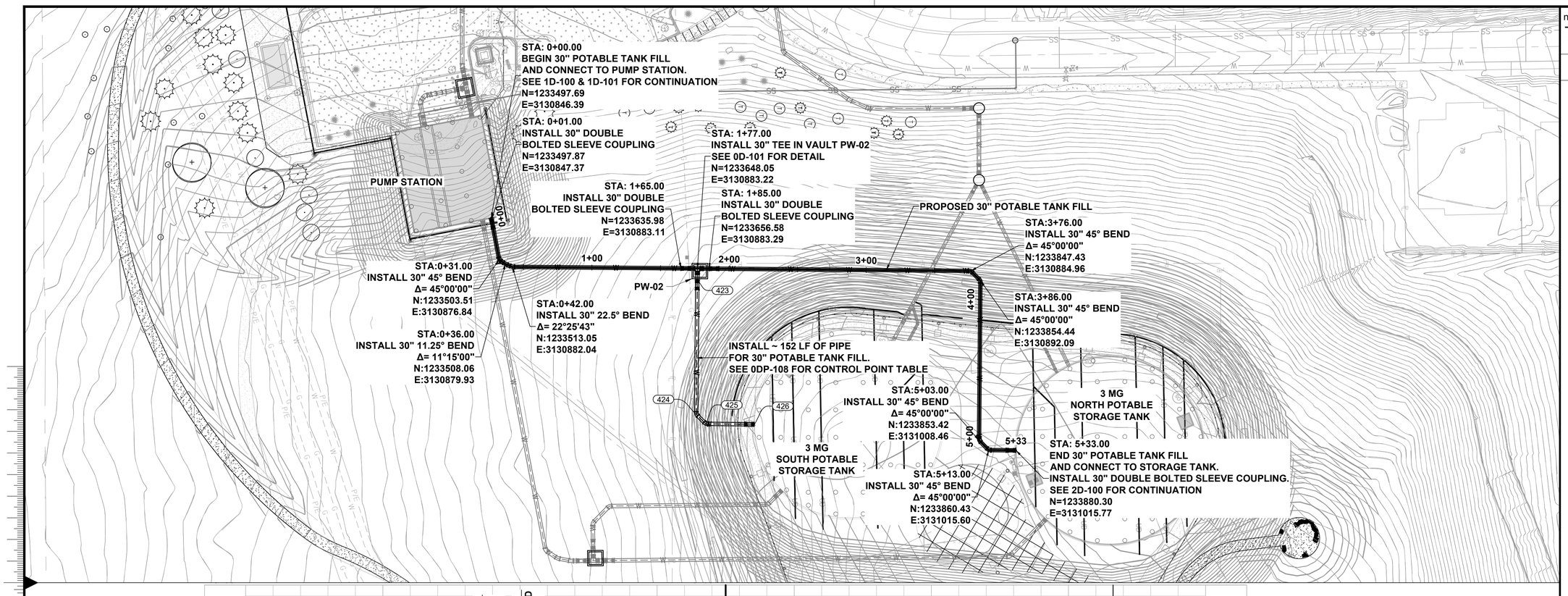
drawing **0DP-100** rev. **1**

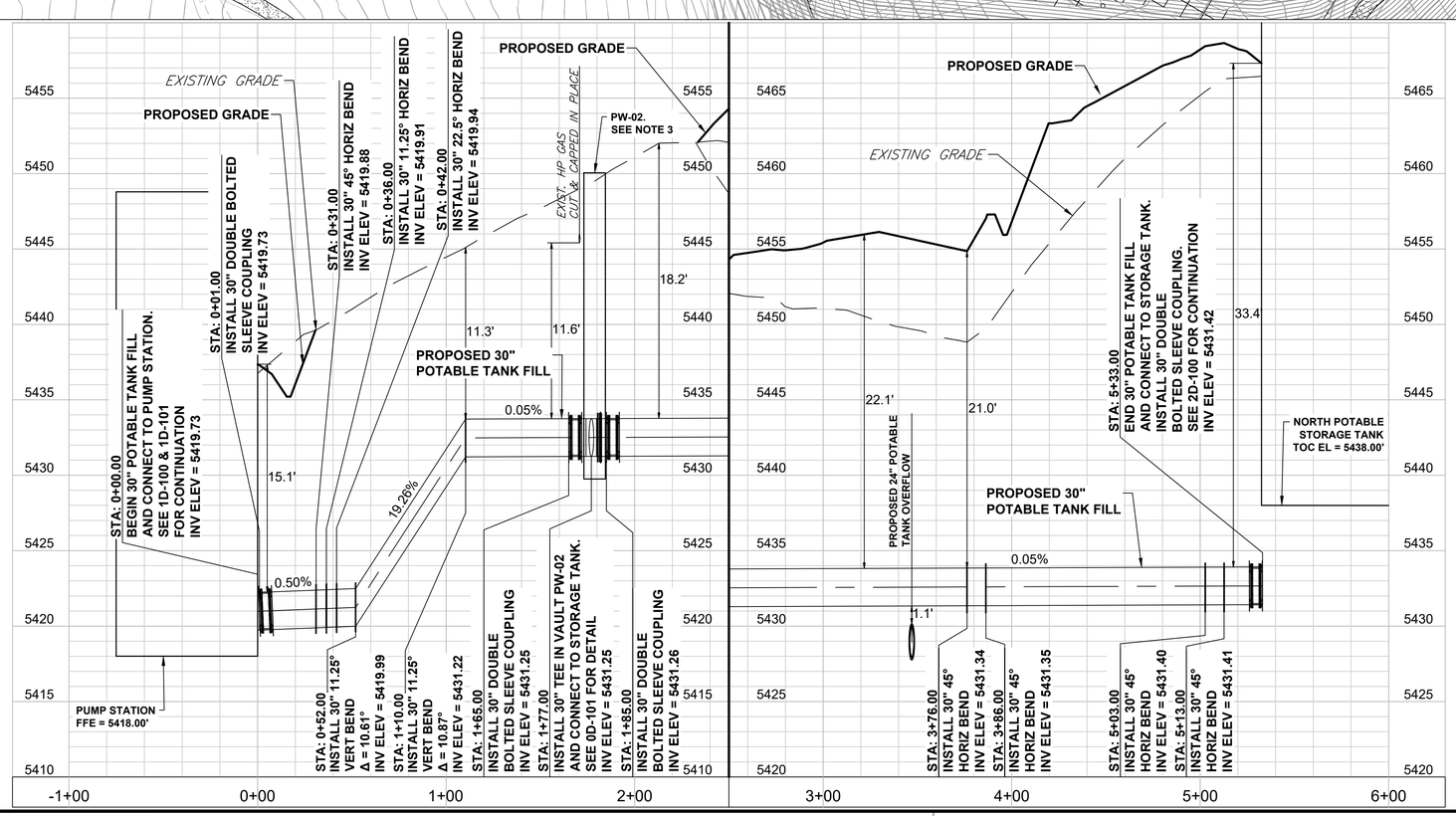
sheet of sheets

file 0DP-100.dwg

COLORADO LICENSED
NICHOLAS A. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

Millimeters
Inches
Scale For Microfilming





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0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements. **THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."**

City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	checked by
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

COLORADO LICENSED
NICHOLAS A. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
30" POTABLE TANK FILL
STA. 00+00 TO STA. 05+33

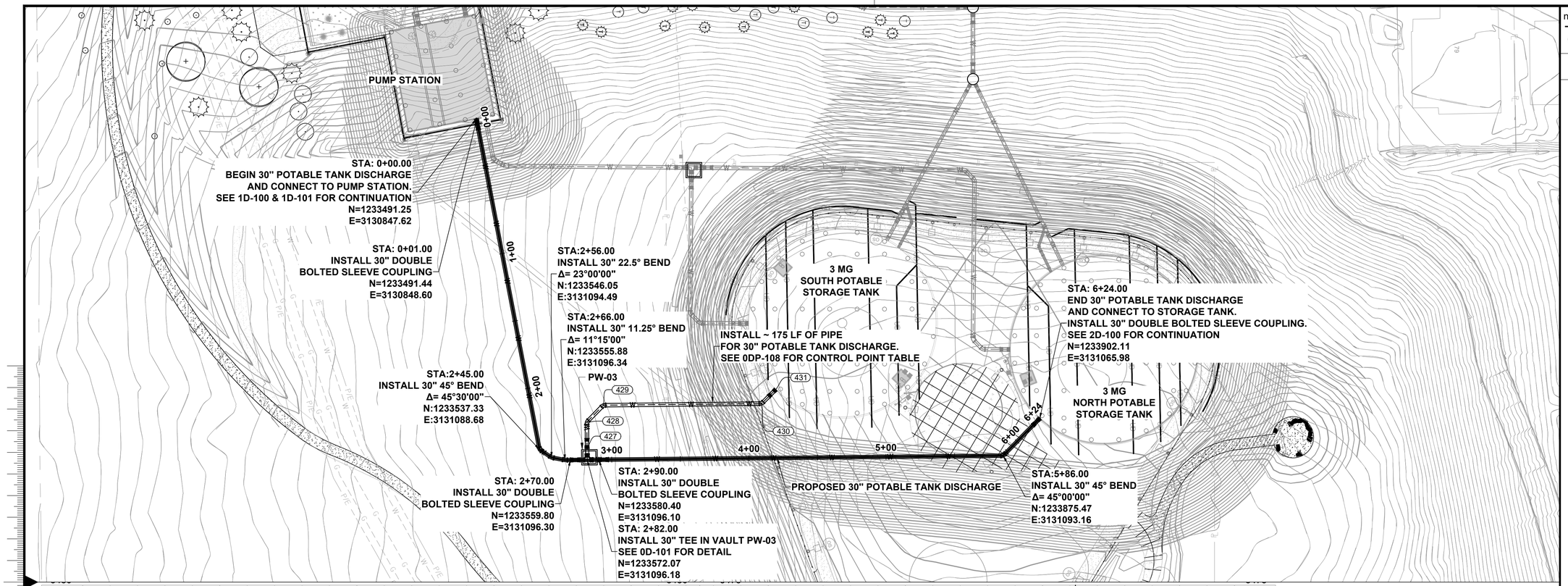
project	contract
135303	

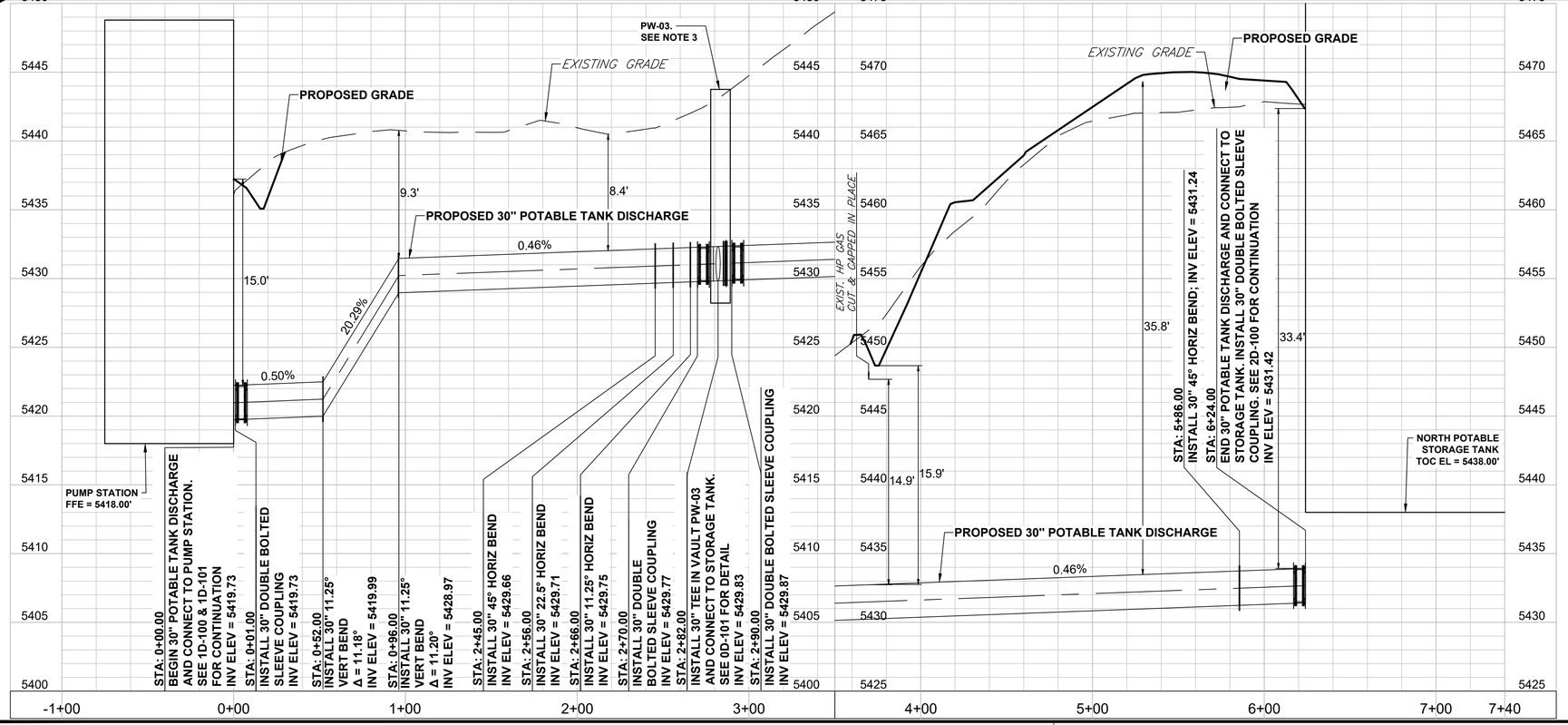
drawing **0DP-101** rev. **1**

sheet of sheets

file 0DP-101.dwg

Scale For Microfilming
Millimeters
Inches





NOTES:

1. **RESTRAIN ALL PIPING.**
2. **DR 25 PVC PIPE SHALL BE EMBEDDED IN CLSM 20-FEET BELOW GRADE OR DEEPER. DR 18 PVC PIPE SHALL BE EMBEDDED IN CLSM 30-FEET BELOW GRADE OR DEEPER.**
3. **CONTRACTOR TO BUILD UP GRADE AROUND VAULT AS NEEDED.**

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date: MAY 2025	detailed by: K. WEISS
designed by: J. DAVIS	checked by: N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
30" POTABLE TANK DISCHARGE
STA. 00+00 TO STA. 06+24

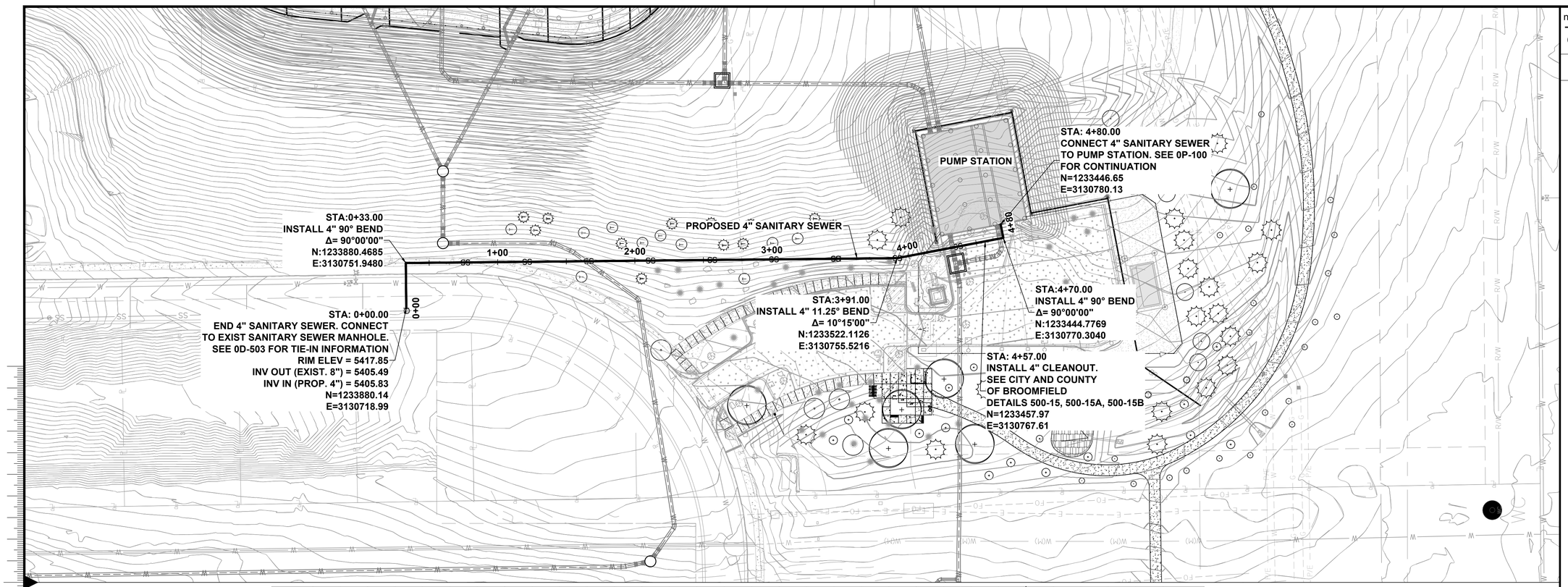
project	contract
135303	

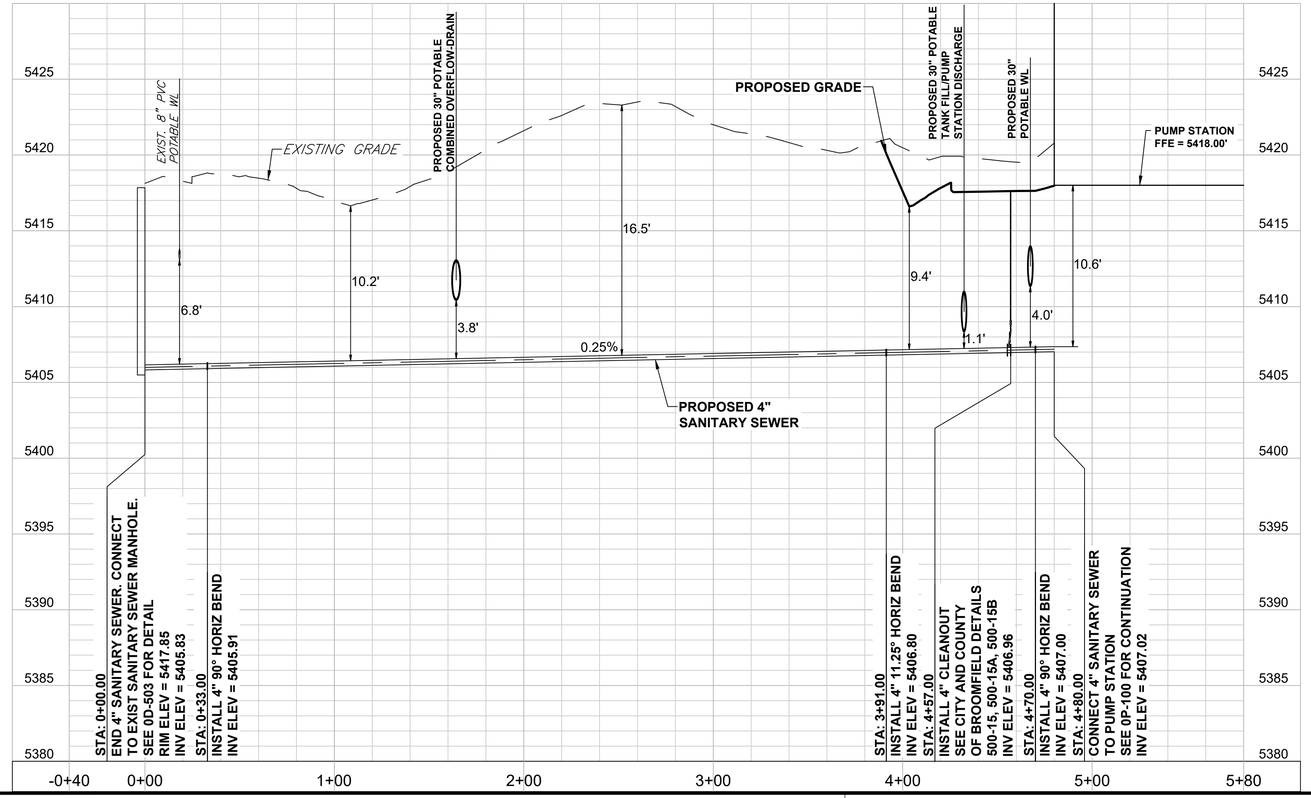
drawing **0DP-102** rev. **1**

sheet of sheets
file 0DP-102.dwg

COLORADO LICENSED
NICOLE RACHELSON
47887
05/08/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches





NOTES:

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no.	date	by	ckd	description
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1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	checked by
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

COLORADO LICENSED
Nikki K. Rachelson
47887
05/06/2025
PROFESSIONAL ENGINEER

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
4" SAN SEWER
STA. 00+00 TO STA. 04+80

project	contract
135303	

drawing **0DP-103** rev. **1**

sheet of sheets

file 0DP-103.dwg

Scale For Microfilming
Millimeters
Inches

no.	date	by	ckd	description
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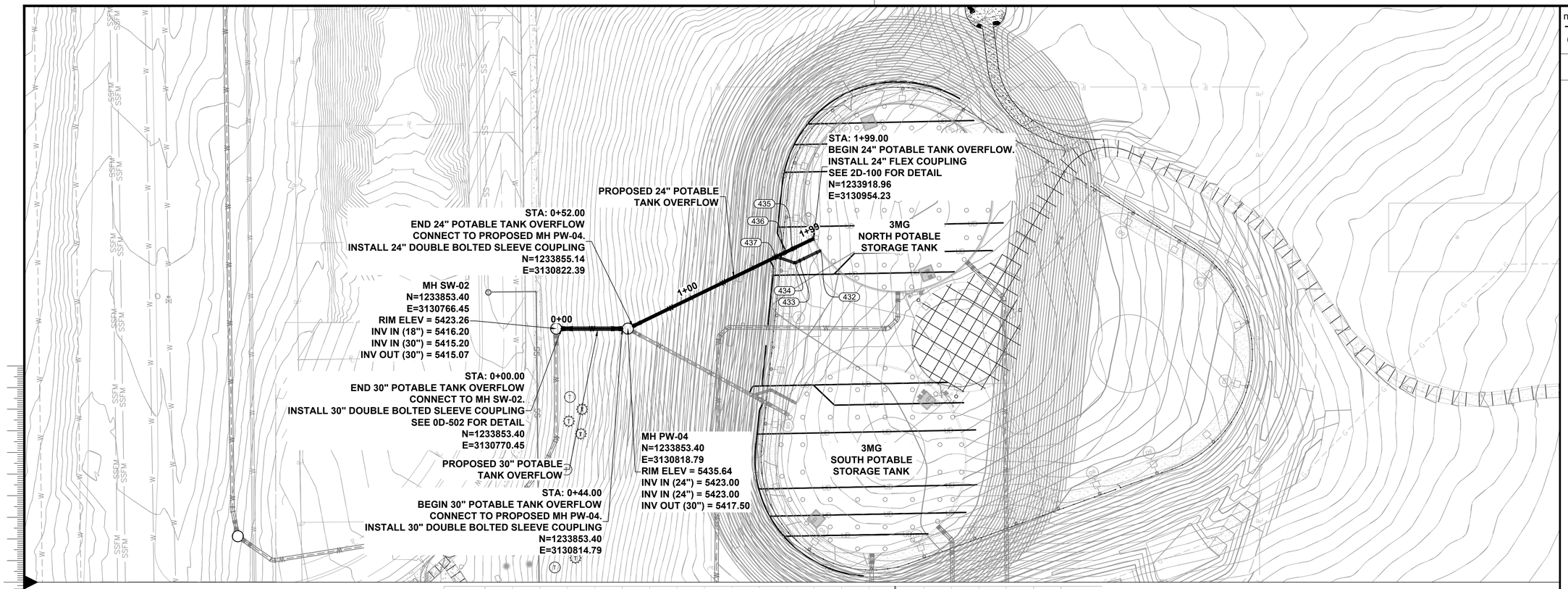
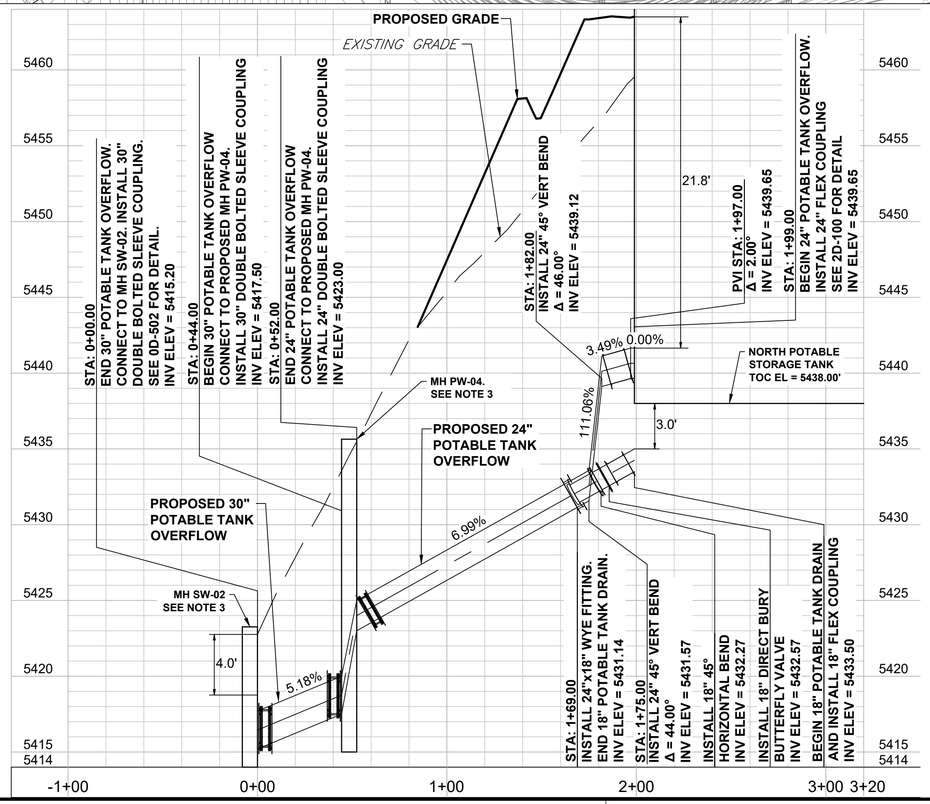
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION





NOTES:

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2. **DR 25 PVC PIPE SHALL BE EMBEDDED IN CLSM 20-FEET BELOW GRADE OR DEEPER. DR 18 PVC PIPE SHALL BE EMBEDDED IN CLSM 30-FEET BELOW GRADE OR DEEPER.**
3. **CONTRACTOR TO BUILD UP GRADE AROUND VAULT AS NEEDED.**

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements. THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."

City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

COLORADO LICENSED
Nicholas K. Rachelson
47887
05/06/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	checked by
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
18"/24" POTABLE TANK OVERFLOW
STA. 00+00 TO STA. 01+99

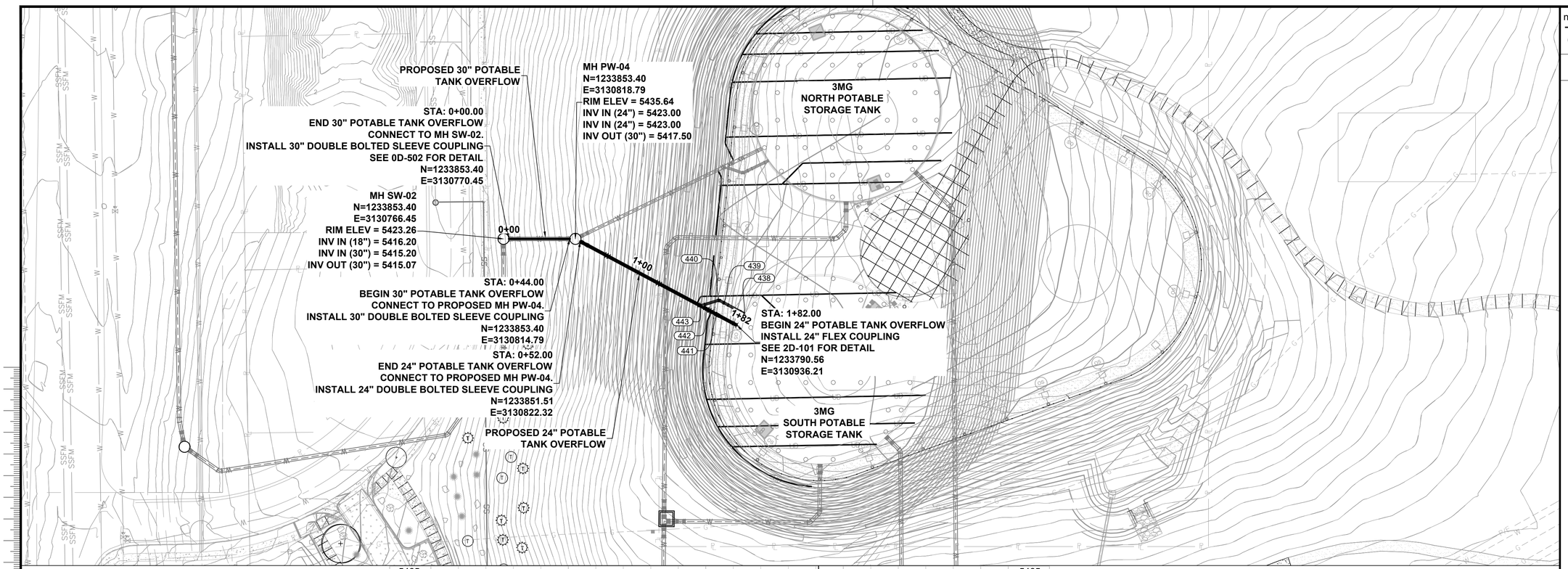
project	contract
135303	

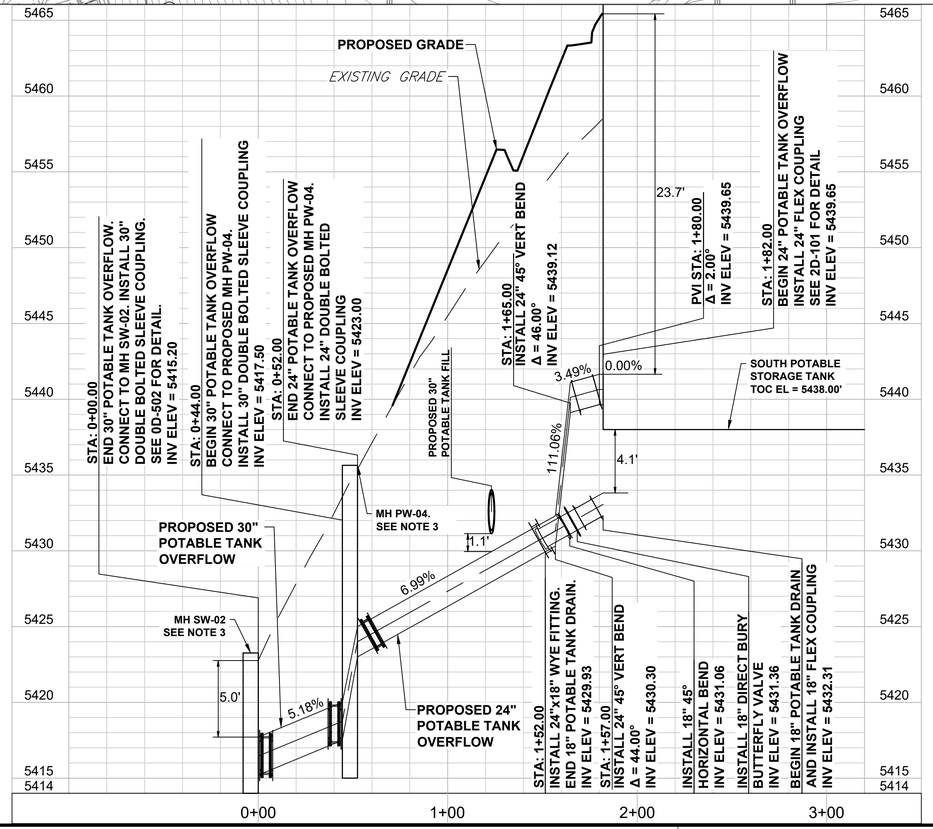
drawing **0DP-104** rev. **1**

sheet of sheets

file 0DP-104.dwg

Scale For Microfilming
Millimeters
Inches





NOTES:

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2. **DR 25 PVC PIPE SHALL BE EMBEDDED IN CLSM 20-FEET BELOW GRADE OR DEEPER. DR 18 PVC PIPE SHALL BE EMBEDDED IN CLSM 30-FEET BELOW GRADE OR DEEPER.**
3. **CONTRACTOR TO BUILD UP GRADE AROUND VAULT AS NEEDED.**

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	**checked by**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
18"/24" POTABLE TANK OVERFLOW
STA. 00+00 TO STA. 01+82

project	contract
135303	

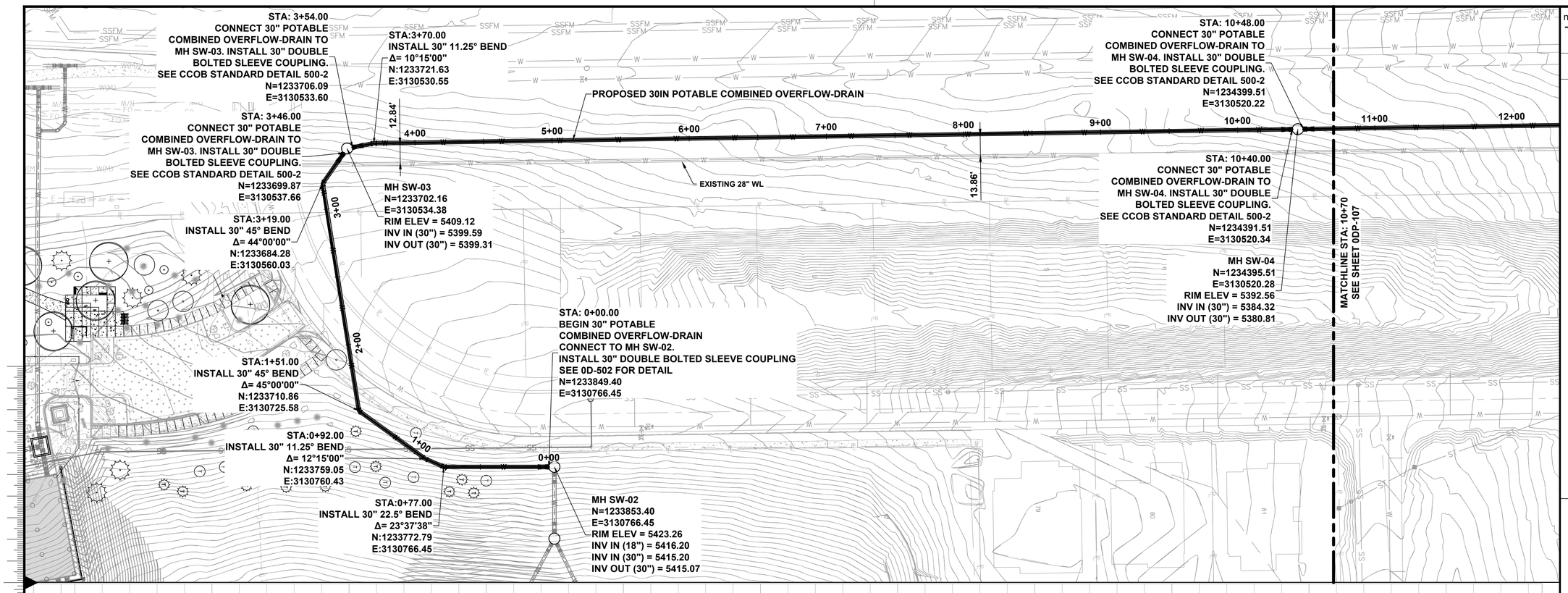
drawing **0DP-105** rev. **1**

sheet of sheets

file 0DP-105.dwg

COLORADO LICENSED
NICHOLAS E. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches



NOTES:

1. RESTRAIN ALL PIPING.
2. DR 25 PIPE SHALL BE EMBEDDED IN CLSM 20-FEET BELOW GRADE OR DEEPER. DR 18 PIPE SHALL BE EMBEDDED IN CLSM 30-FEET BELOW GRADE OR DEEPER.
3. CONTRACTOR TO BUILD UP GRADE AROUND VAULT AS NEEDED.
4. CONTRACTOR TO LOCATE AND VERIFY EXISTING UTILITIES IN THE VICINITY PRIOR TO CONSTRUCTION.
5. SURFACE INFORMATION SHOWN MAY BE OUT OF DATE AND MAY NOT ACCURATELY REPRESENT CURRENT CONDITIONS. CONTRACTOR TO VERIFY EXISTING SURFACE CONDITIONS PRIOR TO CONSTRUCTION.

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

COLORADO LICENSED
KYLE R. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	checked by
J. DAVIS	N. RACHELSON

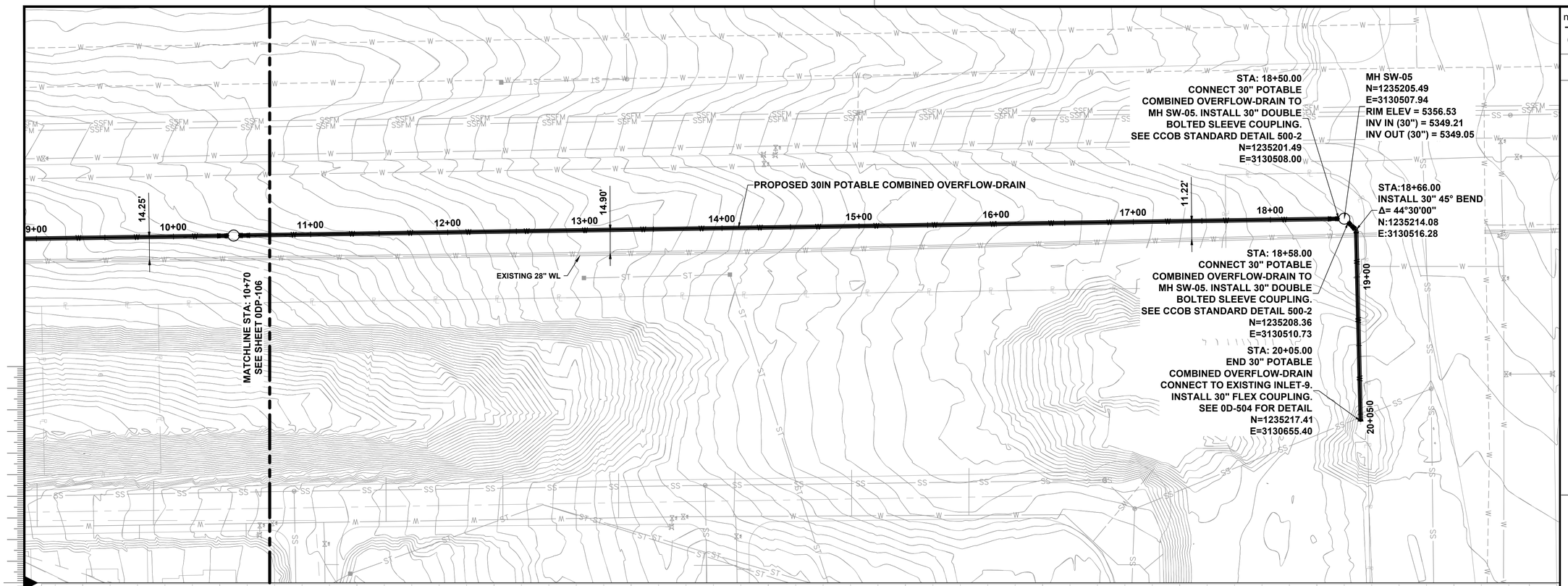
CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
30" POTABLE COMBINED OVERFLOW-DRAIN
STA. 00+00 TO STA. 10+70

project	contract
135303	

drawing **0DP-106** rev. **1**

sheet of sheets
file 0DP-106.dwg



NOTES:

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3. **CONTRACTOR TO BUILD UP GRADE AROUND VAULT AS NEEDED.**
4. **CONTRACTOR TO LOCATE AND VERIFY EXISTING UTILITIES IN THE VICINITY PRIOR TO CONSTRUCTION.**
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City and County Engineer (or Designee) Date

NORTH

0 20' 40' 80'
HORIZONTAL SCALE IN FEET

0 5' 10'
VERTICAL SCALE IN FEET

COLORADO LICENSED
NICOLE RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	**checked by**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
30" POTABLE COMBINED OVERFLOW-DRAIN
STA. 10+70 TO STA. 20+05

project	contract
135303	

drawing **0DP-107** rev. **1**

sheet of sheets

file 0DP-106.dwg

CONTROL POINT TABLE

POINT #	ELEVATION (T.O.P.)	NORTHING	EASTING	DESCRIPTION
400	5397.73	1233504.17	3130473.96	20" RESTRAINED SOLID SLEEVE COUPLING
401	5397.73	1233499.34	3130473.96	20" BUTTERFLY VALVE BV-150
402	5397.73	1233496.48	3130473.97	20"x20" DI TEE w/FOSTER ADAPTER. SEE CONNECTION DETAIL #1 ON DWG 0D-500.
403	5397.73	1233493.62	3130473.97	20" BUTTERFLY VALVE BV-151
404	5397.73	1233488.61	3130473.96	20" RESTRAINED SOLID SLEEVE COUPLING
405	5397.73	1233496.48	3130476.83	20" BUTTERFLY VALVE BV-133
406	5397.73	1233496.48	3130478.98	20" 45° BEND
407	5394.51	1233496.49	3130482.21	20" 45° BEND
408	5394.51	1233496.49	3130496.25	20" 45° BEND
409	5398.01	1233496.49	3130499.75	20" 45° BEND
410	5398.01	1233496.50	3130515.89	20" 45° BEND
411	5398.01	1233491.09	3130521.31	20" 45° BEND
412	5398.30	1233485.27	3130489.98	24" RESTRAINED SOLID SLEEVE COUPLING
413	5398.30	1233480.51	3130489.95	24" BUTTERFLY VALVE BV-152
414	5398.30	1233474.06	3130489.96	24" BUTTERFLY VALVE BV-153
415	5398.30	1233469.18	3130489.96	24" RESTRAINED SOLID SLEEVE COUPLING
416	5410.92	1233471.76	3130752.93	30" FLEX COUPLING
417	5410.92	1233463.09	3130754.59	30" 22.5° BEND
418	5413.92	1233455.90	3130755.96	30" 22.5° BEND
419	5413.92	1233449.09	3130757.26	30" 45° BEND
420	5413.92	1233445.91	3130761.94	30" 45° BEND
421	5413.92	1233447.75	3130771.58	30" DOUBLE BOLTED SLEEVE COUPLING
422	5413.92	1233449.29	3130779.62	END 30" LINE AND CONNECT TO PUMP STATION
423	5433.75	1233647.97	3130891.64	30" DOUBLE BOLTED SLEEVE COUPLING
424	5433.87	1233647.12	3130989.34	30" 45° BEND
425	5433.88	1233654.13	3130996.47	30" 45° BEND
426	5433.92	1233689.50	3130996.78	END 30" POTABLE TANK FILL AND CONNECT TO STORAGE TANK AND INSTALL 30" DOUBLE BOLTED SLEEVE COUPLING
427	5432.34	1233571.98	3131087.77	30" DOUBLE BOLTED SLEEVE COUPLING
428	5432.52	1233571.79	3131068.66	30" 45° BEND
429	5432.69	1233583.85	3131056.37	30" 45° BEND
430	5433.78	1233699.26	3131055.22	30" 45° BEND
431	5433.92	1233709.56	3131044.92	END 30" POTABLE TANK DISCHARGE AND CONNECT TO STORAGE TANK AND INSTALL 30" DOUBLE BOLTED SLEEVE COUPLING
432	5435.00	1233910.29	3130959.24	BEGIN 18" POTABLE TANK DRAIN AND INSTALL 18" FLEX COUPLING
433	5433.71	1233902.98	3130944.15	INSTALL 18" DIRECT BURY BUTTERFLY VALVE BV-137
434	5433.41	1233901.25	3130940.57	18" 45° BEND
435	5441.12	1233911.63	3130939.09	24" 45° VERTICAL BEND
436	5433.57	1233908.58	3130932.79	24" 45° VERTICAL BEND
437	5432.66	1233905.89	3130927.23	24"x18" WYE FITTING AND END 18" POTABLE TANK DRAIN.
438	5433.81	1233799.00	3130941.61	BEGIN 18" POTABLE TANK DRAIN AND INSTALL 18" FLEX COUPLING
439	5432.50	1233806.92	3130926.80	INSTALL 18" DIRECT BURY BUTTERFLY VALVE BV-138
440	5432.22	1233808.81	3130923.28	18" 45° BEND
441	5441.12	1233798.36	3130921.64	24" 45° VERTICAL BEND
442	5432.30	1233802.13	3130914.59	24" 45° VERTICAL BEND
443	5431.46	1233804.72	3130909.76	24"x18" WYE FITTING AND END 18" POTABLE TANK DRAIN.

Scale For Microfilming
Millimeters
Inches

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

COLORADO LICENSED
NATHAN K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	K. WEISS
designed by	**checked by**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
YARD PIPING PLAN AND PROFILE
CONTROL POINT TABLE

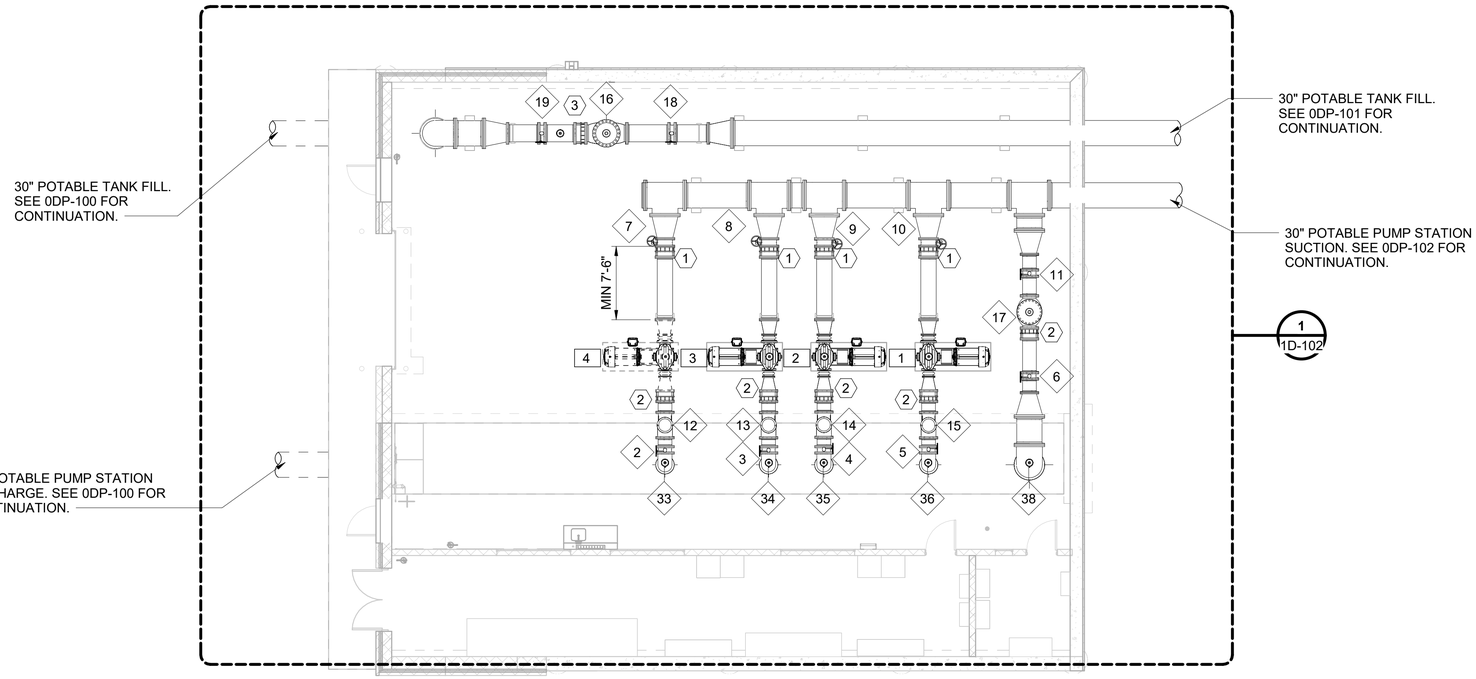
project	contract
135303	

drawing **0DP-108** — rev. **1**

sheet of sheets
file 0DP-108.dwg

KEYED NOTES:

1. 18" DISMANTLING JOINT.
2. 16" DISMANTLING JOINT.
3. 20" DISMANTLING JOINT.



PUMP STATION UPPER LEVEL PLAN

0 4' 8' 16'
SCALE IN FEET

NORTH

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date MAY 2025	**detailed** J. DAVIS
designed J. DAVIS	**checked** N. RACHELSON

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION UPPER LEVEL PLAN

project 135303	**contract**
drawing 1D-100	**rev.** 1
sheet	**of** **sheets**
file	

COLORADO LICENSED
NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

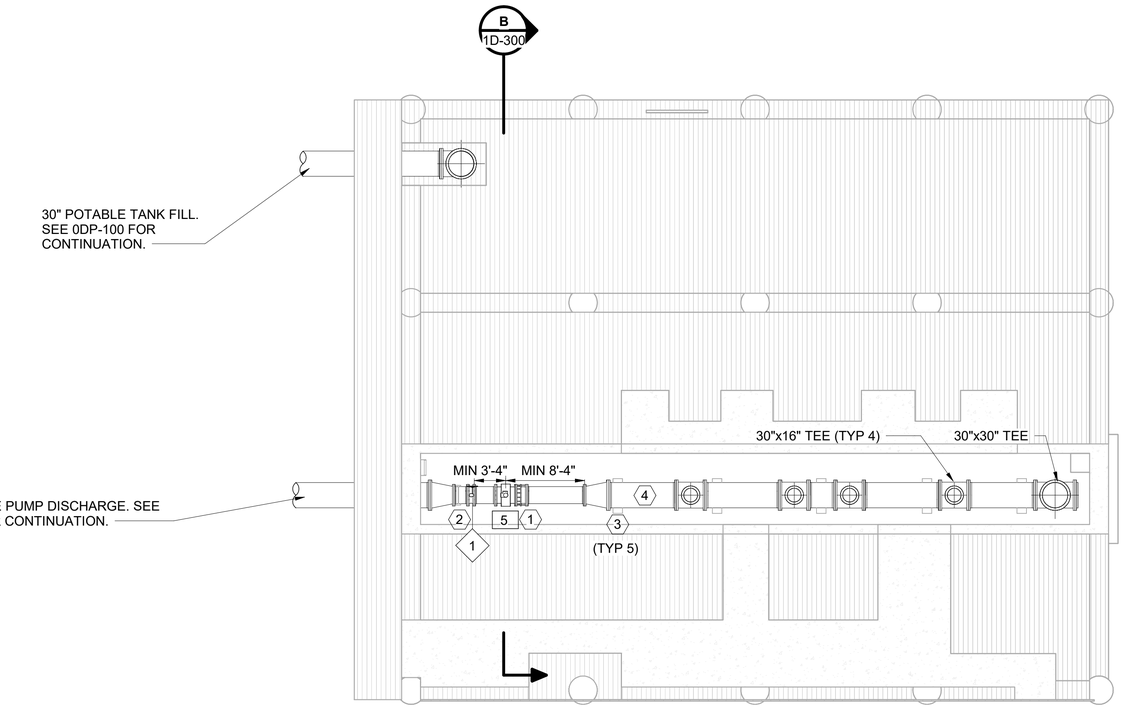
Scale For Microfilming
Millimeters
Inches

5/6/2025 11:22:06 AM

Autodesk Docs://135303_TanksProject/135303_D_POT_ONLY.rvt.rvt

KEYED NOTES:

1. 20" DISMANTLING JOINT.
2. PS-1, SEE STRUC DWGS FOR DETAIL.
3. PS-4, SEE STRUC DWGS FOR DETAIL.
4. SAMPLE TAP OFF BOTTOM OF PIPE WITH 3/4" STEEL BALL VALVE.



PUMP STATION LOWER LEVEL PLAN

0 4' 8' 16'
SCALE IN FEET

NORTH

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
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City and County Engineer (or Designee) Date

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	J. DAVIS
designed	**checked**
J. DAVIS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

PUMP STATION LOWER LEVEL PLAN

project	contract
135303	

drawing **1D-101** — rev. **1**

sheet of sheets

file

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NICOLE K. RACHELSON
47887
05/06/2025
PROFESSIONAL ENGINEER

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Millimeters
Inches

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30" POTABLE TANK FILL. SEE 0DP-100 FOR CONTINUATION.

B 1D-300

A 1D-301

4' - 7 3/8"

30" BLIND FLANGE

30"x30" TEE (TYP 5)

3' - 10 7/8"

MIN 7'-6"

MIN 9'-5"

MIN 4'-2"

MIN 9'-5"

MIN 8'-6"

18" POTABLE SUCTION (TYP 4)

16" POTABLE DISCHARGE (TYP 4)

8' - 11 1/8"

4' - 3 3/4"

30" POTABLE TANK FILL. SEE 0DP-101 FOR CONTINUATION.

30" POTABLE PUMP STATION SUCTION. SEE 0DP-102 FOR CONTINUATION.

30" POTABLE PUMP STATION DISCHARGE. SEE 0DP-100 FOR CONTINUATION.

NOTES:

1. ALL WALL PENETRATIONS SHALL BE DOUBLE LINK SEAL. ALL FLOOR PENETRATIONS SHALL BE SINGLE LINK SEAL. SEE PROCESS DETAILS.

KEYED NOTES:

1. 18" DISMANTLING JOINT.
2. 12" DISMANTLING JOINT.
3. 14" DISMANTLING JOINT.
4. 16" DISMANTLING JOINT.
5. 20" DISMANTLING JOINT.
6. EXPANSION JOINT, MATCH PUMP CONNECTION SIZE.
7. PS-1, SEE STRUC DWGS FOR DETAIL.
8. PS-4, SEE STRUC DWGS FOR DETAIL.
9. SAMPLE TAP OFF SIDE OF PIPE WITH 3/4" STEEL BALL VALVE.

ENLARGED POTABLE PUMP STATION PLAN

0 2' 4' 8'

SCALE IN FEET

NORTH

Scale For Microfilming: Millimeters / Inches

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9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	M. WILLIS
designed	**checked**
J. DAVIS	N. RACHELSON

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BROOMFIELD TANKS AND PUMP STATION

ENLARGED POTABLE PUMP STATION PLAN

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drawing 1D-102 — **rev.** 1

sheet **of** **sheets**

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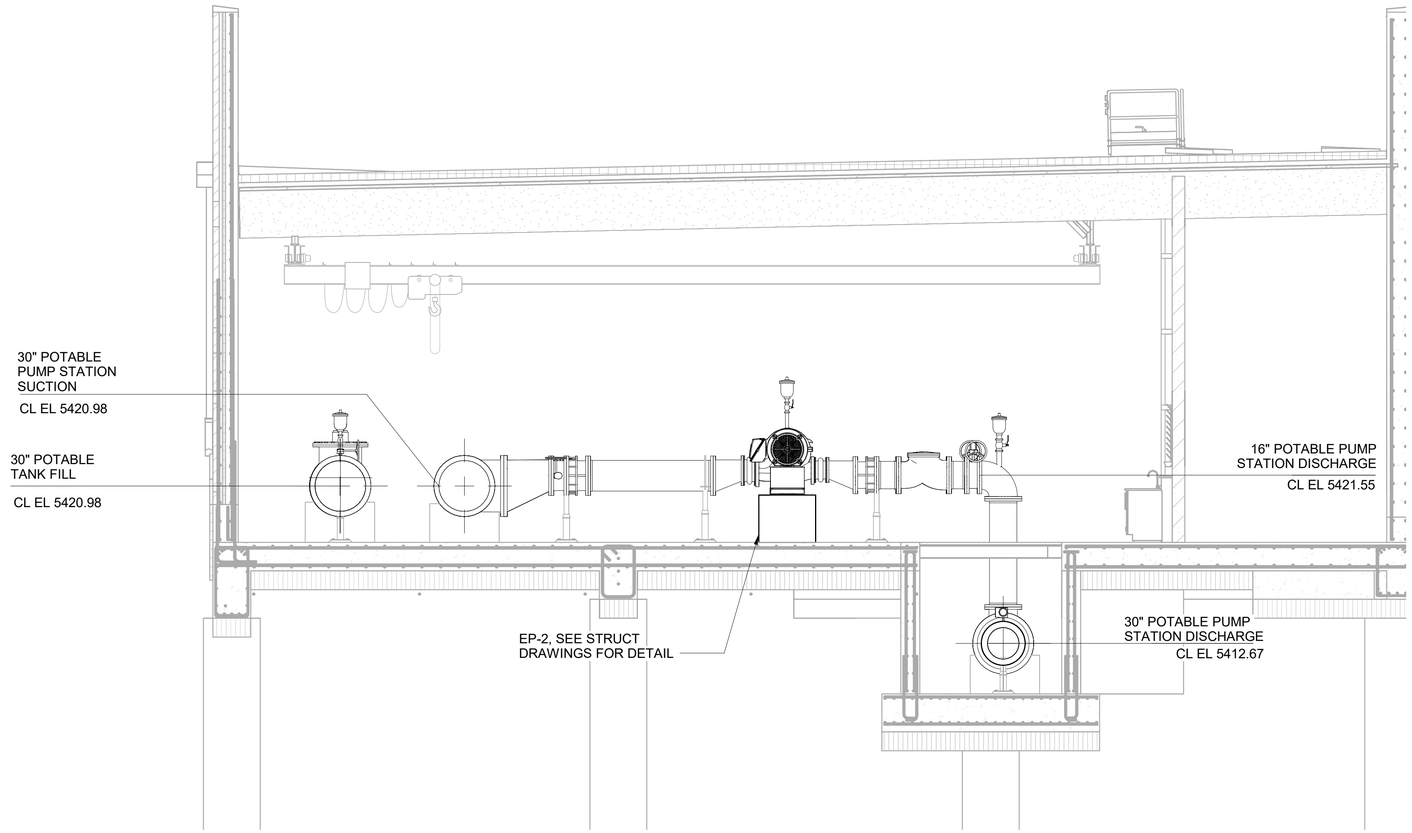
NOTES:

1. SEE VAULT AND MANHOLE FLOOR AND RIM ELEVATIONS ON PLAN AND PROFILE DRAWINGS.



POTABLE PUMP STATION SECTION — B / 1D-101

0 2' 4' 8'
SCALE IN FEET

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date	detailed
MAY 2025	J. DAVIS
designed	**checked**
J. DAVIS	N. RACHELSON

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BROOMFIELD TANKS AND PUMP STATION

POTABLE PUMP STATION SECTION

project	contract
135303	

drawing 1D-300 — **rev.** 1

sheet of **sheets**

file

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47887
05/06/2025
PROFESSIONAL ENGINEER

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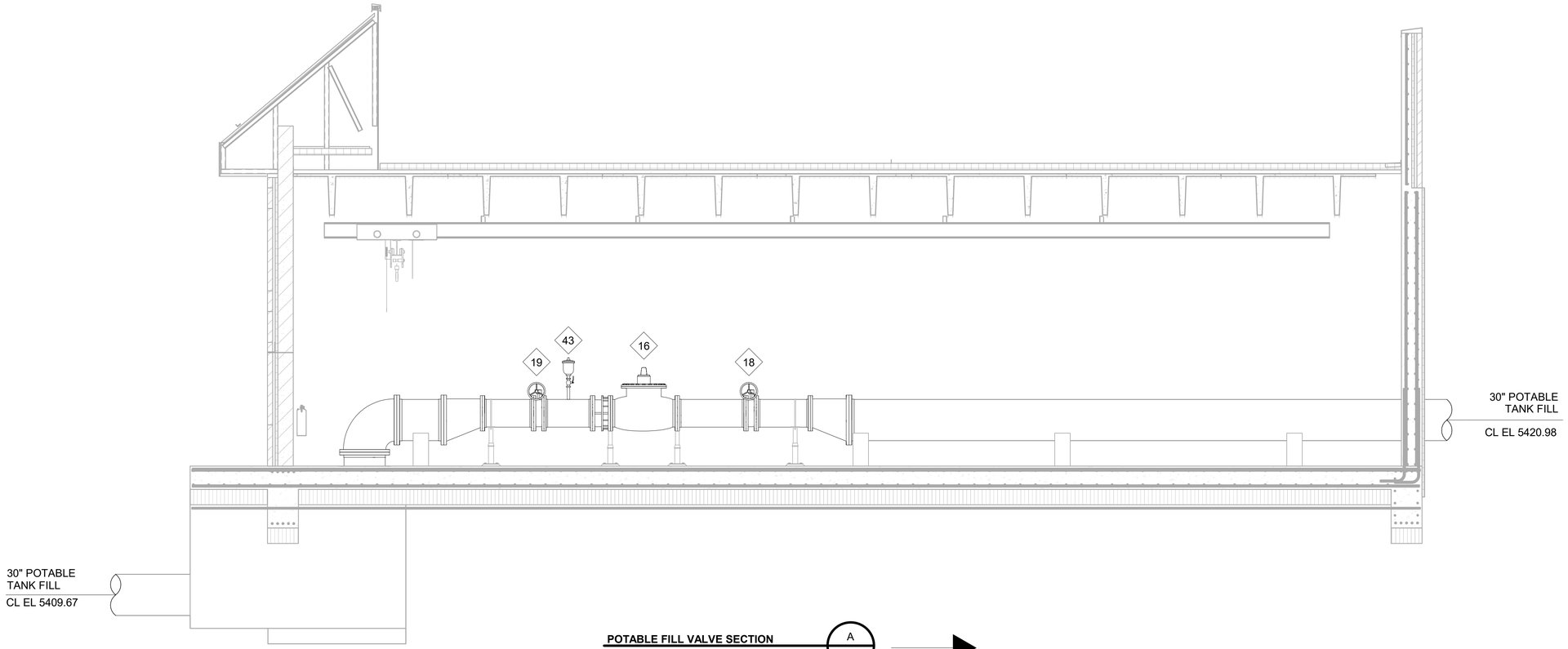

POTABLE FILL VALVE SECTION A / 1D-102

0 2' 4' 8'

SCALE IN FEET

FLOW

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
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date	detailed
MAY 2025	M. WILLIS
designed	**checked**
J. DAVIS	N. RACHELSON

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BROOMFIELD TANKS AND PUMP STATION

POTABLE FILL VALVE SECTION

project	contract
135303	

drawing 1D-301 — **rev.** 1

sheet **of** **sheets**

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47887
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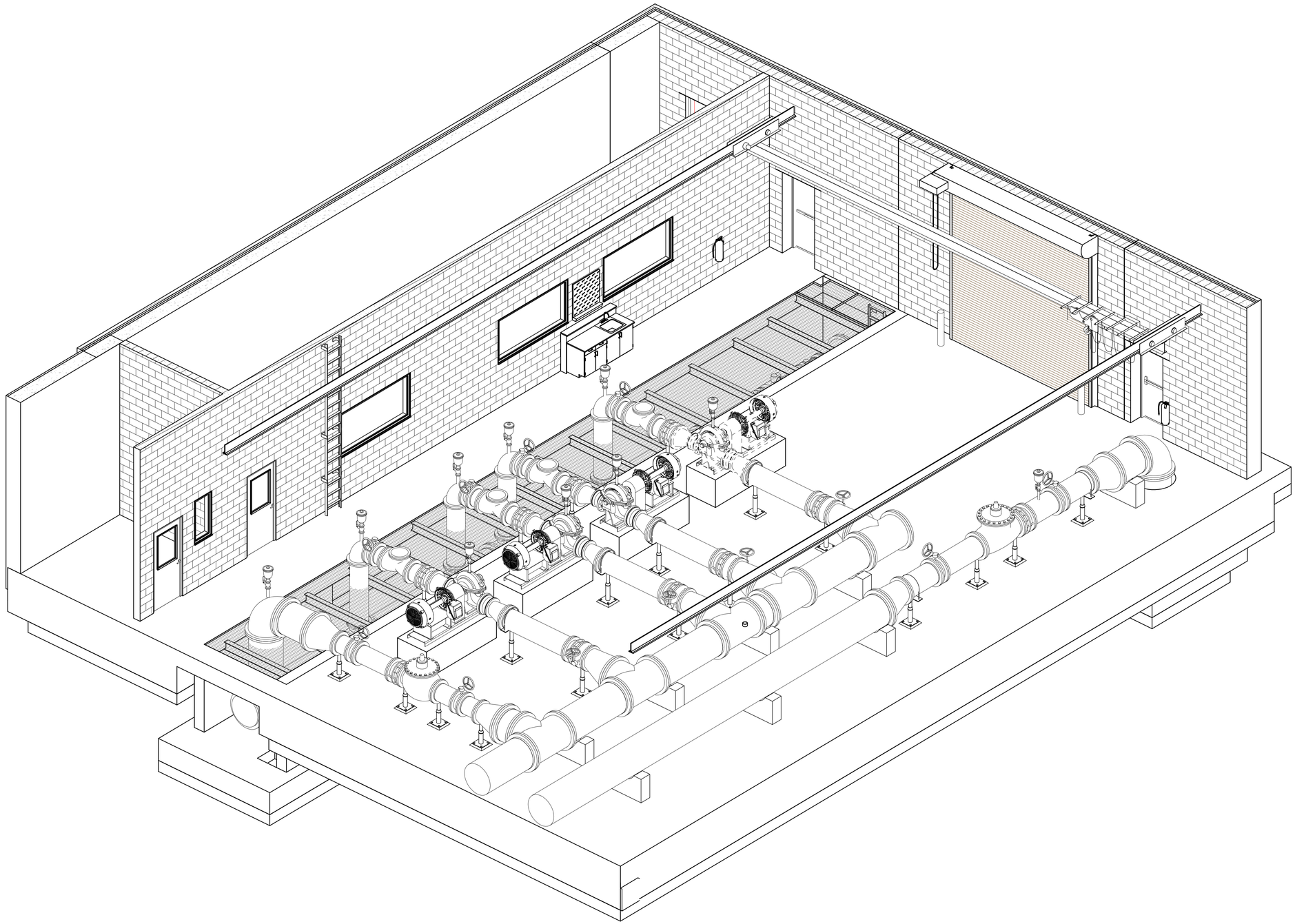

NORTHEAST POTABLE PUMP STATION
ISOMETRIC
NOT TO SCALE

no.	date	by	ckd	description
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date	detailed
MAY 2025	M .WILLIS
designed	**checked**
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BROOMFIELD TANKS AND PUMP STATION

POTABLE PUMP STATION ISOMETRIC

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135303	
drawing	**rev.**
1D-400	1
sheet	**of** **sheets**
file	

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NATHAN C. RACHELSON
47887
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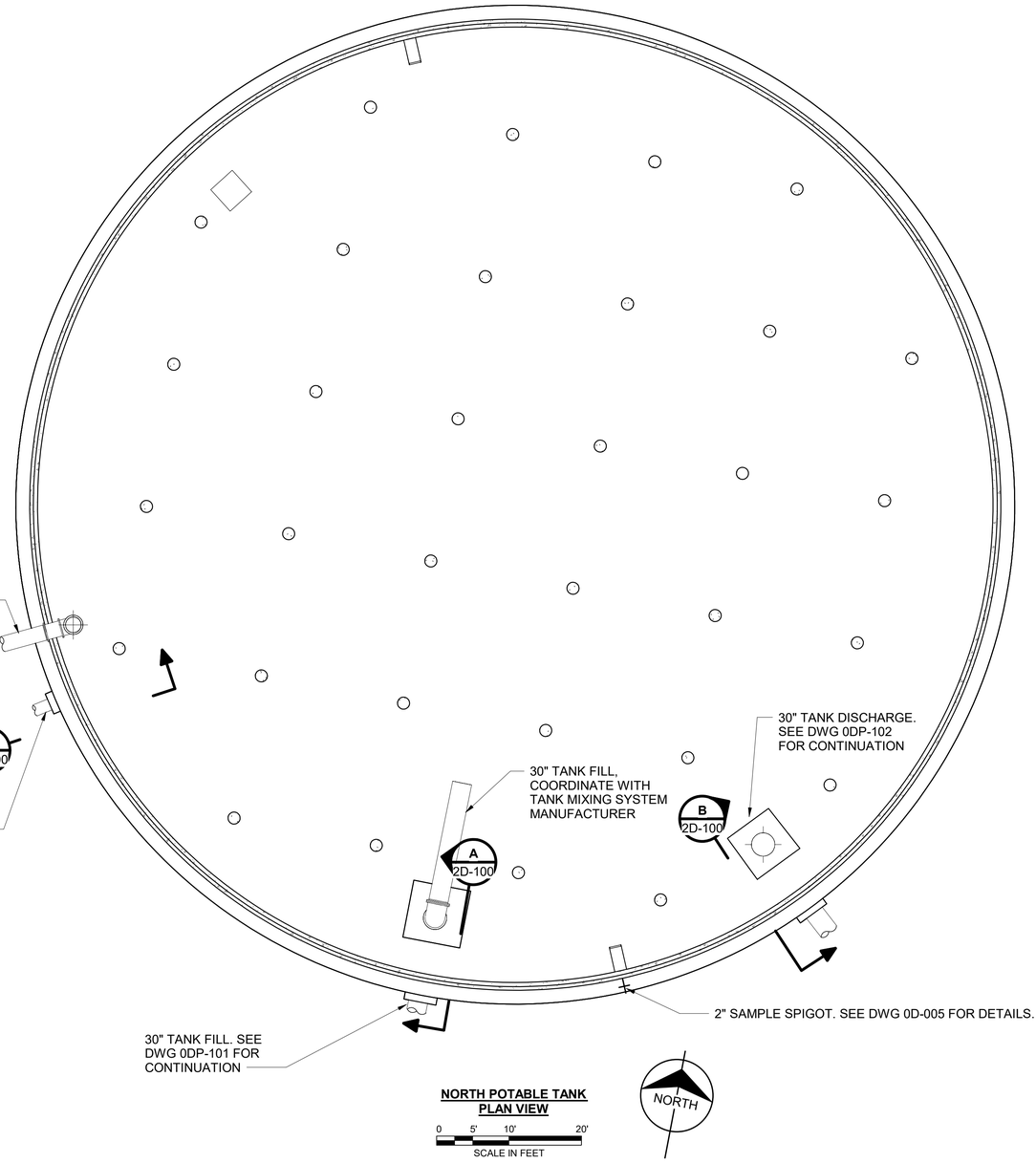


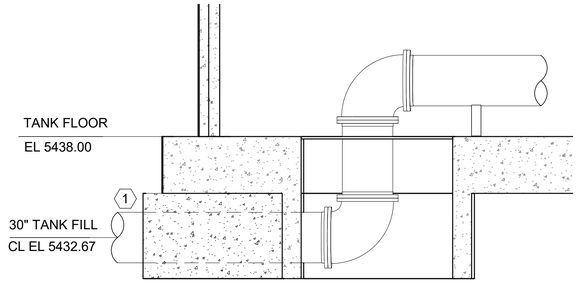
NORTH POTABLE TANK PLAN VIEW

0 5' 10' 20'

SCALE IN FEET

KEYED NOTES:

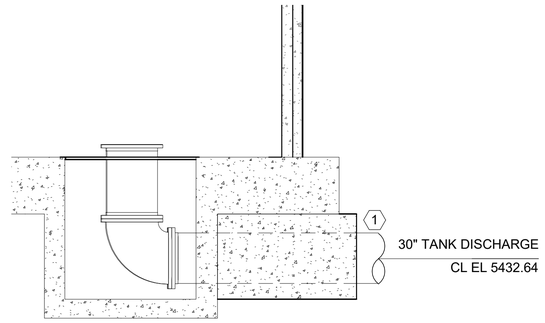
1. POLYETHLYENE WRAP TO BE INSTALLED ON BURIED DIP SECTIONS. SEE CCOB STANDARD DETAIL 400-10.



SECTION A 2D-100

0 2' 4' 8'

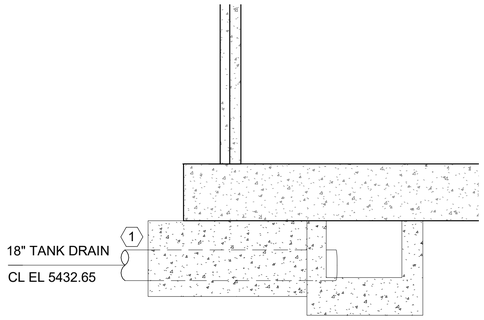
SCALE IN FEET



SECTION B 2D-100

0 2' 4' 8'

SCALE IN FEET



SECTION C 2D-100

0 2' 4' 8'

SCALE IN FEET

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date	detailed
MAY 2025	J. DAVIS
designed	**checked**
J. DAVIS	N. RACHELSON

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BROOMFIELD TANKS AND PUMP STATION

NORTH POTABLE TANK PIPING PLAN

project	contract
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drawing 2D-100 — **rev.** 1

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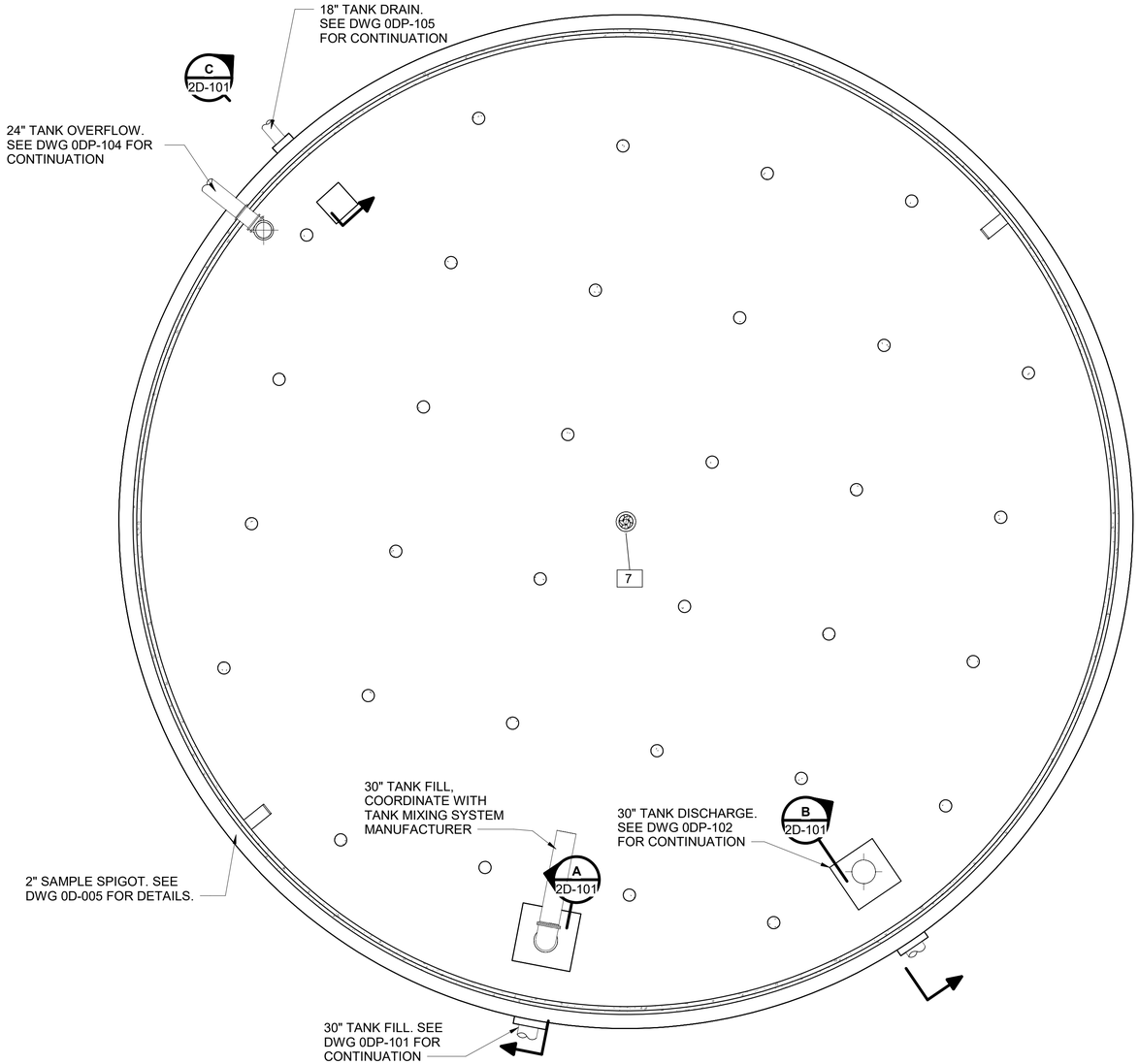
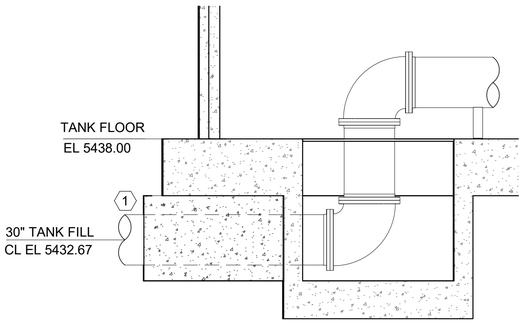


SOUTH POTABLE TANK
PLAN VIEW

0 5' 10' 20'
SCALE IN FEET

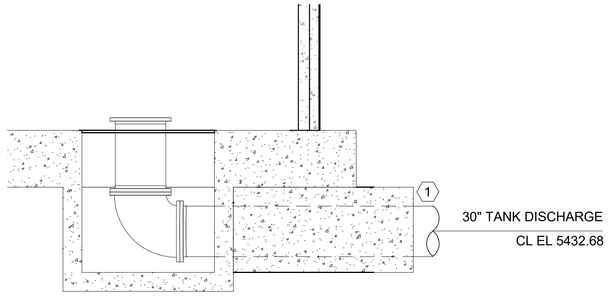
KEYED NOTES:

1. POLYETHLYENE WRAP TO BE INSTALLED ON BURIED DIP SECTIONS. SEE CCOB STANDARD DETAIL 400-10.



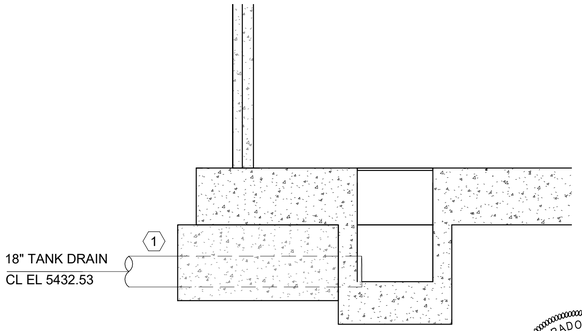
SECTION A 2D-101

0 2' 4' 8'
SCALE IN FEET



SECTION B 2D-101

0 2' 4' 8'
SCALE IN FEET



SECTION C 2D-101

0 2' 4' 8'
SCALE IN FEET

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date MAY 2025	**detailed** J. DAVIS
designed J. DAVIS	**checked** N. RACHELSON

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

SOUTH POTABLE TANK PIPING PLAN

COLORADO LICENSED NICHOLAS RACHELSON 47887 05/06/2025 PROFESSIONAL ENGINEER

project 135303	**contract**
drawing 2D-101	**rev.** 1
sheet	**of** **sheets**
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HVAC LEGEND

- CONTROL DAMPER, MOTOR OPERATED
- MANUAL BALANCE DAMPER
- BACKDRAFT DAMPER (BD)
- ACCESS DOOR (AD) ACCESS PANEL (AP) (AD)
- DAMPERS: FIRE (F) - SMOKE (S) - FIRE SMOKE (F/S) - (AD)
- FLEXIBLE DUCT CONNECTION
- RECTANGLUAR ELBOW WITH TURNING VANES
- RECTANGULAR TEE WITH TURNING VANES
- RECTANGULAR RADIUS ELBOW
- ROUND & RECTANGULAR DUCT TAKEOFF
- RISE IN RESPECT TO AIR-FLOW (R)
- DROP IN RESPECT TO AIR-FLOW (D)
- SQUARE OR RECTANGULAR TO ROUND TRANSITION
- SUPPLY AIR OR OUTSIDE AIR RECTANGULAR DUCT SECTION
- RETURN AIR RECTANGULAR DUCT SECTION
- EXHAUST AIR RECTANGULAR DUCT SECTION
- SUPPLY AIR OR OUTSIDE AIR ROUND DUCT SECTION
- RETURN AIR ROUND DUCT SECTION
- EXHAUST AIR ROUND DUCT SECTION
- ROUND FLEXIBLE DUCT (5'-0" MAX LENGTH)
- SQUARE OR RECTANGULAR SUPPLY DIFFUSER
- RETURN AIR DIFFUSER
- EXHAUST AIR DIFFUSER
- THERMOSTAT (T)
- HUMIDISTAT (H)
- CARBON DIOXIDE SENSOR (CO2)
- CARBON MONOXIDE SENSOR (CO)
- MOTOR (M)
- OCCUPANCY SENSOR (OCC)
- EMERGENCY SHUT-OFF SWITCH (ESS)
- FAN CONTROL PANEL (FCP)
- STATIC PRESSURE SENSOR (S)
- DIFFERENTIAL PRESSURE SENSOR (DP)
- AIRFLOW ARROW

PIPE LINE ACCESSORIES

- GATE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- 2-WAY VALVE
- 3-WAY VALVE
- BALL VALVE
- BALANCING VALVE / CIRCUIT SETTER
- RELIEF, SAFETY OR THERMAL RELIEF VALVE
- MOTORIZED CONTROL VALVE (M)
- HOSE GATE DRAIN VALVE
- GLOBE VALVE
- PLUG VALVE
- SPRING RETURN CLOSED BALL VALVE (SRC)
- ANGLE VALVE
- SELF CONTAINED PRESSURE REDUCING (REGULATING) VALVE
- FLEX CONNECTION
- PUMP
- THERMOMETER
- BACKFLOW PREVENTION ASSEMBLY (BFP)
- PRESSURE GUAGE
- Y-TYPE STRAINER
- REMOVABLE CAP
- REMOVABLE PLUG
- REDUCER (CONCENTRIC)
- UNION
- FLOW ARROW

MECHANICAL ABBREVIATIONS

12"Ø	ROUND DUCT DIMENSION	MAT	MIXED AIR TEMPERATURE
24x12	RECTANGULAR DUCT DIMENSION (INCHES)	MAU	MAKEUP AIR UNIT
AFF	ABOVE FINISHED FLOOR	MFR	MANUFACTURER
AFMS	AIR FLOW MEASURING STATION	NC	NORMALLY CLOSED (FAIL POSITION)
AHU	AIR HANDLING UNIT	NG	NATURAL GAS
BOD	BOTTOM OF DUCT	NO	NORMALLY OPEN (FAIL POSITION)
CFM	CUBIC FEET PER MINUTE	OA	OUTSIDE AIR
COND	COOLING COIL CONDENSATE DRAIN	OB	OPPOSED BLADE
CU	CONDENSING UNIT	OD	OVERFLOW DRAIN
CUH	CABINET UNITE HEATER	PB	PARALLEL BLADE
DB	DRY BULB	PSIA	POUND PER SQUARE INCH ABSOLUTE
DN	DOWN	PSIG	POUND PER SQUARE INCH GAUGE
DRG	DIFFUSER, REGISTER, GRILLE	RA	RETURN AIR
EA	EXHAUST AIR	RG	REFRIGERANT HOT GAS DISCHARGE
EAT	ENTERING AIR TEMPERATURE	RL	REFRIGERANT LIQUID
EF	EXHAUST FAN	RS	REFRIGERANT SUCTION
EG	EXHAUST GRILLE	SA	SUPPLY AIR
EL	ELEVATION	SCH	SCHEDULE
ER	EXHAUST REGISTER	SCR	SPRING RETURN CLOSED
ESP	EXTERNAL STATIC PRESSURE	SP	STATIC PRESSURE SENSOR
FCU	FAN COIL UNIT	SR	SUPPLY REGISTER
IH	INFRARED HEATER	TA	TRANSFER AIR
IN.W.C	INCHES WATER COLUMN	TYP	TYPICAL
L	LOUVER	UH	UNIT HEATER
LAT	LEAVING AIR TEMPERATURE	V	VENT
MA	MIXED AIR	VAV	VARIABLE AIR VOLUME
		VFD	VARIABLE FREQUENCY DRIVE

PIPE SYMBOLS

- PIPE ELBOW
- PIPE DOWN
- PIPE UP
- PIPE CONTINUATION

PIPELINE ABBREVIATIONS

D	DRAIN
NG	NATURAL GAS

AIR DISTRIBUTION DEVICE IDENTIFICATION

GENERAL NOTES:

1. LEGEND IS GENERAL IN NATURE AND MAY INDICATE MORE INFORMATION THAN IS APPLICABLE TO PROJECT. SEE PLANS FOR SPECIFIC SYMBOLS AND ABBREVIATIONS.
2. PROVIDE ALL MATERIALS, VALVES, HANGERS, ETC. AND EQUIPMENT AND PERFORM ALL LABOR REQUIRED TO INSTALL COMPLETE AND OPERABLE MECHANICAL SYSTEMS AS INDICATED ON THE DRAWINGS, AS SPECIFIED, AND AS REQUIRED BY CODE.
3. INSTALL ALL MECHANICAL EQUIPMENT AND APPURTENANCES IN ACCORDANCE WITH MANUFACTURERS RECOMMENDATIONS, CONTRACT DOCUMENTS, AND APPLICABLE CODES AND REGULATIONS.
4. COORDINATE CONSTRUCTION OF ALL MECHANICAL WORK WITH STRUCTURAL, CIVIL, ELECTRICAL WORK, ETC., SHOWN ON OTHER CONTRACT DOCUMENT DRAWINGS.
5. LOCATE ALL MECHANICAL EQUIPMENT FOR UNOBSTRUCTED ACCESS TO UNIT ACCESS PANELS, CONTROLS, AND VALVING.
6. VERIFY DIMENSIONS AND CONNECTION SIZE WITH FURNISHED EQUIPMENT.
7. DUCT DIMENSIONS INDICATED REFER TO SHEET METAL DIMENSIONS. SHEET METAL SIZE SHALL BE AIR OPENING DIMENSION PLUS THE THICKNESS OF ACOUSTICAL LINER WHERE LINER IS INSTALLED. WHERE LINER IS NOT INSTALLED, AIR OPENING SIZE AND SHEET METAL SIZE SHALL BE THE SAME.
8. COORDINATE ALL WALL AND ROOF PENETRATIONS WITH STRUCTURAL AND ARCHITECTURAL PLANS.
9. INSTALL TEMPERATURE CONTROLS AT 48" ABOVE FINISHED FLOOR AND COORDINATE WITH OTHER DEVICES LOCATED ON WALLS. COORDINATE WITH ARCHITECTURAL WALL FINISHES.
10. PROVIDE STRUCTURAL EQUIPMENT PADS IN ACCORDANCE WITH STRUCTURAL DRAWINGS AND SPECIFICATIONS.
11. CONTRACTOR SHALL AIR BALANCE ALL GRILLES TO CFM'S SHOWN ON PLANS.

no.	date	by	ckd	description
0	01/28/25	DLO	CG	ISSUED FOR CONSTRUCTION
1	05/06/25	DLO	CG	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: D. OLSEN
designed: D. OLSEN	checked: C. GUERRA

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

MECHANICAL GENERAL NOTES, SYMBOLS, AND ABBREVIATIONS

project: 135303	contract:
drawing: 0M-001	rev.: 1
sheet:	of: sheets:
file:	

COLORADO REGISTERED DAVID L. OLSEN 44374 PROFESSIONAL ENGINEER
5/7/2025

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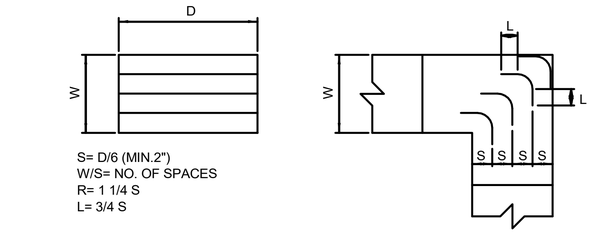
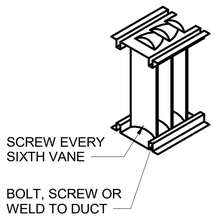
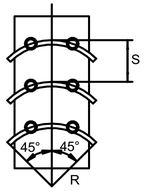


S= D/6 (MIN.2")
W/S= NO. OF SPACES
R= 1 1/4 S
L= 3/4 S

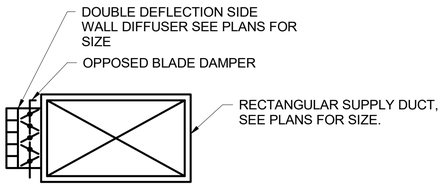
BLADES IN TRANSITION ELBOWS SHALL BE DETERMINED ACCORDING TO SMALLEST WIDTH OF ELBOW.



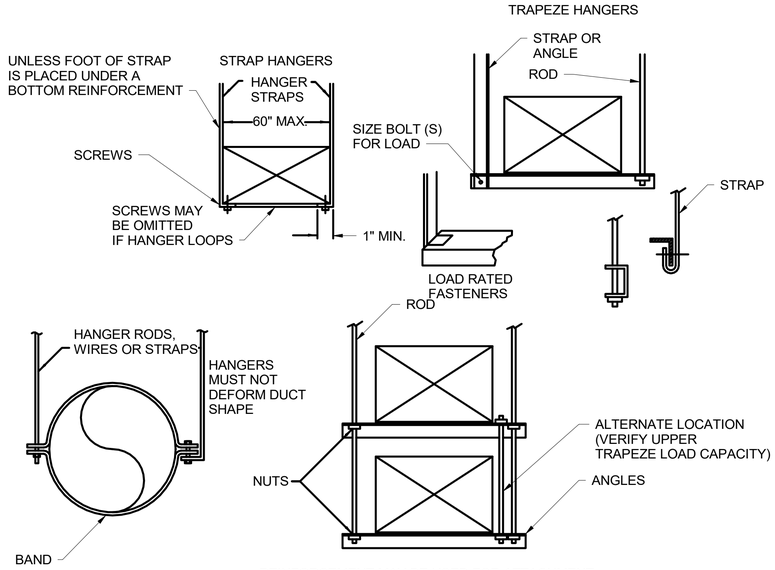
SINGLE VANE SCH.			
	R	S	GA
SMALL	51	38	24
LARGE	114	83	22



RECTANGULAR AIR DUCT ELBOW TURNING VANES
NOT TO SCALE



SIDE WALL DIFFUSER
NOT TO SCALE

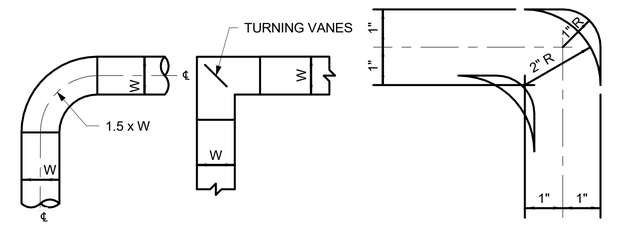


ONE HALF-ROUND MAY BE USED IF DUCT SHAPE IS MAINTAINED.

REINFORCEMENT MAY BE USED FOR ATTACHMENT IF IT QUALIFIES FOR BOTH DUTIES DO NOT EXCEEED ALLOWABLE LOAD LIMITS

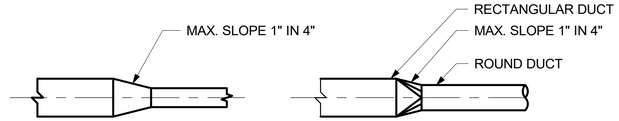
NOTE: FOR DUCTWORK ABOVE THE JOIST BOTTOM CHORD, PROVIDE UNISTRUT FRAMING AT JOIST TOP CHORD FOR DUCT HANGER ATTACMENT.

LOWER DUCT HANGAR ATTACHMENTS
NOT TO SCALE



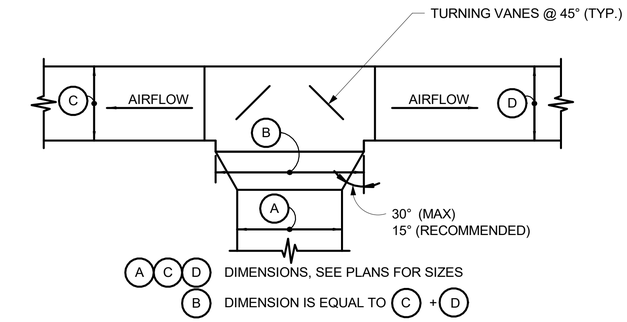
ROUND 90 ELBOW **SQUARE 90 ELBOW** **TURNING VANES DETAIL**

NOTE:
1. USE THIS DESIGN WHERE SQUARE 90°ELBOWS ARE SHOWN ON DRAWINGS OR IF SPACE DOES NOT PERMIT ROUND 90° ELBOWS.



RECTANGULAR TRANSITION **RECTANGULAR TO ROUND TRANSITION**

LOW VELOCITY DUCT LAYOUT
NOT TO SCALE



LOW PRESSURE "TEE" DUCT FITTING
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	DLO	CG	ISSUED FOR CONSTRUCTION
1	05/06/25	DLO	CG	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	D. OLSEN
designed	**checked**
D. OLSEN	C. GUERRA

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

MECHANICAL DETAILS

project	contract
135303	
drawing	**rev.**
0M-002	1
sheet	**of** **sheets**
file	

COLORADO REGISTERED DAVID L. OLSEN 44374 PROFESSIONAL ENGINEER
5/7/2025

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ROOF TOP UNIT (RTU) SCHEDULE

TAG NO.	AREA SERVED	BASIS OF DESIGN		ALTITUDE (FT)	SUPPLY FAN				DX COOLING COIL		HEATING COIL			WEIGHT (LBS)	ELECTRICAL (B.O.D.)					EER	IEER	NOTES
		MFGR	MODEL		MAX. AIRFLOW (CFM)	OUTSIDE AIRFLOW (CFM)	EXTERNAL STATIC PRESSURE (IN. W.C.)	MOTOR HP	TOTAL CAPACITY (MBH)	SENSIBLE (MBH)	TYPE	MINIMUM DESIGN CAPACITY (MBH)	CAPACITY (KW)		VOLTS	PHASE	FLA	MOP	MCA			
RTU-181	POTABLE PUMP STATION	TRANE	TSJ300A4SON	5400	8000 CFM	0 CFM	1.97	5	237	202	ELECTRIC	7	36	1970	460	3	43.4	70	67	10	13.7	1,2,3,4,5
RTU-182	POTABLE ELECTRICAL ROOM	TRANE	TED360C4A-4B2EHCAB	5400	12000 CFM	0 CFM	1.5	10	298	291	ELECTRIC	37	36	4538	460	3	60.3	100	86	10.6	14.8	1,2,3,4,5

NOTES:

1. PROVIDE ELECTRICAL DISCONNECTS RATED FOR 65KA SCCR FOR A SINGLE-POINT ELECTRICAL CONNECTION (EXCEPT CONVENIENCE OUTLET) PER DIVISION 26 SPECIFICATIONS.
2. PROVIDE 18" ROOF CURB.
3. PROVIDE SMOKE DETECTOR INSTALLED IN RETURN AIR DUCT WITH UNIT SHUT DOWN.
4. PROVIDE MOTORIZED DAMPERS, 2" MERV 8 OR HIGHER FILTRATION AND ECONOMIZER.
5. PROVIDE CONDENSER COIL HAIL GUARDS,CONVENIENCE OUTLET, CONDENSATE OVERFLOW SWITCH, CLOGGED FILTER SWITCH, THERMOSTAT WITH STAND ALONE MICROPROCESSOR CONTROLS.

DIFFUSER, REGISTER, & GRILLE SCHEDULE (DRG)

TAG NO.	DESCRIPTION	MOUNTING	BASIS OF DESIGN:		REMARKS
			MFGR	MODEL NO.	
A	LOUVERED FACE SUPPLY AIR GRILLE WITH BLADES PARALLEL WITH SHORT DIMENSION	DUCT	TITUS	300RS	PROVIDE WITH OPTIONAL OBD

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MAY 2025	D. OLSEN
designed	**checked**
D. OLSEN	C. GUERRA

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

MECHANICAL SCHEDULES

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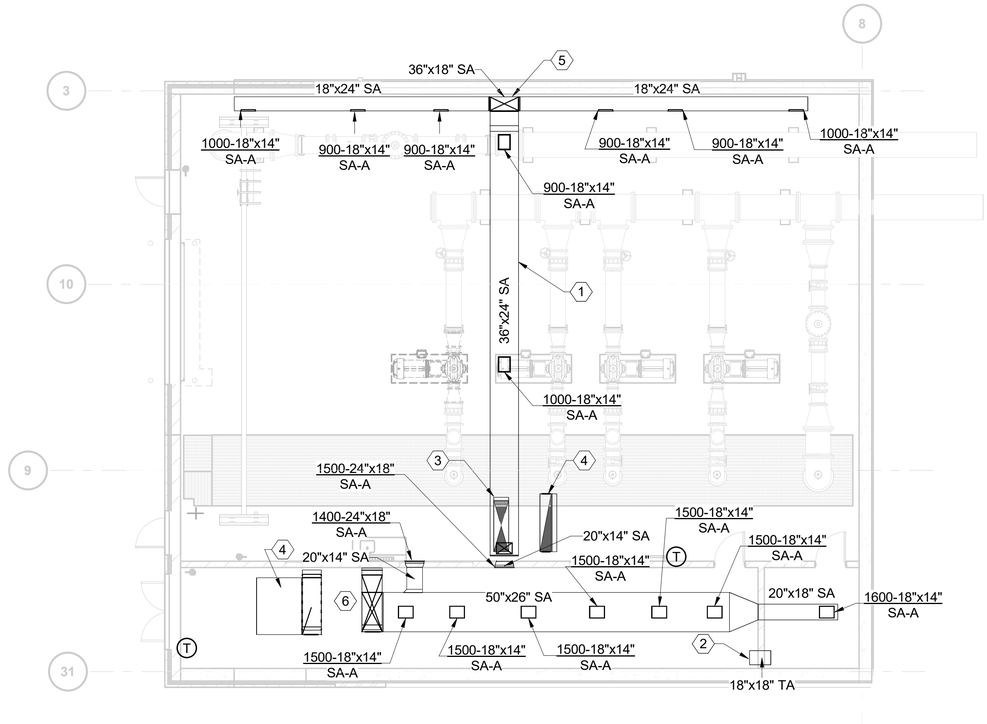

PUMP STATION FF

0 4' 8' 16'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. FIELD ROUTE DUCTWORK COORDINATING WITH OTHER DISCIPLINES FOR FINAL ELEVATIONS AND ROUTING.

KEYED NOTES: (#)

1. AS HIGH AS POSSIBLE, PROVIDE TRANSITION DOWN AS TIGHT AS POSSIBLE TO WALL TO AVOID CONFLICT WITH BRIDGE CRANE.
2. PROVIDE TRANSFER RETURN OPENING IN THE WALL BETWEEN CONTROL ROOM AND ELECTRICAL ROOM.
3. PROVIDE DUCT TRANSITIONS FOR SUPPLY DUCT THROUGH ROOF TO DUCTWORK BELOW ROOF. (TYP-4)
4. ROUTE FULL SIZED RETURN DUCT WITH ELBOW BELOW ROOF AND BIRD SCREEN AT OPENING. (TYP-4)
5. ROUTE DUCT FROM BETWEEN TEES DOWN WALL, TIGHT TO THE WALL, DOWN TO HORIZONTAL DUCT AT 8 FEET ABOVE THE FLOOR.
6. PROVIDE DUCT OFFSETS FOR DUCTWORK DROP FROM RTU TO DUCT RUNS AS SHOWN, AVOID RUNNING DUCT ABOVE ELECTRICAL EQUIPMENT AS POSSIBLE.

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designed	**checked**
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5/7/2025

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BROOMFIELD TANKS AND PUMP STATION

MECHANICAL PLAN

project	contract
135303	
drawing	**rev.**
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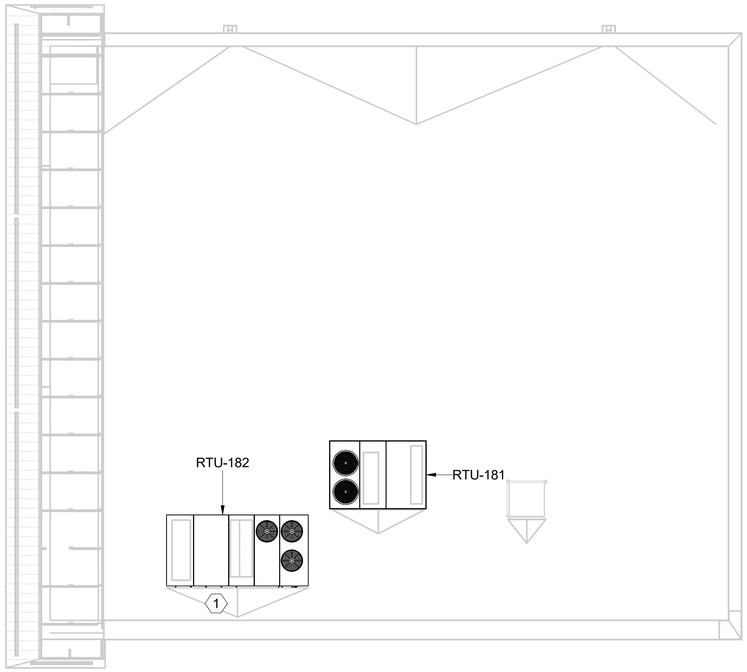

PUMP STATION ROOF

0 4' 8' 16'
SCALE IN FEET

NORTH

GENERAL NOTES:

1. COORDINATE FINAL LOCATION WITH ROOF STRUCTURE TO MAINTAIN REQUIRED CLEARANCES.

KEYED NOTES: ⟨#⟩

1. LOCATE RTU TO MAINTAIN 4' SERVICE CLEARANCE FROM PARAPET WALL.

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BROOMFIELD TANKS AND PUMP STATION

MECHANICAL ROOF PLAN

project	contract
135303	

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ONE-LINE AND CONTROL DIAGRAMS

LINES AND TERMINALS

- POWER CIRCUIT AND EQUIPMENT INSTALLED BY THIS CONTRACT
- EXISTING CIRCUIT AND EQUIPMENT
- FUTURE POWER CIRCUIT AND EQUIPMENT
- EQUIPMENT ENCLOSURE
- CONTROL OR INTERLOCK CIRCUIT
- REMOTE WIRING
- TERMINALS
- + (A) - (B) (A) POSITIVE TERMINAL (B) NEGATIVE TERMINAL
- A B (A) CONDUCTOR CONNECTION (B) NO CONNECTION

PROTECTION/DISCONNECTS

- XX PROTECTION DEVICE (ANSI C37.2 DEVICE NUMBER AS INDICATED)
- CIRCUIT BREAKER
- FUSE
- FUSED DISCONNECT SWITCH
- DISCONNECT SWITCH
- POLE MOUNTED FUSED DISCONNECT SWITCH
- PLUG-IN OR DRAWOUT CONNECTION
- CAPACITOR
- THERMAL OVERLOADS
- O.L. (3) THERMAL OVERLOAD RELAY (SHOWN WITH QUANTITY)
- ARMS ARC FLASH REDUCTION MAINTENANCE SWITCH
- TU ELECTRONIC TRIP UNIT
- LSIG LONG TIME, SHORT TIME, INSTANTANEOUS, AND GROUND TRIP SETTINGS

STARTERS

- SINGLE SPEED NON-REVERSING MANUAL MOTOR STARTER
- SINGLE SPEED NON-REVERSING MAGNETIC MOTOR STARTER
- SINGLE SPEED REVERSING MANUAL MOTOR STARTER
- TWO SPEED NON-REVERSING MANUAL MOTOR STARTER
- RVSS (XXXA) REDUCED VOLTAGE SOLID-STATE STARTER, , WHERE XXXA IS THE FULL LOAD CURRENT RATING.
- RVAT * REDUCED VOLTAGE AUTOTRANSFORMER STARTER
- VFD (XXXA) * VARIABLE FREQUENCY DRIVE, , WHERE XXXA IS THE FULL LOAD CURRENT RATING.
- * - REFER TO APPROPRIATE SCHEMATIC BASED ON IDENTIFIER SHOWN WITHIN PARENTHESIS (XX) FOUND ON ONE-LINE DRAWINGS

TRANSFORMERS

- POWER TRANSFORMER (XFMR)
- (2) POTENTIAL TRANSFORMER (SHOWN WITH QUANTITY)
- 200:5 (2) CURRENT TRANSFORMER, SINGLE RATIO (SHOWN WITH QUANTITY)
- CONTROL POWER TRANSFORMER (ONE-LINE DIAGRAMS)
- CONTROL POWER TRANSFORMER (CONTROL SCHEMATIC DIAGRAMS)

LOADS/SOURCES

- UTILITY
- GENERATOR
- X ELECTRIC MOTOR - APPROX. HORSEPOWER AS INDICATED
- EQUIPMENT AS NOTED ON DIAGRAM

METERING/NETWORKING

- A AMMETER
- V VOLTMETER
- PQM POWER QUALITY METER
- NSW NETWORK SWITCH
- PSU POWER SUPPLY UNIT

MISC ONE-LINE SYMBOLS

- (X) "X" INDICATES NUMBER OF DEVICES WHEN MORE THAN ONE
- DELTA WINDING CONNECTION
- GROUNDING WYE WINDING CONNECTION
- GROUNDING CONNECTION
- LIGHTNING ARRESTOR

CONTROL DEVICES

- A B (A) LEVEL SWITCH - CLOSES WITH RISING LEVEL (B) LEVEL SWITCH - OPENS WITH RISING LEVEL
- A B (A) FLOW SWITCH - CLOSES WITH INCREASING FLOW (B) FLOW SWITCH - OPENS WITH INCREASING FLOW
- A B (A) MAINTAINED PUSH-BUTTON - N.O. (B) MAINTAINED PUSH-BUTTON - N.C.
- A B (A) LIMIT SWITCH - N.C. (B) LIMIT SWITCH - N.C. HELD OPEN
- A B (A) LIMIT SWITCH - N.O. (B) LIMIT SWITCH - N.O. HELD CLOSED
- A B (A) PRESSURE SWITCH - CLOSES WITH INCREASING PRESSURE (B) PRESSURE SWITCH - OPENS WITH INCREASING PRESSURE
- A B (A) MOMENTARY PUSH-BUTTON - N.O. (B) MOMENTARY PUSH-BUTTON - N.C.
- A B (A) TEMP. SWITCH - CLOSES WITH RISING TEMP. (B) TEMP. SWITCH - OPENS WITH RISING TEMP.
- A B (A) N.O. TIME DELAY CONTACT (B) N.C. TIME DELAY CONTACT
- XO TWO POSITION SELECTOR SWITCH
- XOO THREE POSITION SELECTOR SWITCH
- XOOO FOUR POSITION SELECTOR SWITCH
- SOLENOID VALVE
- PHOTOCELL
- X INDICATING LIGHT, COLOR AS INDIATED
- X PUSH-TO-TEST INDICATING LIGHT, COLOR AS INDIATED

PLANS

LINES

- NEW CONSTRUCTION
- EXISTING CONSTRUCTION
- CONDUIT EXPOSED
- CONDUIT CONCEALED IN WALL, CEILING OR HIDDEN FROM VIEW
- CONDUIT CONCEALED IN FLOOR OR UNDERGROUND
- HOMERUN TO PANEL
- FLEXIBLE CONDUIT
- FO FIBER-OPTIC CABLE
- E UNDGERGROUND ELECTRICAL
- OHE OVERHEAD ELECTRICAL
- CONDUIT TURNING UP
- CONDUIT TURNING DOWN
- CONDUIT TERMINATED AND CAPPED
- CONDUIT WITH BUSHING
- CONDUIT PASSING THRU ELEVATION

GROUNDING/LIGHTNING PROTECTION

- GROUND CABLE
- BOLTED CONNECTION
- WELDED CONNECTION
- BI-METALIC CONNECTION
- GROUND ROD
- GROUND TEST WELL
- AIR TERMINAL
- GROUND BUS BAR

EQUIPMENT

- NEW EQUIPMENT
- EXISTING EQUIPMENT
- FUTURE EQUIPMENT
- LIGHTING PANEL
- POWER PANEL
- DISCONNECT SWITCH
- FUSED DISCONNECT SWITCH
- COMBINATION DISCONNECT/ MAGNETIC MOTOR STARTER
- REDUCED VOLTAGE COMBINATION DISCONNECT/MAG MOTOR STARTER
- M MOTOR
- E MISC. ELECTRICAL LOAD
- J JUNCTION BOX
- P PULL BOX
- EQUIPMENT RACK
- GOOSENECK PEDESTAL

LIGHTING

- RECTANGULAR LUMINAIRE
- RECTANGULAR LUMINAIRE WITH EMERGENCY BACK-UP
- CIRCULAR LUMINAIRE
- CIRCULAR LUMINAIRE WITH EMERGENCY BACK-UP
- EMERGENCY WALL PACK UNIT
- CEILING MOUNTED EXIT SIGN
- WALL MOUNTED EXIT SIGN
- POLE-MOUNTED AREA LIGHT
- S SINGLE POLE SWITCH
- S_3 THREE-WAY SWITCH
- S_4 FOUR-WAY SWITCH
- S_{WP} WEATHERPROOF SWITCH
- S_D DIMMER SWITCH
- S_{EXP} EXPLOSIONPROOF SWITCH
- OS CEILING MOUNTED OCCUPANCY SENSOR
- OS WALL/POLE MOUNTED OCCUPANCY SENSOR
- PC CEILING/ROOF MOUNTED PHOTOCELL
- PC WALL MOUNTED PHOTOCELL

RECEPTACLES

- 208/240V RECEPTACLE
- 480V RECEPTACLE
- SURFACE, SIMPLEX RECEPTACLE
- SURFACE, SIMPLEX, GFI RECEPTACLE
- FLUSH, SIMPLEX RECEPTACLE
- FLUSH, SIMPLEX, GFI RECEPTACLE
- SURFACE, DUPLEX RECEPTACLE
- SURFACE, DUPLEX, GFI RECEPTACLE
- FLUSH, DUPLEX RECEPTACLE
- FLUSH, DUPLEX, GFI RECEPTACLE
- SURFACE, QUADPLEX RECEPTACLE
- SURFACE, QUADPLEX, GFI RECEPTACLE
- FLUSH, QUADPLEX RECEPTACLE
- FLUSH, QUADPLEX, GFI RECEPTACLE

DATA JACKS

- RECESSED DATA JACK
- RECESSED MIXED DATA JACK
- RECESSED TELEPHONE JACK
- SURFACE DATA JACK
- SURFACE MIXED DATA JACK
- SURFACE TELEPHONE JACK

INSTRUMENTS

- ACTUATED VALVE
- CONTROL STATION
- INSTRUMENT
- H HORN
- X STROBE LIGHT, COLOR AS INDICATED
- H STROBE LIGHT AND HORN COMBINATION

TAG DESIGNATION SCHEMES

LUMINAIRE TAG SCHEME

LXX — LUMINAIRE TYPE
XXX-PNL-XXX-XX — CIRCUIT
SXXX — SWITCHING DEVICE(S)
XX'-XX" AFF — ELEVATION TO BOTTOM OF FIXTURE

RECEPTACLE TAG SCHEME

XXX-PNL-XXX — POWER SOURCE TAG
XX — CIRCUIT NUMBER
XXX — MODIFIER (IF APPLICABLE)

INSTRUMENT TAG SCHEME

EQUIPMENT/INSTRUMENT IDENTIFIER
FACILITY AREA OR SYSTEM
LOOP NUMBER
XXX-XXX / XXX

NOTES
XX'-XX" AFF
XXX-PLC-XXX

NOTES
INSTRUMENT ELEVATION
ASSOCIATED CONTROL PANEL

CABLE TRAY TAG SCHEME

XXX-CT-XXX — CABLE TRAY TAG
XX" x XX" — HEIGHT x WIDTH
XX'-XX" AFF — ELEVATION TO BOTTOM OF TRAY

ABBREVIATIONS

A	AMPERES	INDUST	INDUSTRIAL
AFG	ABOVE FINISHED GRADE	LC	LIGHTING CONTACTOR
AFF	ABOVE FINISHED FLOOR	LFMC	LIQUID-TIGHT FLEXIBLE METALLIC CONDUIT
AIC	AMPS INTERRUPTING CURRENT		
AWG	AMERICAN WIRE GUAGE	GND	GROUND
BC	BARE COPPER WIRE	GRC	GALVANIZED RIGID CONDUIT
BF	BELOW FLOOR	MCC	MOTOR CONTROL CENTER
BG	BELOW GRADE	MSC	MANUFACTURER SUPPLIED CABLE
BKR	BREAKER		
C	CONDUIT	MUN	MUNICIPAL
C-GRC	PVC-COATED GALVANIZED RIGID CONDUIT	N.O.	NORMALLY OPEN
		N.C.	NORMALLY CLOSED
CHL	CHLORINE	P	POLE
COND	CONDUCTIVITY	PP	POWER PANEL
CP	CONTROL PANEL	PLC	PROGAMMABLE LOGIC CONTROLLER
CPT	CONTROL POWER TRANSFORMER		
ERMS	ENERGY REDUCTION MAINTENANCE SWITCH	REC	RECEPTACLE
		RW	RAW WATER
EL	ELEVATION	SP	SPARE
EO	ELECTRICALLY OPERATED	SW	SWITCH
EX	EXPOSED	TYP.	TYPICAL
EXP	EXPLOSION-PROOF (CLASS1, DIV 1, GROUP D)	TVSS	TRANSIENT VOLTAGE SURGE SUPPRESSOR
EXT	EXTERIOR	UE	UNDERGROUND ELECTRICAL
FACP	FIRE ALARM CONTROL PANEL	VFD	VARIABLE FREQUENCY DRIVE
AHF	ACTIVE HARMONIC FILTER	WP	WEATHERPROOF
		XFMR	TRANSFORMER
		ZSI	ZONE SELECTIVE INTERLOCK

GENERAL NOTES:

1. THIS IS A STANDARD ELECTRICAL LEGEND AND NOT ALL DEVICES AND DEVICE DESIGNATIONS ARE USED ON THIS PROJECT.

COLORADO LICENSED PROFESSIONAL ENGINEER
MARK A. HOPKINS
52646
05/13/2025

no.	date	by	ckd	description
0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
1	05/06/25	JPH	MAH	ISSUED FOR CONSTRUCTION

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: A.BENSON
designed: M. HOPKINS	checked: V.PATWARI

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL LEGEND, ABBREVIATIONS AND NOTES

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drawing: 0E-001	rev.: 1
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LOCATION	AREA CLASSIFICATION	CONDUIT AND FITTING	FLEXIBLE TYPE	ENCLOSURE NEMA RATING	HARDWARE AND SUPPORTS	NOTE
PUMP STATION ROOMS	UNCLASSIFIED, WET	C-GRC	LFMC	NEMA 4X, SS	GALVANIZED	
OUTDOORS, NON-PROCESS AREA	UNCLASSIFIED, WET	C-GRC	LFMC	NEMA 4X, SS	GALVANIZED	
DUCTBANKS, MANHOLES, HANDHOLES	UNCLASSIFIED, WET	PVC	LFMC	NEMA 6P	STAINLESS STEEL	
ELECTRICAL ROOMS	UNCLASSIFIED, DRY	GRC	FMC	NEMA 12, 1-GASKETED	GALVANIZED	

1. ALL WIRES TERMINATING IN CORROSIVE AREAS ARE TO USE TIN COATED COPPER.

GENERAL NOTE:

1. CONDUIT TABLES ARE GENERAL AND ARE TO BE USED FOR SIZING CONDUIT AND CONDUCTORS BASED ON DESCRIPTORS FOUND ON THE DRAWINGS. WHEN NOTED ON THE DRAWINGS, CONDUITS CAN BE COMBINED FOLLOWING THE NEC REQUIREMENTS; SUCH AS CONDUCTOR DERATING AND CONDUIT FILL RATIOS.

AREA CLASSIFICATION AND MATERIAL DESIGNATIONS

CONDUIT DESCRIPTOR	WIRE/CONDUIT
A1	1-#16/2 TSP, 3/4"C
A2	2-#16/2 TSP, #18 GND, 3/4"C
A3	3-#16/2 TSP, #18 GND, 3/4"C
A4	4-#16/2 TSP, #18 GND, 1"C
A5	5-#16/2 TSP, #18 GND, 1"C
A6	6-#16/2 TSP, #18 GND, 1-1/4"C
A7	7-#16/2 TSP, #18 GND, 1-1/4"C
A8	8-#16/2 TSP, #18 GND, 1-1/4"C
A9	9-#16/2 TSP, #18 GND, 1-1/4"C
A10	10-#16/2 TSP, #18 GND, 1-1/4"C
A11	11-#16/2 TSP, #18 GND, 1-1/2"C
A12	12-#16/2 TSP, #18 GND, 1-1/2"C
A13	13-#16/2 TSP, #18 GND, 1-1/2"C
A14	14-#16/2 TSP, #18 GND, 2"C
A15	15-#16/2 TSP, #18 GND, 2"C
A16	16-#16/2 TSP, #18 GND, 2"C
A17	17-#16/2 TSP, #18 GND, 2"C
A18	18-#16/2 TSP, #18 GND, 2"C
A19	19-#16/2 TSP, #18 GND, 2"C
A20	20-#16/2 TSP, #18 GND, 2"C
A21	21-#16/2 TSP, #18 GND, 2"C
A22	22-#16/2 TSP, #18 GND, 2"C
A23	23-#16/2 TSP, #18 GND, 2-1/2"C
A24	24-#16/2 TSP, #18 GND, 2-1/2"C
A25	25-#16/2 TSP, #18 GND, 2-1/2"C

CONDUIT DESCRIPTOR	WIRE/CONDUIT
C1	NOT USED
C2	2-#14, #14 GND, 3/4"C
C3	3-#14, #14 GND, 3/4"C
C4	4-#14, #14 GND, 3/4"C
C5	5-#14, #14 GND, 3/4"C
C6	6-#14, #14 GND, 3/4"C
C7	7-#14, #14 GND, 3/4"C
C8	8-#14, #14 GND, 3/4"C
C9	9-#14, #14 GND, 3/4"C
C10	10-#14, #14 GND, 3/4"C
C11	11-#14, #14 GND, 3/4"C
C12	12-#14, #14 GND, 1"C
C13	13-#14, #14 GND, 1"C
C14	14-#14, #14 GND, 3/4"C
C15	15-#14, #14 GND, 3/4"C
C16	16-#14, #14 GND, 3/4"C
C17	17-#14, #14 GND, 3/4"C
C18	18-#14, #14 GND, 3/4"C
C19	19-#14, #14 GND, 3/4"C
C20	20-#14, #14 GND, 1-1/4"C
C21	21-#14, #14 GND, 1-1/4"C
C22	22-#14, #14 GND, 1-1/4"C
C23	23-#14, #14 GND, 1-1/4"C
C24	24-#14, #14 GND, 1-1/4"C
C25	25-#14, #14 GND, 1-1/4"C

CONDUIT DESCRIPTOR	WIRE/CONDUIT
N1	1 - CAT 6 NETWORK, 3/4"C
N2	2 - CAT 6 NETWORK, 3/4"C
N3	3 - CAT 6 NETWORK, 1"C
N4	4 - CAT 6 NETWORK, 1"C
N5	1 - 6 STR MM FIBER, 1"C
N6	1 - 12 STR MM FIBER, 1"C
N7	1 - 24 STR MM FIBER, 1"C
N8	1 - 6 STR SM FIBER, 1"C
N9	1 - 12 STR SM FIBER, 1"C
N10	1 - 24 STR SM FIBER, 1"C

NETWORK CABLE/CONDUIT DESIGNATIONS

ANALOG CABLE/CONDUIT SIZES

CONDUIT DESCRIPTOR	WIRE/CONDUIT	CONDUIT DESCRIPTOR	WIRE/CONDUIT
P1*	2-#12, #12 GND, 3/4"C	P21	2 SETS - 3-300KCMIL, #1/0 GND, 2-1/2"C
P2*	3-#12, #12 GND, 3/4"C	P21N	2 SETS - 4-300KCMIL, #1/0 GND, 3"C
P3*	2-#10, #12 GND, 3/4"C	P22	3-350KCMIL, #2 GND, 2-1/2"C
P4*	3-#10, #12 GND, 3/4"C	P22N	4-350KCMIL, #2 GND, 3"C
P5*	2-#8, #10 GND, 3/4"C	P23	2 SETS - 3-350KCMIL, #1/0 GND, 2-1/2"C
P6*	3-#8, #10 GND, 1"C	P23N	2 SETS - 4-350KCMIL, #1/0 GND, 3"C
P7*	2-#6, #8 GND, 3/4"C	P24	3-500KCMIL, #2 GND, 4"C
P8*	3-#6, #8 GND, 1"C	P24N	4-500KCMIL, #2 GND, 4"C
P9*	2-#4, #8 GND, 3/4"C	P25	2 SETS - 3-500KCMIL, #1/0 GND, 4"C
P10*	3-#4, #8 GND, 1-1/4"C	P25N	2 SETS - 4-500KCMIL, #1/0 GND, 4"C
P11*	2-#2, #6 GND, 1"C	P26	3 SETS - 3-500KCMIL, #2/0 GND, 4"C
P12*	3-#2, #6 GND, 1-1/4"C	P26N	3 SETS - 4-500KCMIL, #2/0 GND, 4"C
P13*	2-#1/0, #6 GND, 1-1/4"C	P27	4 SETS - 3-500KCMIL, #4/0 GND, 4"C
P14*	3-#1/0, #6 GND, 1-1/2"C	P27N	4 SETS - 4-500KCMIL, #4/0 GND, 4"C
P15*	3-#2/0, #6 GND, 2"C	P28	5 SETS - 3-500KCMIL, 250KCMIL GND, 4"C
P16*	3-#3/0, #6 GND, 2"C	P28N	5 SETS - 4-500KCMIL, 250KCMIL GND, 4"C
P17*	3-#4/0, #4 GND, 2"C	P29	6 SETS - 3-500KCMIL, 350KCMIL GND, 4"C
P18	3-250KCMIL, #4 GND, 2"C	P29N	6 SETS - 4-500KCMIL, 350KCMIL GND, 4"C
P18N	4-250KCMIL, #4 GND, 2"C	P30	7 SETS - 3-500KCMIL, 500KCMIL GND, 4"C
P19	2 SETS - 3-250KCMIL, #4 GND, 2"C	P30N	7 SETS - 4-500KCMIL, 500KCMIL GND, 4"C
P19N	2 SETS - 4-250KCMIL, #4 GND, 2-1/2"C	P31	8 SETS - 3-500KCMIL, 500KCMIL GND, 4"C
P20	3-300KCMIL, #4 GND, 2-1/2"C	P31N	8 SETS - 4-500KCMIL, 500KCMIL GND, 4"C
P20N	4-300KCMIL, #4 GND, 2-1/2"C		

NOTE: WHERE "N" IS USED ON THE DRAWINGS APPENDED TO THE DESCRIPTORS SHOWN ABOVE AN ADDITIONAL CONDUCTOR EQUAL TO THE PHASE CONDUCTORS IS TO BE PROVIDED.

POWER CABLE/CONDUIT SIZES

DISCRETE CABLE/CONDUIT SIZES

CONDUIT DESCRIPTOR	WIRE/CONDUIT	BELDEN #, OR EQUAL
V1	#12 VFD CABLE, 1"C	29502
V2	#10 VFD CABLE, 1-1/4"C	29503
V3	#8 VFD CABLE, 1-1/4"C	29504
V4	#6 VFD CABLE, 1-1/2"C	29505
V5	#4 VFD CABLE, 2"C	29506
V6	#2 VFD CABLE, 2"C	29507
V7	#1 VFD CABLE, 2"C	29528
V8	#1/0 VFD CABLE, 2"C	29529
V9	#2/0 VFD CABLE, 2-1/2"C	29530
V10	#3/0 VFD CABLE, 2-1/2"C	29531
V11	#4/0 VFD CABLE, 3"C	29532
V12	250KCMIL VFD CABLE, 3"C	29533
V13	350KCMIL VFD CABLE, 4"C	29534
V14	500KCMIL VFD CABLE, 4"C	29535

NOTE: VFD CABLE DIAMETERS ARE BASED ON BELDEN CABLE NUMBERS LISTED ABOVE. CONTRACTOR TO INCREASE CONDUIT SIZE IF SUPPLIED CABLE IS OF LARGER DIAMETER.

VFD CABLE/CONDUIT SIZES

CONDUIT DESCRIPTOR	WIRE/CONDUIT
R1	1-(#16/3 TSP), 3/4"C
R2	2-(#16/3 TSP), 3/4"C
R3	3-(#16/3 TSP), 3/4"C
R4	4-(#16/3 TSP), 1"C
R5	5-(#16/3 TSP), 1"C
R6	6-(#16/3 TSP), 1-1/4"C
R8	8-(#16/3 TSP), 1-1/4"C

RTDS-TRIPLEX SIZES

no.	date	by	ckd	description
0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
1	05/06/25	JPH	MAH	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
M. HOPKINS	V.PATWARI

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL MATERIALS & AREA CLASSIFICATION

project	contract
135303	

drawing **0E-002** — rev. **1**

sheet of sheets

file

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

Scale For Microfilming: Millimeters / Inches

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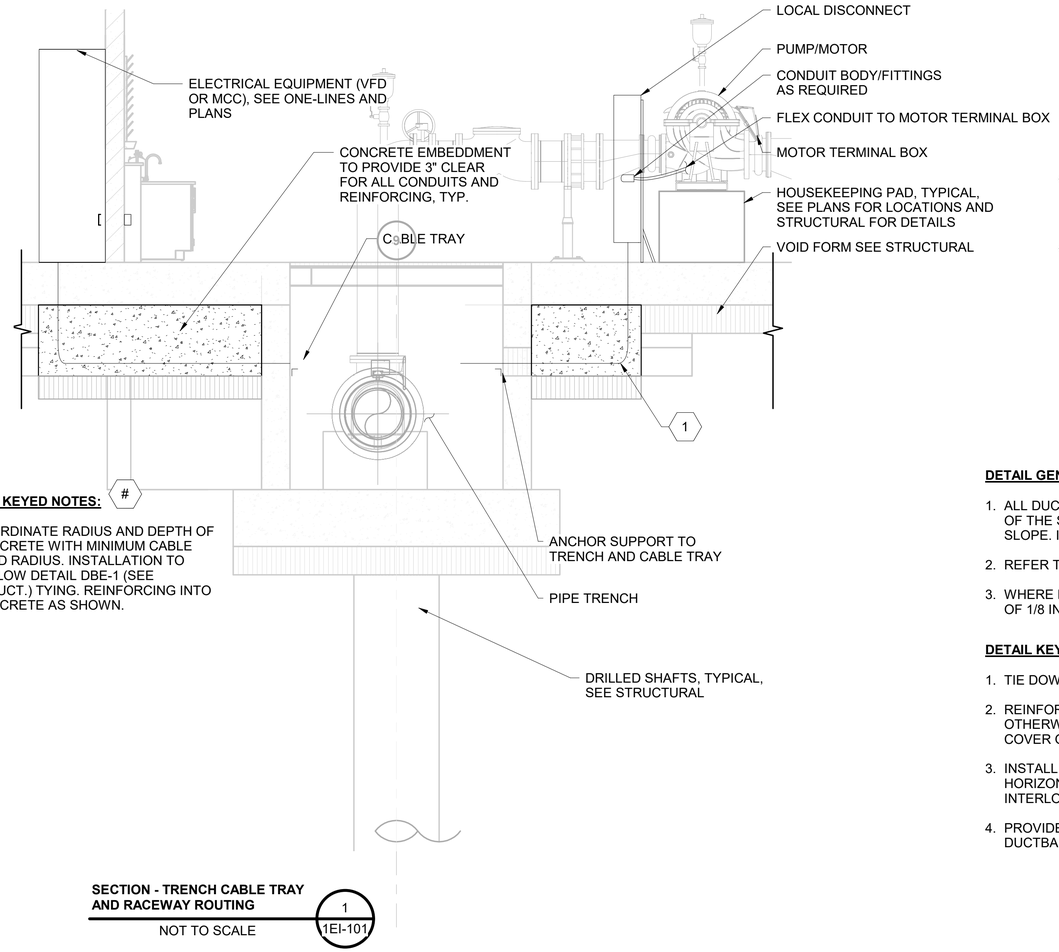
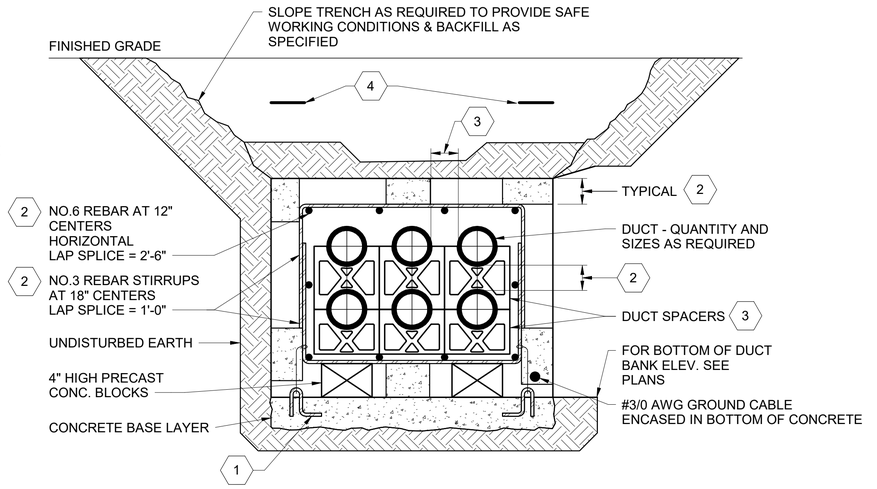


DETAIL KEYED NOTES: #

1. COORDINATE RADIUS AND DEPTH OF CONCRETE WITH MINIMUM CABLE BEND RADIUS. INSTALLATION TO FOLLOW DETAIL DBE-1 (SEE STRUCT.) TYING. REINFORCING INTO CONCRETE AS SHOWN.

SECTION - TRENCH CABLE TRAY AND RACEWAY ROUTING
1 / 1EI-101
NOT TO SCALE



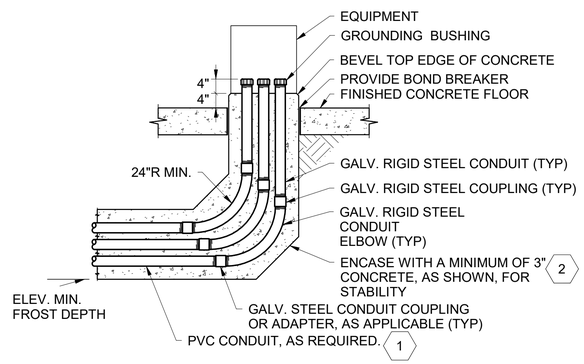
DETAIL GENERAL NOTES:

1. ALL DUCT BANKS SHALL BE ENCASED IN CONCRETE PER SPECIFICATIONS AND SHALL BE SMOOTH FORMED A MINIMUM OF 3'-0" FROM THE TOP OF THE STUB-UPS. DUCT BANKS MAY BE EARTH FORMED WITH UNDISTRUBED EARTH PROVIDED THE EARTH WILL STAND TO A NEAR VERTICAL SLOPE. IF TRENCH IS OVER-EXCAVATED, COMPACT PER SITEWORK PREPARATION AND EARTHWORK SPECIFICATIONS.
2. REFER TO DUCT BANK SECTIONS FOR DUCT QUANTITY, SIZE AND CONFIGURATION.
3. WHERE DUCT BANKS TERMINATE AT A MANHOLE, HANDHOLE OR OTHER UNDERGROUND STRUCTURE THE DUCTS SHALL BE SLOPED A MINIMUM OF 1/8 IN./FT/ UNLESS OTHERWISE NOTED TO PROVIDE DRAINAGE BACK TO THE STRUCTURE.

DETAIL KEYED NOTES: #

1. TIE DOWN DUCTS TO BASE LAYER AS REQUIRED TO PREVENT FLOATING CONDUITS DURING CONCRETE PLACEMENT.
2. REINFORCING STEEL SHALL BE USED IN ALL DUCT BANKS PASSING UNDER DEFINED ROADWAYS AND DRIVE/PARKING AREAS UNLESS OTHERWISE NOTED. DO NOT ALLOW REINFORCING STEEL TO BE IN CONTACT WITH DUCTS & PROVIDE A MINIMUM OF 3" OF CONCRETE COVER OVER THE REINFORCING STEEL.
3. INSTALL INTERLOCKING TYPE PLASTIC DUCT SPACERS AT INTERVALS PER SPECIFICATIONS TO MAINTAIN A 3 INCH MINIMUM HORIZONTAL AND VERTICAL SPACING BETWEEN DUCTS. PREFABRICATED PVC TEMPATE SPACERS MAY BE USED IN LIEU OF INTERLOCKING TYPE.
4. PROVIDE METALLIC WARNING TAPES ABOVE THE OUTSIDE EDGES ON BOTH SIDES OF THE DUCT BANK AS CAUTIONARY MARKINGS. FOR DUCTBANKS WIDER THAN 48", PROVIDE ADDITIONAL WARNING TAPE CENTERED ABOVE DUCT BANK.

TYPICAL DUCT BANK AND TRENCH SECTION
NOT TO SCALE



DETAIL GENERAL NOTE:

1. THIS DETAIL IS TYPICAL FOR SINGLE AND MULTI-DUCT ARRANGEMENTS.

DETAIL KEYED NOTES: #

1. USE RIGID GALVANIZED STEEL CONDUITS WHERE A DUCT BANK CROSSES UNDER DEFINED ROADWAYS, RAILROADS AND FOR A DISTANCE OF 10 FEED BEYOND EACH SIDE.
2. ALL DUCT BANKS SHALL BE REINFORCED AS SHOWN IN TYPICAL BUCT BANK AND TRENCH DETAIL ON THIS PAGE.

TYPICAL STUBBED DUCT BANK RISER INTO FLOOR SLAB
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
1	05/06/25	JPH	MAH	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: A.BENSON
designed: M. HOPKINS	checked: V.PATWARI

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL DETAILS I

project: 135303	contract:
drawing: 0E-003	rev.: 1
sheet:	of: sheets
file:	

Millimeters
Inches
Scale For Microfilming
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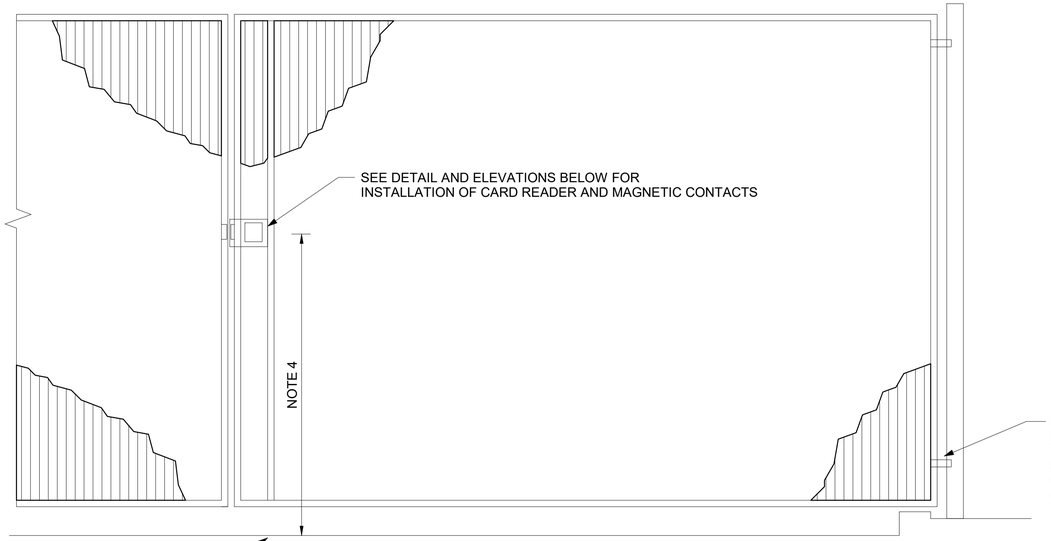
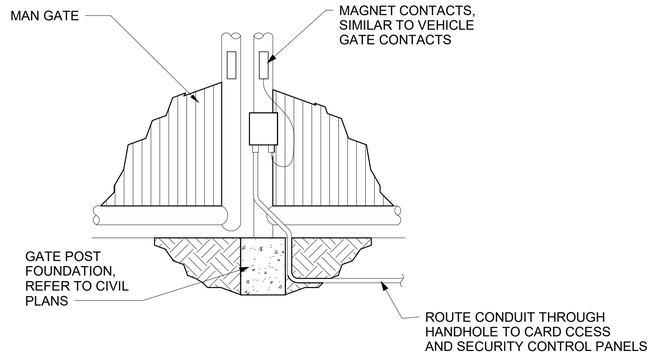
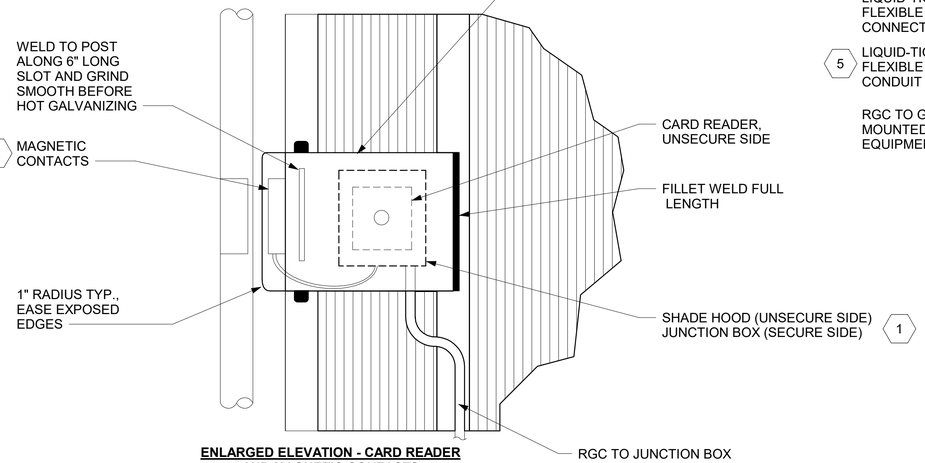


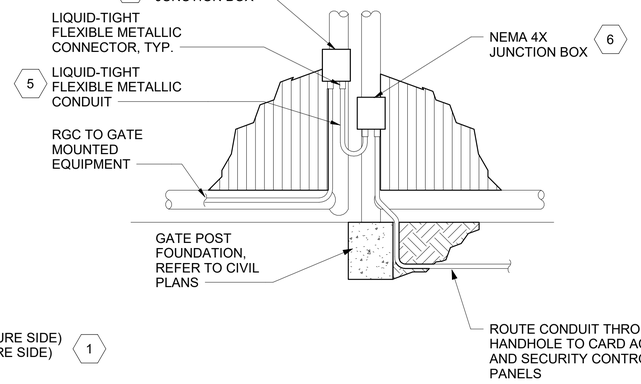
SWING GATE CARD READER AND MAGNETIC CONTACTS
NOT TO SCALE



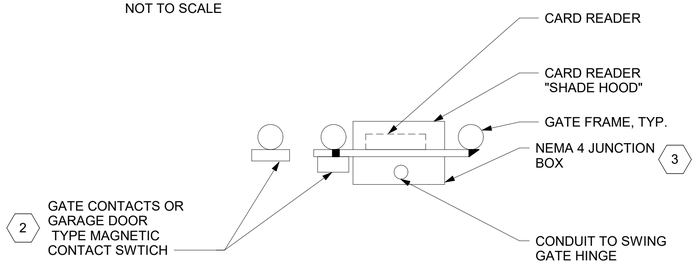
MAGNETIC CONTACT AT MAN GATE
NOT TO SCALE



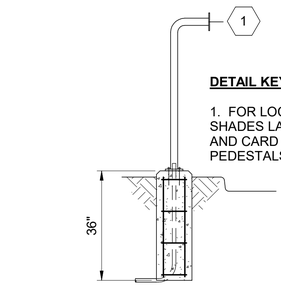
ENLARGED ELEVATION - CARD READER AND MAGNETIC CONTACTS
NOT TO SCALE



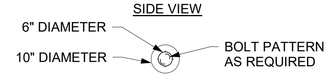
ENLARGED ELEVATION- FLEX CONDUIT AT SWING GATE HINGE
NOT TO SCALE



SECTION A
NOT TO SCALE



SIDE VIEW



TOP VIEW

CARD READER PEDESTAL
NOT TO SCALE

DETAIL KEYED NOTES: (#)

1. FOR LOCATION AT TANKS, PROVIDE SUN SHADES LARGE ENOUGH FOR LIGHT SWITCHES AND CARD READERS MOUNTED ON SEPARATE PEDESTALS.

SWING GATE DETAIL NOTES: (#)

1. WELD CARD READER "SHADE HOOD" TO STEEL PLATE ON UNSECURE SIDE AND ATTACH JUNCTION BOX TO SECURE SIDE. DIMENSIONS OF STEEL PLATE TO BE DETERMINED BY CONTRACTOR BASED ON CARD ACCESS AND SECURITY RELATED PRODUCTS PROVIDED.
2. PROVIDE NEMA 4X RATED MAGNETIC CONTACT SWITCH SIMILAR TO EDWARDS SIGNALING (GE) MODEL 2507A-L, OR APPROVED EQUAL. ROUTE FLEXIBLE METAL RACEWAY TO JUNCTION BOX.
3. PROVIDE JUNCTION BOX WITH SECURITY TYPE SCREWS.
4. ATTACH PLATE APPROXIMATELY 54" TO CENTER ABOVE FINISHED GRADE.
5. INSTALL LOOP IN CONDUIT IF NECESSARY TO ACCOMODATE GATE MOTION.
6. PLACE JUNCTION BOXES TO NOT LIMIT GATE SWING.

no.	date	by	ckd	description
0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
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Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: A.BENSON
designed: M. HOPKINS	checked: V.PATWARI

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL DETAILS II

project: 135303	contract:
drawing: 0E-004	rev.: 1
sheet:	of sheets
file:	

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches
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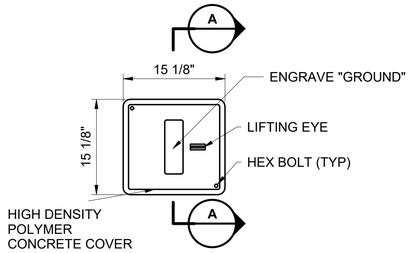
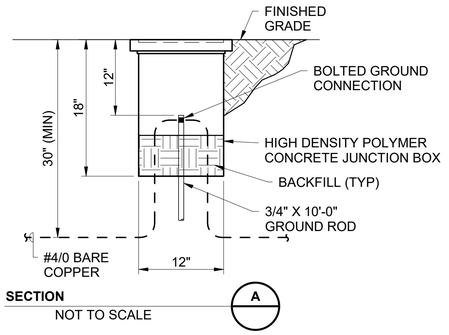
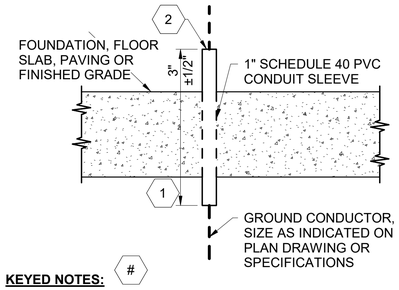


TYPICAL GROUND TEST WELL
NOT TO SCALE



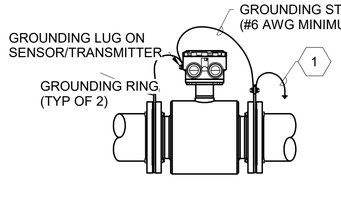
SECTION
NOT TO SCALE



KEYED NOTES: #

1. 8" MINIMUM; FOR CONCRETE SLAB, FOUNDATION OR PAVING, EXTEND SLEEVE 2" BELOW CONCRETE OR PAVING.
2. FILL SLEEVE WITH RTV COMPOUND AND CAULK WITH TWO COMPONENT POLYSULFIDE SYSTEM SEALANT PER SPECIFICATION SECTION 03300 - CONCRETE ACCESSORIES.

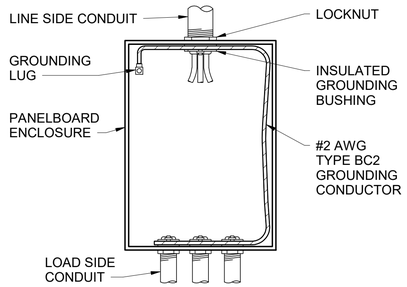
GROUND CONDUCTOR PROTECTION
NOT TO SCALE



KEYED NOTE: #

1. PROVIDE CONNECTION TO GROUNDING ELECTRODE ONLY WHEN INDICATED. POWER CIRCUIT EQUIPMENT GROUNDING CONDUCTOR SHALL NORMALLY SERVE AS EARTH CONNECTION FOR THE INSTRUMENT.

TYPICAL MAG METER GROUNDING DETAIL
NOT TO SCALE



TYPICAL PANEBOARD CONDUIT GROUNDING
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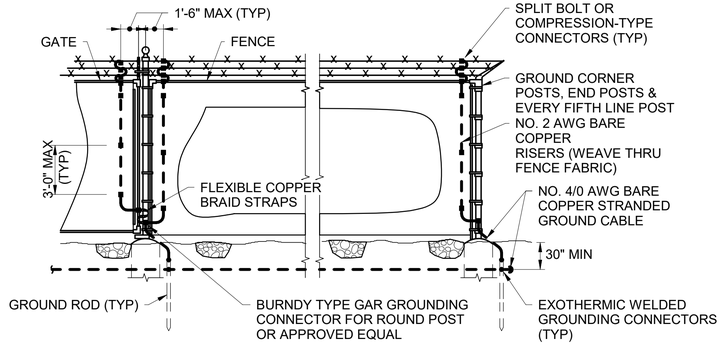

TYPICAL FENCE GROUNDING
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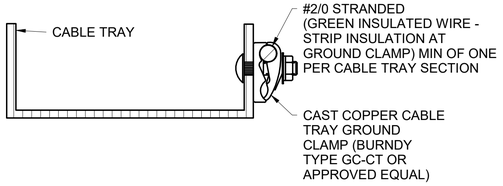
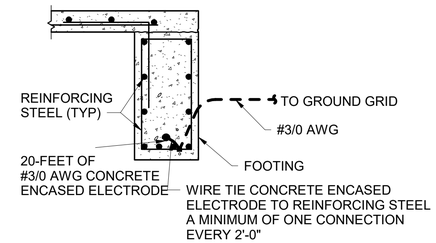
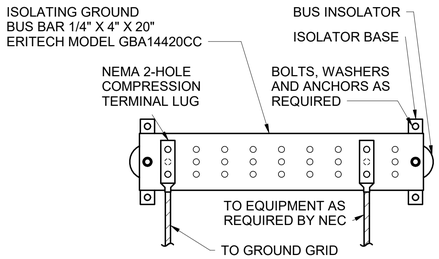


CABLE TRAY GROUND CLAMP
NOT TO SCALE

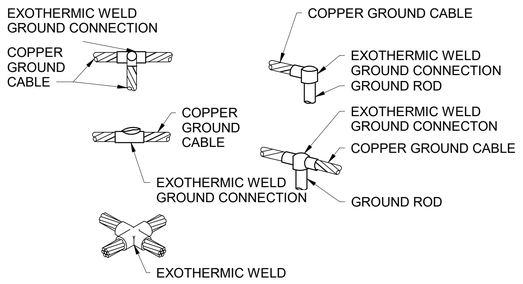
TYPICAL GROUND ROD CONNECTION
NOT TO SCALE



TYPICAL CONCRETE ENCASED ELECTRODE (UFER GROUND) DETAIL
NOT TO SCALE



TYPICAL GROUND BUS BAR
NOT TO SCALE



TYPICAL EXOTHERMIC WELDS
NOT TO SCALE

no.	date	by	ckd	description
0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
1	05/06/25	JPH	MAH	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
M. HOPKINS	V.PATWARI

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL DETAILS III

project	contract
135303	

drawing **0E-005** rev. **1**

sheet of sheets

file

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

Scale For Microfilming
Millimeters
Inches
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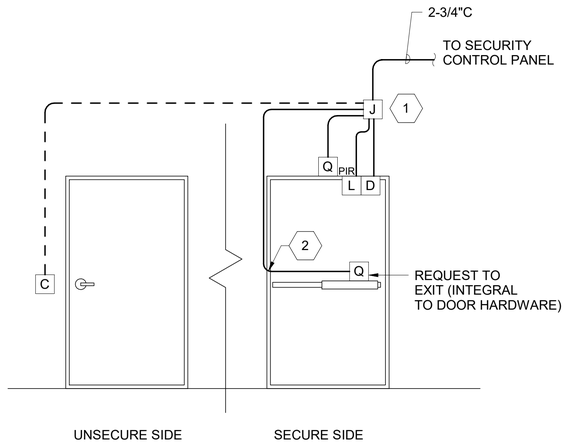


GENERAL NOTES:

1. ALL CONDUIT SHALL BE INSTALLED WITHIN WALL IF DEVICES ARE LOCATED IN A FINISHED AREA.
2. CONDUIT AND JUNCTION BOXES SHALL BE SURFACE MOUNTED IF INSTALLED WITHIN UNFINISHED INTERIOR AREAS.
3. IF CARD READER IS LOCATED ON THE EXTERIOR SIDE OF BUILDING, JUNCTION BOX SHALL BE FLUSH MOUNTED WITHIN EXTERIOR WALL.
4. ALL CONDUIT SHALL BE 3/4-INCH UNLESS NOTED OTHERWISE.

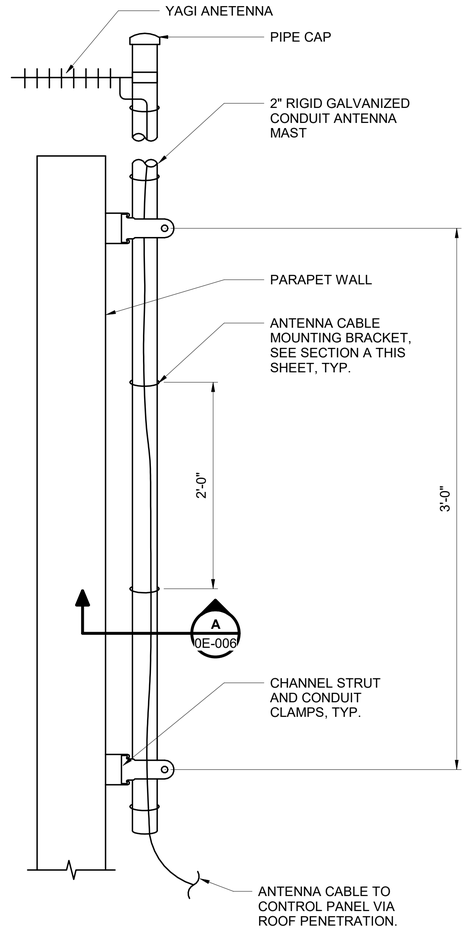
KEYED NOTES: (#)

1. JUNCTION BOX SHALL BE INSTALLED A MINIMUM OF 12-INCHES ABOVE CEILING.
2. USE POWER TRANSFER HARDWARE TO TRANSITION REQUIRED WIRES FROM DOOR TO DOOR FRAME.

DETAIL LEGEND:

- [C] CARD READER
- [D] DOOR SWITCH
- [J] JUNCTION BOX
- [Q] REQUEST TO EXIT (PIR) = PASSIVE INFRARED

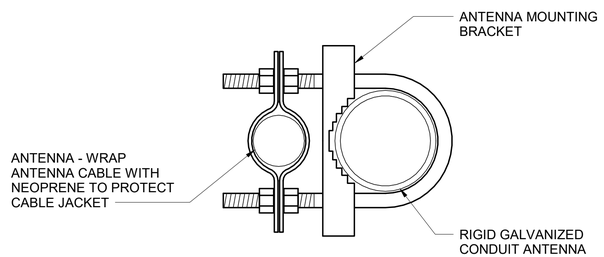
SINGLE DOOR W/ CR AND CRASH BAR
NOT TO SCALE



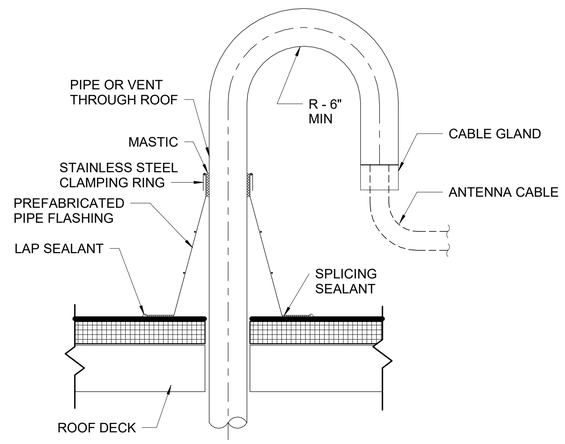
ANTENNA MAST - YAGGI
NOT TO SCALE

GENERAL NOTES:

1. SYSTEM INTEGRATOR TO COORDINATE ALL DETAILS NECESSARY FOR PROPER RADIO OPERATION. PERFORM RADIO PATH STUDY ACCORDING TO RECEIVER LOCATION PROVIDED BY CITY OF BROOMFIELD AND ADJUST ANTENNA AS NECESSARY. MAKE APPLICATION, PAYING ALL NECESSARY FEES, FOR LICENSED FREQUENCY USE.
2. INSTALL YAGGI ANTENNA ON 10' LONG 2" RIGID GALVANIZED CONDUIT ANTENNA MAST. MOUNT MAST TO INNER SURFACE OF PARAPET WALL USING HORIZONTAL SECTIONS OF CHANNEL STRUT WITH CONDUIT CLAMPS LOCATED 36" APART. ALLOW 4" OF MAST BELOW BOTTOM CONDUIT CLAMP. FASTEN ANTENNA CABLE TO MAST EVERY 24" FOLLOWING SECTION - A - ANTENNA CABLE MOUNTING BRACKET.
3. PROVIDE INLINE/COAXIAL SURGE PROTECTION MODULE, POLYPHASER SERIES: IS-50NX, OR APPROVED EQUAL, BONDED TO GROUND SYSTEM.



SECTION - A - ANTENNA CABLE MOUNTING BRACKET
NOT TO SCALE



ANTENNA PENETRATION DETAIL
NOT TO SCALE

no.	date	by	ckd	description
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1	05/06/25	JPH	MAH	ISSUED FOR CONSTRUCTION

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City and County Engineer (or Designee) _____ Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date MAY 2025	**detailed** A.BENSON
designed M. HOPKINS	**checked** V.PATWARI

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL DETAILS IV

project 135303	**contract**
drawing 0E-006	**rev.** 1
sheet	**of** **sheets**
file	

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

Millimeters
Inches
Scale For Microfilming
5/13/2025 9:27:42 AM
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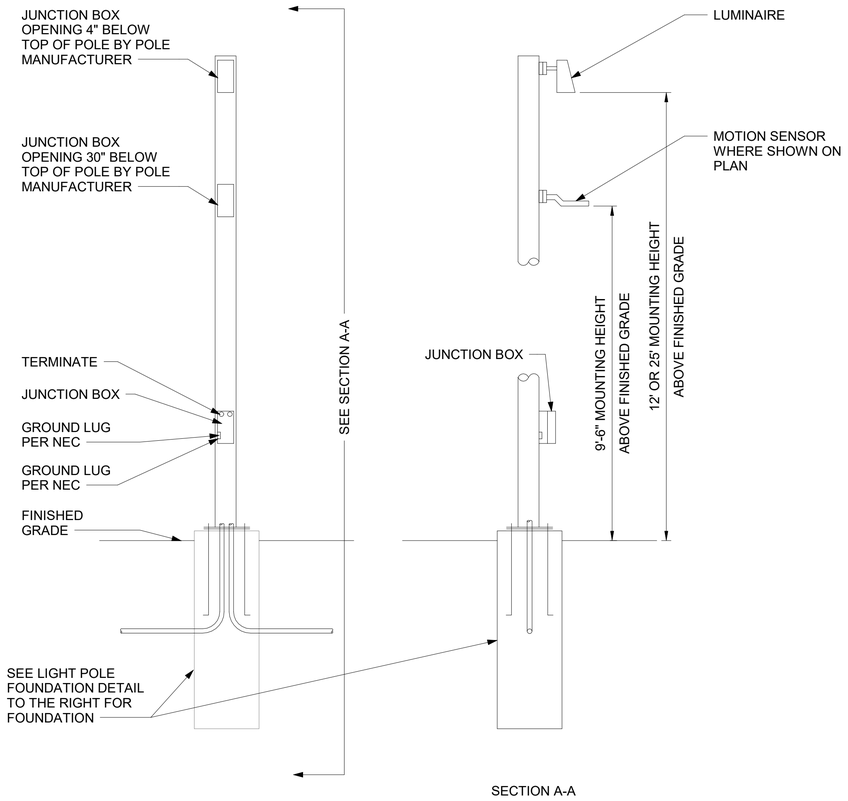
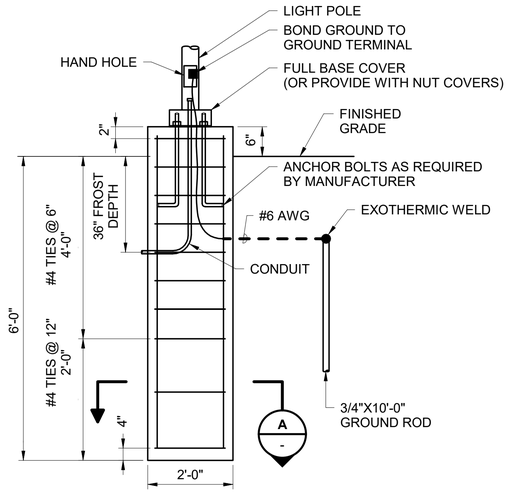
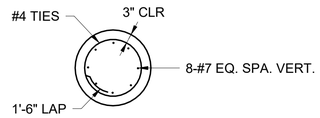


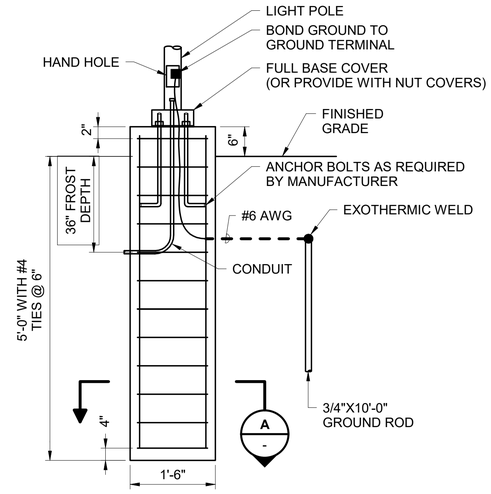
TYPE L7 PERIMETER POLE LIGHT POLE - 12' MOUNTING HEIGHT
NOT TO SCALE

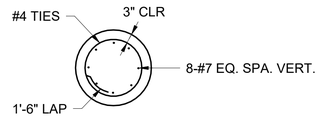




SECTION A -
NOT TO SCALE

TYPE L6 LIGHT POLE FOUNDATION DETAIL
NOT TO SCALE





SECTION A -
NOT TO SCALE

TYPE L7 LIGHT POLE FOUNDATION DETAIL
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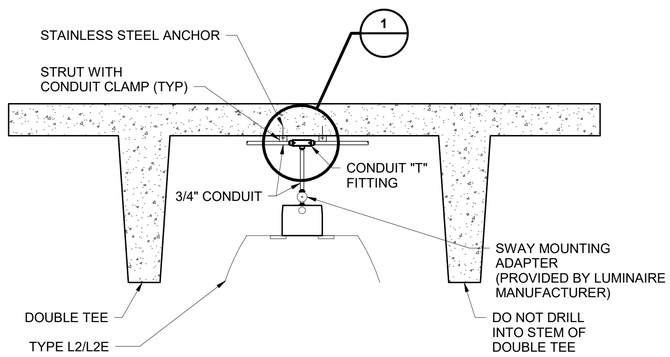
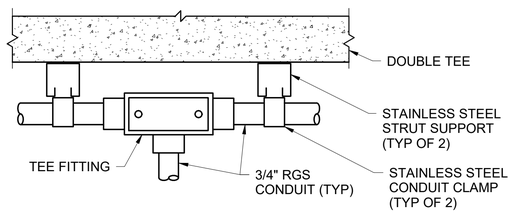


LUMINAIRE MOUNTING FOR DOUBLE TEE
NOT TO SCALE



DETAIL 1
NOT TO SCALE

no.	date	by	ckd	description
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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
M. HOPKINS	V.PATWARI

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

LIGHTING DETAILS - INTERIOR AND POLES

project	contract
135303	

drawing 0E-007 — **rev.** 1

sheet **of** **sheets**
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MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

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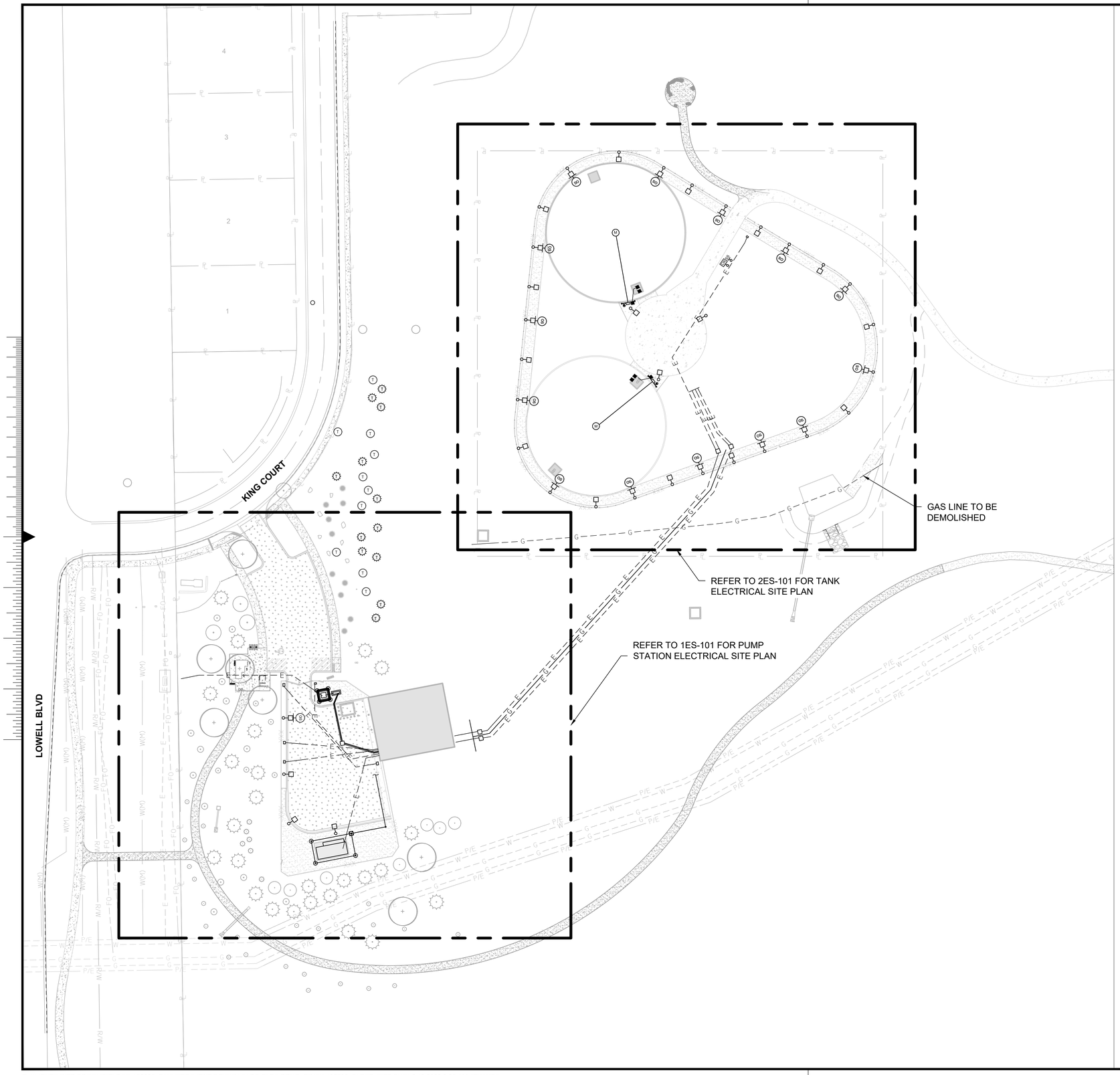

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NORTH

0 50' 100'
SCALE IN FEET

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	M. HOPKINS
designed by	**checked by**
M. HOPKINS	V. PATWARI

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
ELECTRICAL SITE PLAN - OVERALL

project	contract
135303	

drawing **0ES-101** rev. **1**

sheet of sheets
file 135303_ELECT_SITE.dwg

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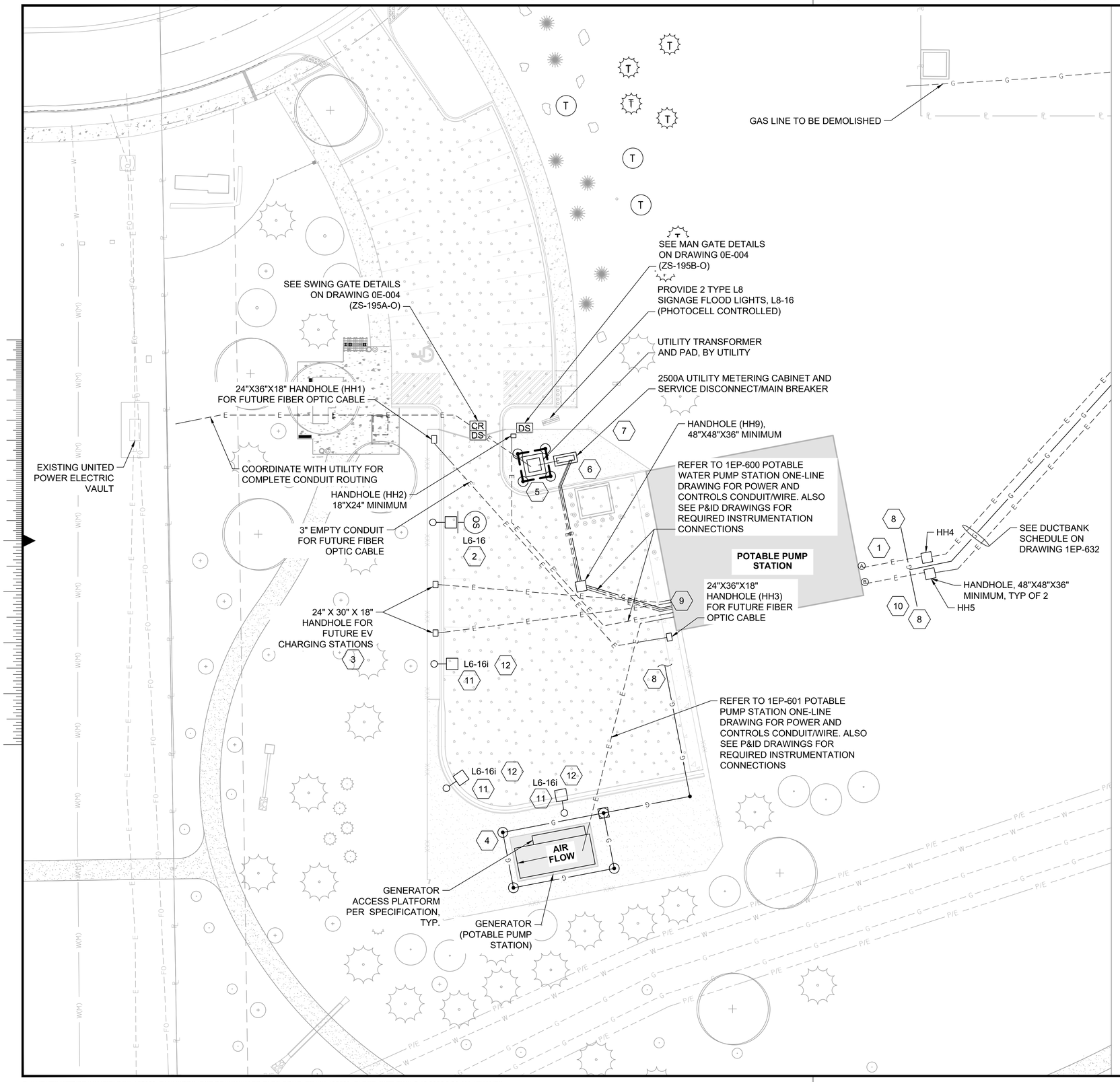

GENERAL NOTES:

1. LUMINAIRES NOTED AS L6-16 FED FROM PANEL LP1, CIRCUIT 16 (208V) IN THE POTABLE WATER PUMP STATION.
2. COORDINATE WITH EQUIPMENT MANUFACTURER TO PROVIDE CONDUIT WINDOWS IN CONCRETE PADS FOR ALL CONDUITS FEEDING EXTERIOR PAD MOUNTED EQUIPMENT. FILL CONDUIT WINDOWS AROUND CONDUIT WITH CLEAN ROCK.
3. PROVIDE 6" U-SHAPE SLACK IN ALL CONDUCTORS FEEDING EXTERIOR PAD MOUNTED EQUIPMENT TO ALLOW FOR EXPANSIVE SOIL MOVEMENT.

KEY NOTES: (#)

1. ROUTE POWER AND CONTROL CONDUITS, QUANTITY AS NEEDED, TO THE FOLLOWING LOCATIONS:
   - A. CONTROL CONDUITS TO POTABLE WATER PUMP STATION ELECTRICAL ROOM.
   - B. POWER CONDUITS TO POTABLE WATER PUMP STATION ELECTRICAL ROOM.
2. LUMINAIRE AND MOTION SENSOR TO BE CONNECTED TO LIGHTING PANEL FOR MOTION CONTROL DURING DUSK TO DAWN HOURS. SEE ADDITIONAL MOTION SENSOR ON DRAWING 1EL-101.
3. COIL 10' OF ADDITIONAL CABLE IN HANDHOLE FOR FUTURE FAST EV CHARGING CIRCUIT. SEAL CABLE ENDS.
4. PROVIDE #4/0 AWG BARE COPPER GROUND RING AROUND GENERATORS, OFFSET 24" AND 24" DEEP. PROVIDE GROUND RODS AT EACH CORNER OF GENERATOR PAD WITH TEST WELLS AT LOCATIONS SHOWN. BOND GENERATOR GROUND TO TEST WELL WITH #4/0 AWG. BOND GENERATOR PLATFORM WITH #2 WIRE AT EACH END.
5. PROVIDE #4/0 AWG BARE COPPER GROUND RING AROUND UTILITY TRANSFORMERS, OFFSET 24" AND 24" DEEP. PROVIDE GROUND RODS AT EACH CORNER OF EQUIPMENT PAD. DO NOT BOND GROUND BUS OF EQUIPMENT TO ONE GROUND ROD USING #4/0 AWG, PROVIDE TEST WELL AT THIS LOCATION. BOND RING TO DUCT BANK GROUND CONDUCTOR. ENSURE NO METALLIC GROUND CONNECTION TO EXIST BETWEEN UTILITY TRANSFORMER AND SERVICE DISCONNECT EQUIPMENT IF UTILITY TRANSFORMER NEUTRAL IS BONDED TO GROUND.
6. PROVIDE #4/0 AWG GROUND RING AROUND SERVICE EQUIPMENT, OFFSET 24" AND 24" DEEP. PROVIDE GROUND RODS AT EACH CORNER OF EQUIPMENT PAD. BOND GROUND BUS OF EQUIPMENT TO ONE GROUND ROD USING #4/0 AWG, PROVIDE TEST WELL AT THIS LOCATION. BOND GROUND RING TO DUCT BANK GROUND CONDUCTOR PER TYPICAL DUCT BANK DETAIL ON DRAWING 0E-003.
7. BOND GROUND RING TO FENCE WITHIN 20' OF ELECTRICAL DISTRIBUTION EQUIPMENT INCLUDING TRANSFORMERS, SERVICE ENTRANCE EQUIPMENT, AND GENERATORS. USE #2 WIRE MINIMUM WITH CONNECTIONS NO GREATER THAN 50' APART.
8. PROVIDE #4/0 AWG GROUND RING AROUND BUILDING, OFFSET 24" AND 24" DEEP. PROVIDE GROUND RODS WHERE SHOWN ON DRAWING 1EP-101. BOND GROUND RING TO DUCT BANK GROUND CONDUCTORS PER TYPICAL DUCT BANK DETAIL ON DRAWING 0E-003. REFER TO DRAWING EP-101 FOR CONTINUATION.
9. BOND GROUND BUS IN ELECTRICAL ROOM TO GROUND RING USING #4/0 AWG. REFER TO DRAWING 1EP-101.
10. BOND GROUND RING TO DUCT BANK GROUND CONDUCTORS PER TYPICAL DUCT BANK DETAIL ON DRAWING 0E-003.
11. SWITCH (i) FOR POLE MOUNTED LIGHTS. SEE DRAWING 1EL101.
12. REFER TO DRAWING 1EL-101 FOR LIGHT SWITCH "i" LOCATION.

NORTH

0 10' 20' 40'
SCALE IN FEET

no.	date	by	ckd	description
0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
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COLORADO LICENSED MARK A. HOPKINS 52646 05/13/2025 PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	M. HOPKINS
designed by	**checked by**
M. HOPKINS	V. PATWARI

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ELECTRICAL SITE PLAN - PUMP STATION

project	contract
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drawing **1ES-101** rev. **0**

sheet of sheets

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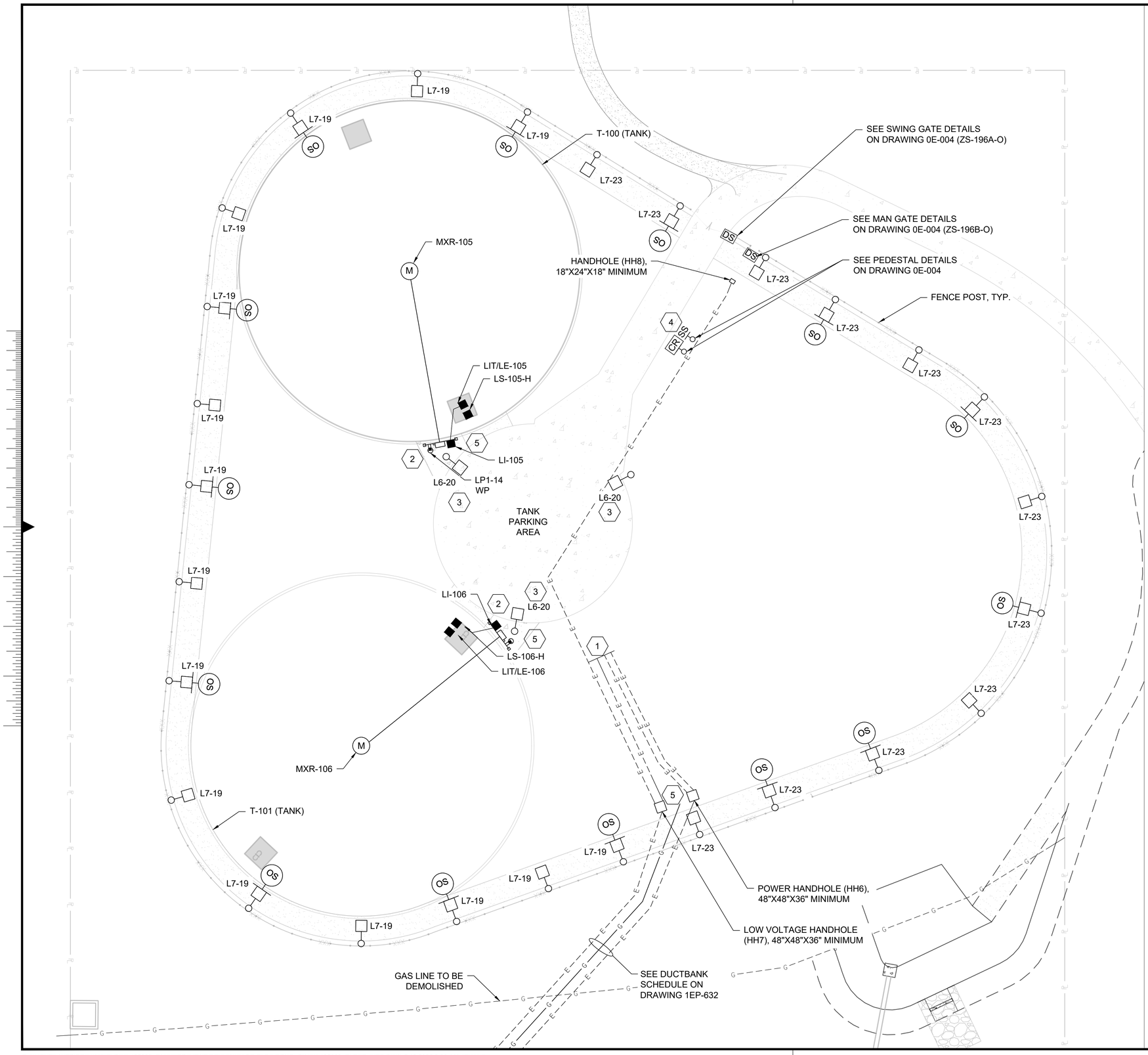

GENERAL NOTES:

1. LUMINAIRES NOTED AS L7-19 AND L7-23 ARE FED FROM PANEL LP1, CIRCUIT 19 AND 23 (208V) IN THE POTABLE WATER PUMP STATION. PROVIDE GROUND ROD ADJACENT TO POLE BONDED USING A BARE #6 AWG SOLID GROUND EMBEDDED IN POLE FOUNDATION.
2. LUMINAIRES NOTED AS L6-20 FED FROM PANEL LP1, CIRCUIT 20 (208VAC) IN THE POTABLE WATER PUMP STATION. LUMINAIRE MOUNTING HEIGHT TO BE 25' AFG. PROVIDE GROUND ROD ADJACENT TO POLE BONDED USING A BARE #6 AWG SOLID GROUND EMBEDDED IN POLE FOUNDATION.
3. ROUTE 120V LIGHTING CONTROLS THROUGH POWER HAND HOLES.
4. REFER TO CIVIL DETAIL 10 ON SHEET 0C-500.

KEYED NOTES: (#)

1. CONTINUE POWER CONDUITS TO MIXERS, PARKING AREA LIGHT POLES, PEDESTAL MOUNTED LIGHT SWITCH, RECEPTACLES, PERIMETER LIGHTING AND CONTROLS. CONTINUE CONTROLS TO LEVEL INSTRUMENTS, CARD ACCESS READER, AND DOOR CONTACT SWITCHES AT VEHICLE AND MAN GATES.
2. MOUNT ELECTRICAL EQUIPMENT ON EQUIPMENT RACK.
3. TYPE L6 LUMINAIRE TO BE CONNECTED TO LIGHTING CONTROL PANEL FOR CONTROL DURING DUSK TO DAWN HOURS.
4. PROVIDE NEMA 4X SELECTOR SWITCHES IN NEMA 4X STAINLESS BOX MOUNTED TO PEDESTAL WITH SEPARATE CONTACT BLOCKS WIRED TO EACH CONTROL PANEL FOR L7 PERIMETER LIGHTS AND L6 PARKING AREA LIGHTS. REFER TO PANEL SCHEMATICS ON SHEET 1E-621. PROVIDE SEPARATE PEDESTAL FOR CARD READER AND LIGHT SWITCHES TO KEEP VOLTAGE CLASSES SEPARATE. SEE PEDESTAL DETAIL ON SHEET E-004.
5. PROVIDE GROUND #4/0 AWG BARE COPPER RING AROUND TANKS WITH 6 GROUND RODS SPREAD EQUALLY AROUND CIRCUMFERENCE OF TANKS, OR A MINIMUM OF 75' SPACING. TIE GROUND RING TO REBAR ALONG SIMILAR 75' SPACING ACCESS HATCH FRAMES, AND HANDRAILS WITH #2 AWG MIN. PROVIDE GROUND ROD AT EACH EQUIPMENT RACK BONDED TO RACK STRUCTURE AND EQUIPMENT ENCLOSURES WITH #4 AWG MIN. CONNECT GROUND RINGS TO DUCTBANK BACK TO PUMP STATION GROUND RING.

NORTH

0 10' 20' 40'
SCALE IN FEET

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0	01/28/25	MAH	VKP	ISSUED FOR CONSTRUCTION
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9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	M. HOPKINS
designed by	**checked by**
M. HOPKINS	V. PATWARI

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
ELECTRICAL SITE PLAN - TANKS

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

project	contract
135303	

drawing **2ES-101** rev. **0**

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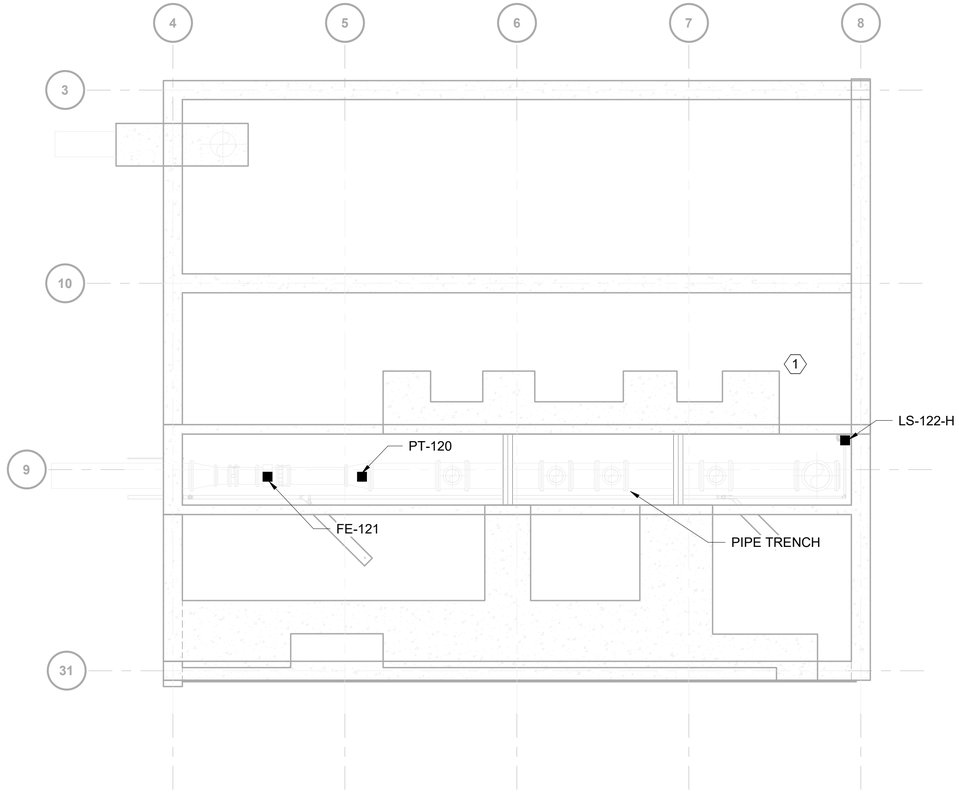
KEYED NOTES: (#)

1. BELOW SLAB CONCRETE EMBEDDMENT SIMILAR TO EMBEDDMENT SHOWN IN SECTION - TRENCH CABLE TRAY AND RACEWAY ROUTING ON DRAWING 0E-003. COORDINATE WITH STRUCTURAL AND ADJUST PER FINAL CONDUIT LAYOUT.



ELECTRICAL FOUNDATION PLAN

0 4' 8' 16'
SCALE IN FEET

NORTH

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BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
M. HOPKINS	V.PATWARI

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BROOMFIELD TANKS AND PUMP STATION

LOWER LEVEL INSTRUMENTATION AND CONTROL PLAN

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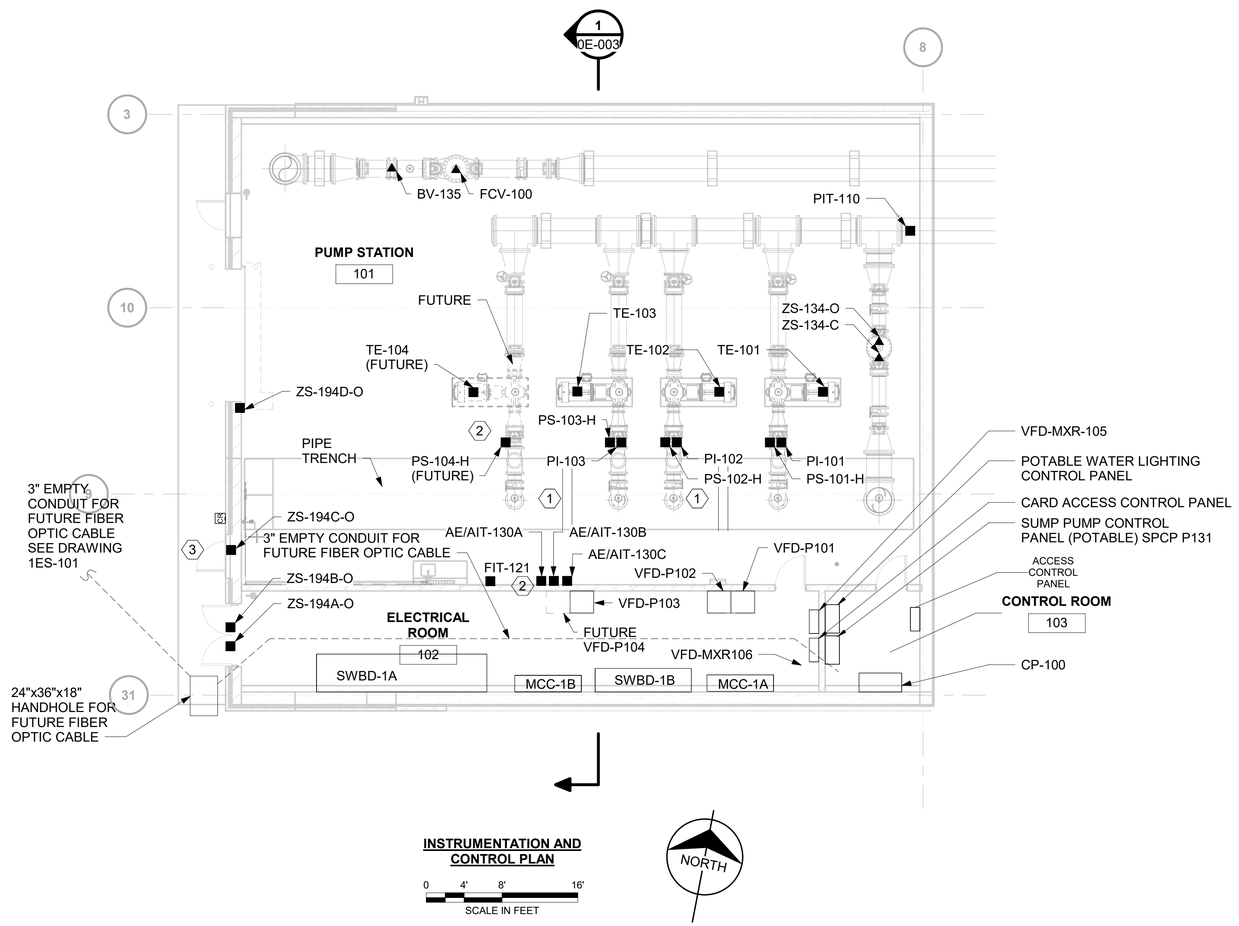

INSTRUMENTATION AND CONTROL PLAN

0 4' 8' 16'

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GENERAL NOTES:

1. PROVIDE CABLE TRAY DIVIDERS TO SEPARATE POWER CONDUCTORS FROM LOW VOLTAGE CONTROLS AND INSTRUMENTATION CONDUCTORS.

KEYED NOTES: (#)

1. REFER TO SECTION - TRENCH CABLE TRAY AND RACEWAY ROUTING ON DRAWING 0E-003. TRAY SIZING SHALL ALLOW 25% SPARE CAPACITY AFTER CONSIDERING FUTURE SPARE CONDUITS FOR P-104.
2. PROVIDE CONDUITS CAPPED WITH THREADED PLUG LEVEL WITH FLOOR FOR FUTURE EQUIPMENT. REFER TO ONE-LINE DIAGRAM FOR EMPTY POWER CONDUITS, AND REFER TO CONNECTION DIAGRAMS FOR CONTROL CONDUIT REQUIREMENTS. PROVIDE SIMILAR TO P-101 THROUGH P-103.
3. REFER TO DETAIL SINGLE DOOR W/ CR AND CRASH BAR ON SHEET 0E-006 FOR ACCESS CONTROL REQUIREMENTS AND EQUIPMENT LOCATIONS AT DOOR.

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date MAY 2025	**detailed** A.BENSON
designed M. HOPKINS	**checked** V.PATWARI

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BROOMFIELD TANKS AND PUMP STATION

UPPER LEVEL INSTRUMENTATION AND CONTROL PLAN

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LUMINAIRE SCHEDULE

LUMINAIRE TYPE	ACCEPTABLE MANUFACTURER	CATALOG NUMBER	CONSTRUCTION	TYPE OF FIXTURE	OPTICS	LAMP	DRIVER	ACCESSORIES/NOTES
L1	HE WILLIAMS OR APPROVED EQUAL	82-4-L64-840-DRV-UNV	DIE-FORMED COLD ROLLED STEEL HOUSING, WHITE POWDER COATING FINISH	1X4 INDUSTRIAL STRIP	OPEN BOTTOM	LED, 6400 LUMEN 80 CRI, 4000K CCT	120-277V NON-DIMMING TYPE	1. TOTAL WATTAGE PER LUMINAIRE: 42.8 WATTS
L1E	HE WILLIAMS OR APPROVED EQUAL	82-4-L64-840-EM/10W-DRV-UNV	SAME AS LUMINAIRE TYPE L1					1. TOTAL WATTAGE PER LUMINAIRE: 42.8 WATTS 2. SELF-CONTAINED EMERGENCY LED POWER PACK. (MIN. 10W BATTERY).
L2	HE WILLIAMS OR APPROVED EQUAL	82-4-L107-840-DRV-UNV	DIE-FORMED COLD ROLLED STEEL HOUSING, WHITE POWDER COATING FINISH	1X4 INDUSTRIAL STRIP	OPEN BOTTOM	LED, 10700 LUMEN 80 CRI, 4000K CCT	120-277V NON-DIMMING TYPE	1. TOTAL WATTAGE PER LUMINAIRE: 68.3 WATTS
L2E	HE WILLIAMS OR APPROVED EQUAL	82-4-L107-840-EM/10W-DRV-UNV	SAME AS LUMINAIRE TYPE L2					1. TOTAL WATTAGE PER LUMINAIRE: 68.3 WATTS 2. SELF-CONTAINED EMERGENCY LED POWER PACK. (MIN. 10W BATTERY).
L3	HE WILLIAMS OR APPROVED EQUAL	82-8-L128-840-DRV-UNV	DIE-FORMED COLD ROLLED STEEL HOUSING, WHITE POWDER COATING FINISH	1X8 INDUSTRIAL STRIP	OPEN BOTTOM	LED, 12800 LUMEN 80 CRI, 4000K CCT	120-277V NON-DIMMING TYPE	1. TOTAL WATTAGE PER LUMINAIRE: 81.9 WATTS
L3E	HE WILLIAMS OR APPROVED EQUAL	82-4-L128-840-EM/10W-DRV-UNV	SAME AS LUMINAIRE TYPE L3					1. TOTAL WATTAGE PER LUMINAIRE: 81.9 WATTS 2. SELF-CONTAINED EMERGENCY LED POWER PACK. (MIN. 10W BATTERY).
L4	HE WILLIAMS OR APPROVED EQUAL	EXIT-R-EM-WHT-D	INJECTION-MOLDED, ENGINEERING GRADE, 5VA FLAME RETARDANT, HIGH- IMPACT RESISTANT THERMOPLASTIC	EXIT SIGN	N/A	LED	120V-277V	1. TOTAL WATTAGE PER LUMINAIRE: 3.8 WATTS 2. UL LISTED FOR DAMP LOCATIONS. 3. SELF-CONTAINED EMERGENCY LED POWER PACK (MIN. 10W BATTERY)
L5	LITHONIA LIGHITING OR APPROVED EQUAL	WDGE3-LED-P2-40K-70CRI-RFT-MVOLT-DDBXD	DIE-CAST ALUMINUM HOUSING, ZINC INFUSED TGIC THERMOSET POWEDER COAT FINISH, IP65 RATING	WALL PACK	ACRYLIC DIFUSED	LED, 8597 LUMENS, 4000K	120-277V NON-DIMMING TYPE	1. TOTAL WATTAGE PER LUMINAIRE: 59 WATTS 2. PHOTOELECTRIC CELL
L5E	LITHONIA LIGHITING OR APPROVED EQUAL	WDGE3-LED-P2-40K-70CRI-RFT-MVOLT-DDBXD	SAME AS LUMINAIRE TYPE L5					1. TOTAL WATTAGE PER LUMINAIRE: 59 WATTS 2. PHOTOELECTRIC CELL 3. EMERGENCY BATTERY BACKUP WITH ENTERNAL ENCLOSURE
L6	HOLOPHANE	MGLED-P1-40K-MVOLT-FT-LT-SPA-DDBSD-NL-US	DIE-CAST ALUMINUM HOUSING, STAINLESS STEEL HARDWARE, 3G VIBRATION RATED, EPOXY PAINT BASECOAT, POLYESTER PAINT TOPCOAT	POLE MOUNT	BOROSILICATE GLASS	LED, 35000 LUMENS, 4000K, 70 CRI	120-277V DIMMABLE TYPE	1. TOTAL WATTAGE PER LUMINAIRE: 246 WATTS
L6-POLE	HOLOPHANE	SSA2566G-DDB-BAA	25'0" TALL, 6.0" X 0.188" STRAIGHT SQUARE ALLUMINUM POLE, 1.00" X 36" ANCHOR BOLTS @ 12.5" BOLT CIRCLE, MIN EFFECTIVE PROJECTED AREA AT 30" OFFSET 3.8 S.F. @ 110 MPH + 1.14 GUST	POLE MOUNT	N/A	N/A	N/A	1. PROVIDE MANUFACTURER SUPPLIED ANCHOR BOLTS.
L7	RAB	WPLED-FC-52-N-120-277V	DIE-CAST ALUMINUM HOUSING & ARM, POLYESTER POWDERCOAT, TEMPERED GLASS LENS	POLE MOUNT	TEMPERED GLASS	LED, 7334 LUMENS, 4000K, 70 CRI, 130 LM/W	120-277V	1. TOTAL WATTAGE PER LUMINAIRE: 56.4 WATTS 2. LUMINAIRE MOUNTED TO FENCE POSTS.
L7-POLE	HOLOPHANE	SSA1244C-DDB-FSB-BAA	12'0" TALL, 4.0" X 0.125" STRAIGHT SQUARE ALLUMINUM POLE, 3/4" x 17" ANCHOR BOLTS @ 9" BOLT CIRCLE, MIN EFFECTIVE PROJECTED AREA AT 30" OFFSET 6.7 S.F. @ 110 MPH + 1.14 GUST	POLE MOUNT	N/A	N/A	N/A	1. PROVIDE MANUFACTURER SUPPLIED ANCHOR BOLTS.
L8	ACUITY/LITHONIA - HYDREL	SAF1-LED-P1-80CRI-35K-MVOLT-70DEG-CWL-KM-L3-C3-BRS	ARCHITECTURAL LED FLOOD LIGHT, DIE-CAST COPPER FREE ALUMINUM CONSTRUCTION, ZINC-INFUSED TGIC POWDER COAT FINISH	CYLINDRICAL JUNCTION BOX (OPTION CJB), KNUCKLE MOUNT	BOROSILICATE GLASS SOFTENING LENS	LED, 430 LUMENS, 3500K, 80 CRI, 72 LM/W	120-277V	1. TOTAL WATTAGE PER LUMINAIRE: 6 WATTS 2. PROVIDE CYLINDRICAL JUNCTION BOX (CJB).

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Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
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BROOMFIELD TANKS AND PUMP STATION

LUMINAIRE SCHEDULE

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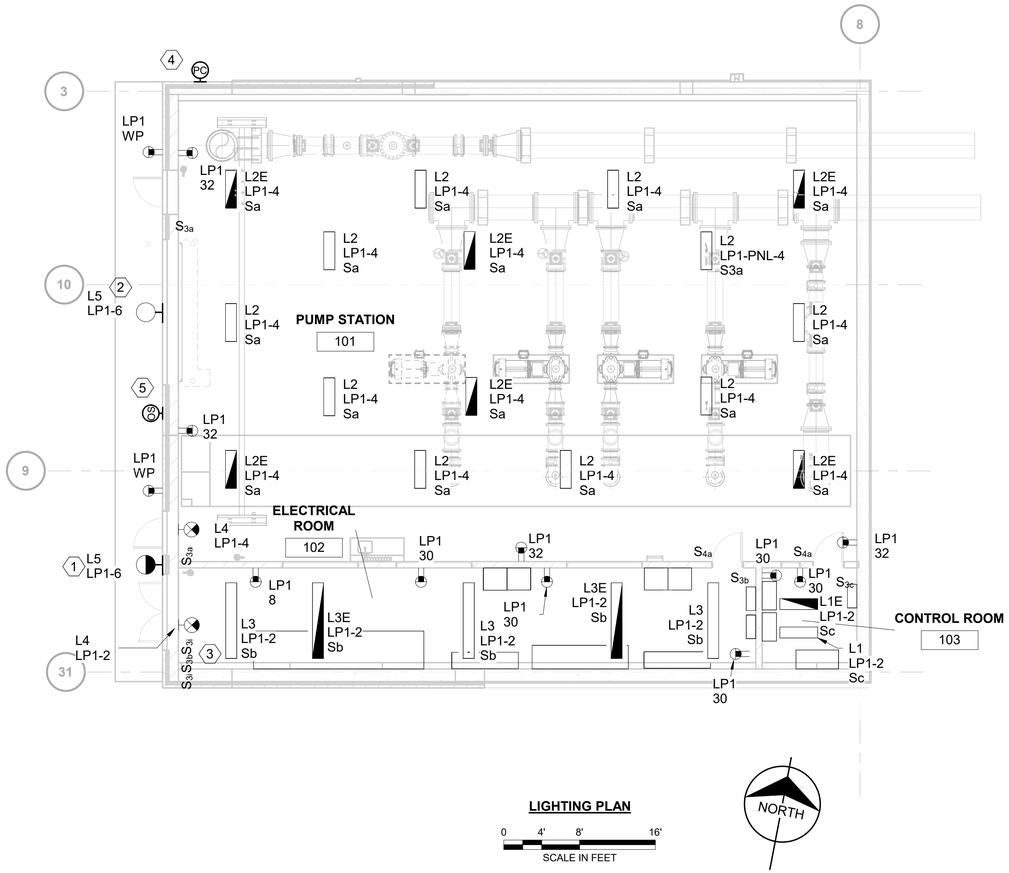

LIGHTING PLAN

0 4' 8' 16'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. LUMINAIRES TO BE MOUNTED IN BETWEEN DOUBLE TEES, SEE TYPICAL DOUBLE TEE LUMINAIRE MOUNTING DETAIL.
2. LUMINAIRES IN POTABLE PUMP ROOMS TO BE MOUNTED AT A HEIGHT OF APPROXIMATELY 18' ABOVE FINISHED FLOOR. MOUNT LUMINARES ABOVE THE BRIDGE CRANE.
3. LUMINAIRES IN THE ELECTRICAL AND CONTROL ROOMS SHALL BE MOUNTED AT A HEIGHT OF 12' ABOVE FINISHED FLOOR.
4. PROVIDE SWITCHED AND UNSWITCHED POWER TO EMERGENCY LUMINAIRES.
5. REFER TO ARCHITECTURAL SHEET 1A-200 AND 1A-201 FOR LOCATIONS.
6. RECEPTACLES IN POTABLE WATER PUMP STATION TO BE POWERED FROM LP1.

KEYED NOTES: (#)

1. MOUNT APPROXIMATELY 9' ABOVE FINISHED GRADE.
2. LUMINAIRE TO BE CONNECTED TO LIGHTING CONTROL PANEL FOR MOTION CONTROL.
3. SWITCH (i) FOR EXTERIOR PARKING LOT POLE-MOUNTED LIGHTS. SEE DRAWING 1ES-101.
4. PROVIDE LIGHTING PHOTOCELL UNITS CONNECTED TO LIGHTING CONTROL PANEL AND SITE SIGNAGE AS REQUIRED. REFER TO LIGHTING CONTROL PANEL SCHEMATIC ON DRAWING 1EP-621. ALTERNATELY, CONTRACTOR MAY PROVIDE A SINGLE PHOTOCELL AND CONTROL RELAY WITH APPROPRIATE CONTACTS FOR THE FOLLOWING:
   A. SITE SIGNAGE
   B. PUMP STATION PARKING AREA
   C. POTABLE WATER TANK PERIMETER
   D. TANK PARKING AREA
5. MOTION SENSORS TO BE INSTALLED AT APPROXIMATELY 9'-0" AFF AND WIRED BACK TO LIGHTING CONTROLLER.

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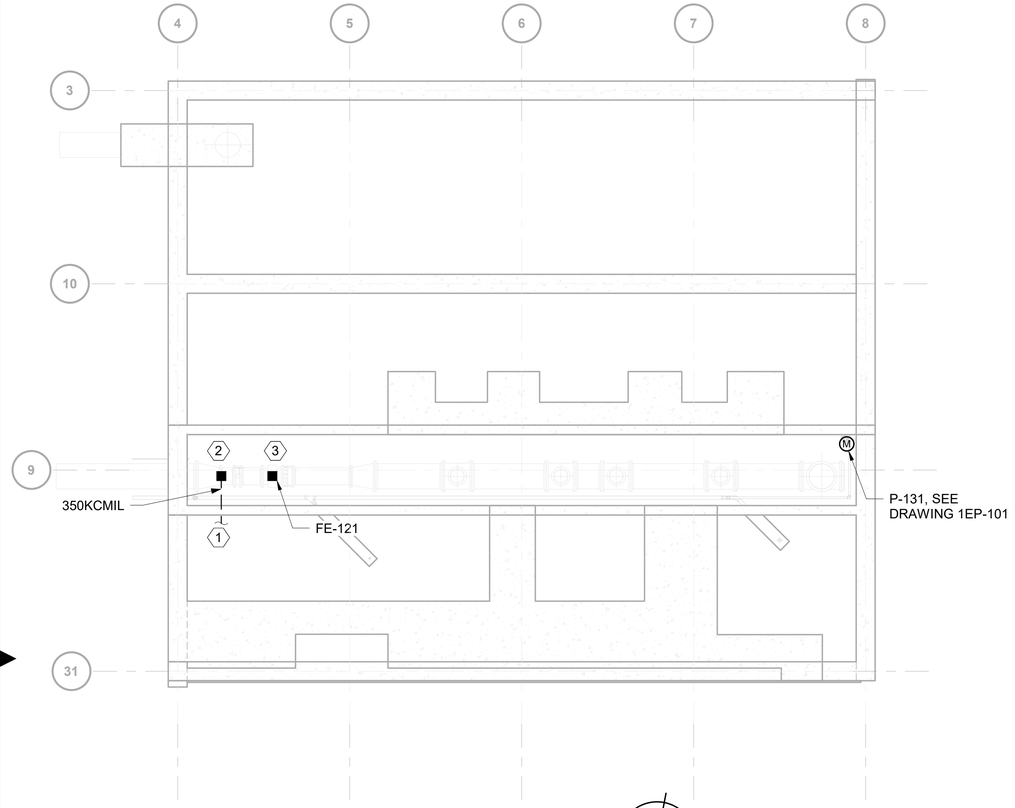

INSTRUMENTATION AND CONTROL PLAN

0 4' 8' 16'

SCALE IN FEET

KEYED NOTES: (#)

1. BOND GROUND TO WATER PUPE IN PIPE TRENCH AND TO REINFORCING STEEL IN CONCRETE - MINIMUM LENGTH 20'.
2. BOND LADDERS AND METALLIC GRATING TO GROUND GRID USING BARE #2 AWG.
3. REFER TO TYPICAL MAG METER TYPICAL GROUNDING DETAIL ON DRAWING 0E-005.

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LOWER LEVEL POWER AND GROUNDING PLAN

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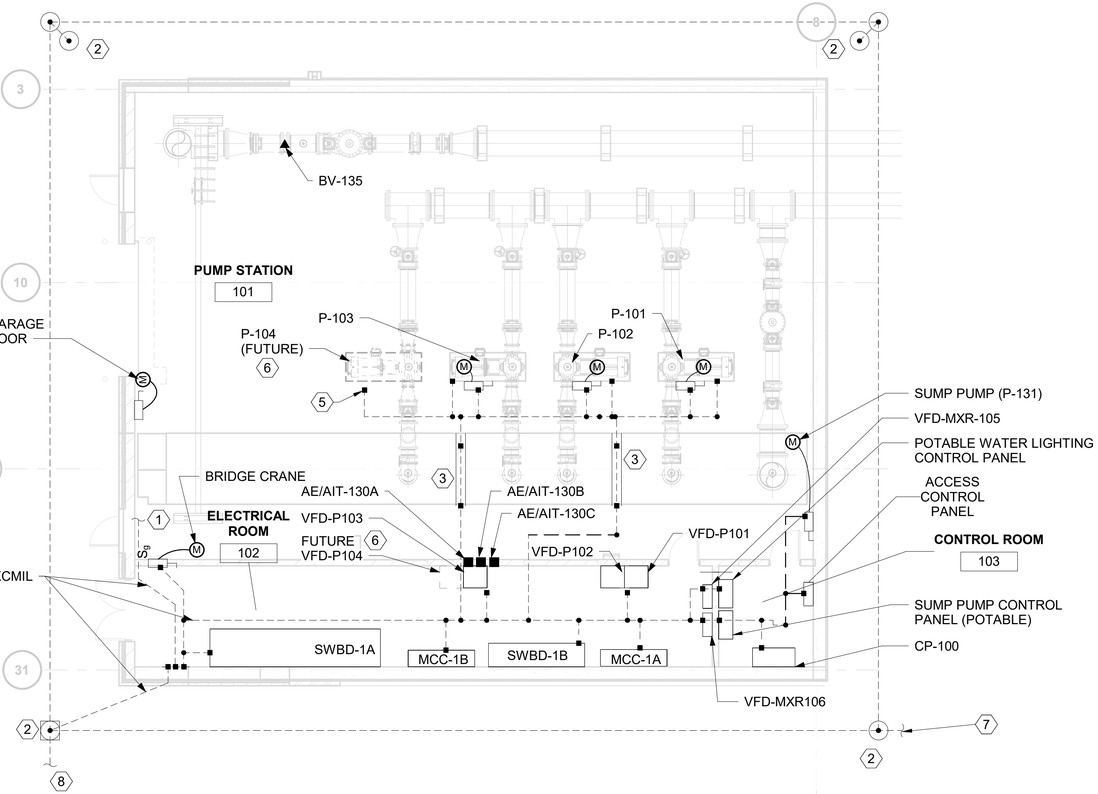

POWER AND GROUNDING PLAN

0 4' 8' 16'

SCALE IN FEET

NORTH

GENERAL NOTES:

1. EXTERIOR RECEPTACLES TO BE SWITCHED AS SHOWN. COORDINATE SWITCH LOCATION WITH LIGHTING SWITCHES.
2. CONTRACTOR TO PROVIDE HOUSEKEEPING PAD FOR ALL FLOOR MOUNTED EQUIPMENT.
3. CONNECT MOTOR CONTROL CENTERS AND SWITCHBOARDS TO GROUND BUS PER SIZES SHOWN ON RESPECTIVE ONE-LINE DIAGRAMS. REFER TO SHEETS 1EP-600 AND 1EP-601.
4. PROVIDE AN ADDITIONAL SUPPLEMENTAL GROUND TO EQUIPMENT SHOWN. GROUND TO BE SIZED PER NEC TABLE 250.122, MINIMUM, UNLESS CABLE SIZE IS IDENTIFIED ON THE ONE-LINE DIAGRAMS OR ON THE PLANS.

KEYED NOTES: (#)

1. BOND GROUND TO WATER PIPE IN PIPE TRENCH AND TO REINFORCING STEEL IN CONCRETE - MINIMUM LENGTH 20'.
2. CONTRACTOR TO PROVIDE LIGHTNING PROTECTION SYSTEM CAPABLE OF RECEIVING UL MASTER LABEL. PROVIDE LIGHTNING PROTECTION SYSTEM DOWN CONDUCTOR AT EACH BUILDING CORNER. CONNECT DOWN CONDUCTOR TO DEDICATED GROUND ROD AND BOND TO ELECTRICAL SYSTEM GROUND RING AT EACH BUILDING CORNER.
3. REFER TO SECTION - TRENCH CABLE TRAY AND RACEWAY ROUTING ON DRAWING 0E-003.
4. BOND GROUND RING TO REINFORCING STEEL EVERY 50' OF BUILDING PERIMETER.
5. PROVIDE EQUIPMENT GROUND PLATE EQUAL TO HARGER XGP1.75/3.254/0, OR APPROVED EQUAL. INSTALL FLUSH IN CONCRETE FLOOR FOR FUTURE EQUIPMENT GROUNDING CONNECTION. PROVIDE STAINLESS ALLEN SET SCREW FLUSH TO TOP SURFACE TO PROTECT HOLES FOR FUTURE USE.
6. PROVIDE CONDUITS CAPPED WITH THREADED PLUG, LEVEL WITH FLOOR FOR FUTURE EQUIPMENT. REFER TO ONE-LINE DIAGRAM FOR EMPTY POWER CONDUITS, AND REFER TO CONNECTION DIAGRAMS FOR CONTROL CONDUIT REQUIREMENTS. PROVIDE SIMILAR TO P-101 THROUGH P-103.
7. TIE GROUND RING TO DUCTBANK FEEDING TANKS. SEE KEYED NOTE 10 ON DRAWING 1ES-101.
8. BOND BUILDING GROUND RING TO GROUND RING AROUND GENERSYOR. REFER TO 1ES-101 FOR ADDITIONAL INFORMATION.

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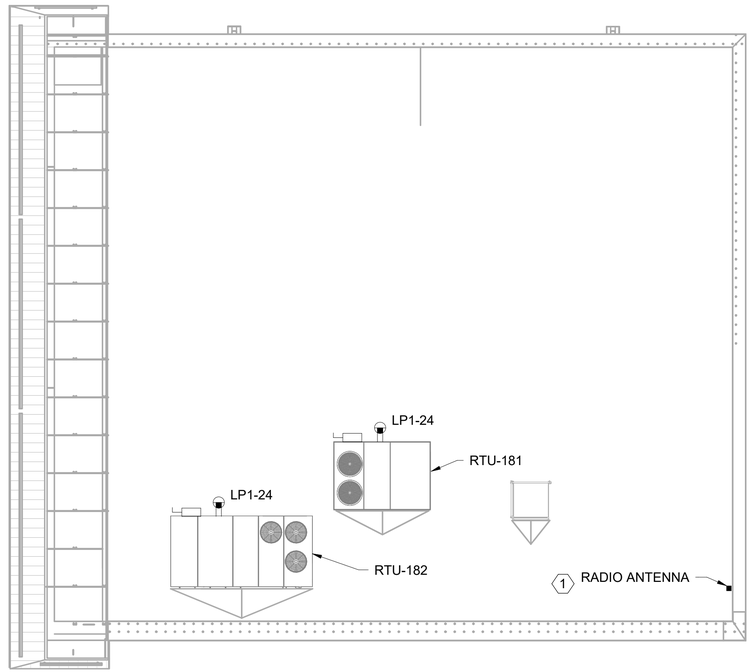

ROOF POWER AND GROUNDING PLAN

0 4' 8' 16'
SCALE IN FEET

NORTH

GENERAL NOTES:

1. PROVIDE LIGHTNING PROTECTION SYSTEM PER SPECIFICATIONS. PROVIDE DOWN CONDUCTORS TO GROUND RODS BONDED TO GROUND RING. BOND SYSTEM TO HATCH, AND HVAC EQUIPMENT.

KEYED NOTES: (#)

1. REFER TO ROOF PENETRATION DETAIL ON SHEET 0E-006. REFER TO DIVISION 40 SPECIFICATIONS FOR RADIO PATH ANALYSIS TO DETERMINE APPROPRIATE AIMING ORIENTATION OF ANTENNA TO REACH THE CITY OF BROOMFIELD NETWORK.

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ROOF POWER AND GROUNDING PLAN

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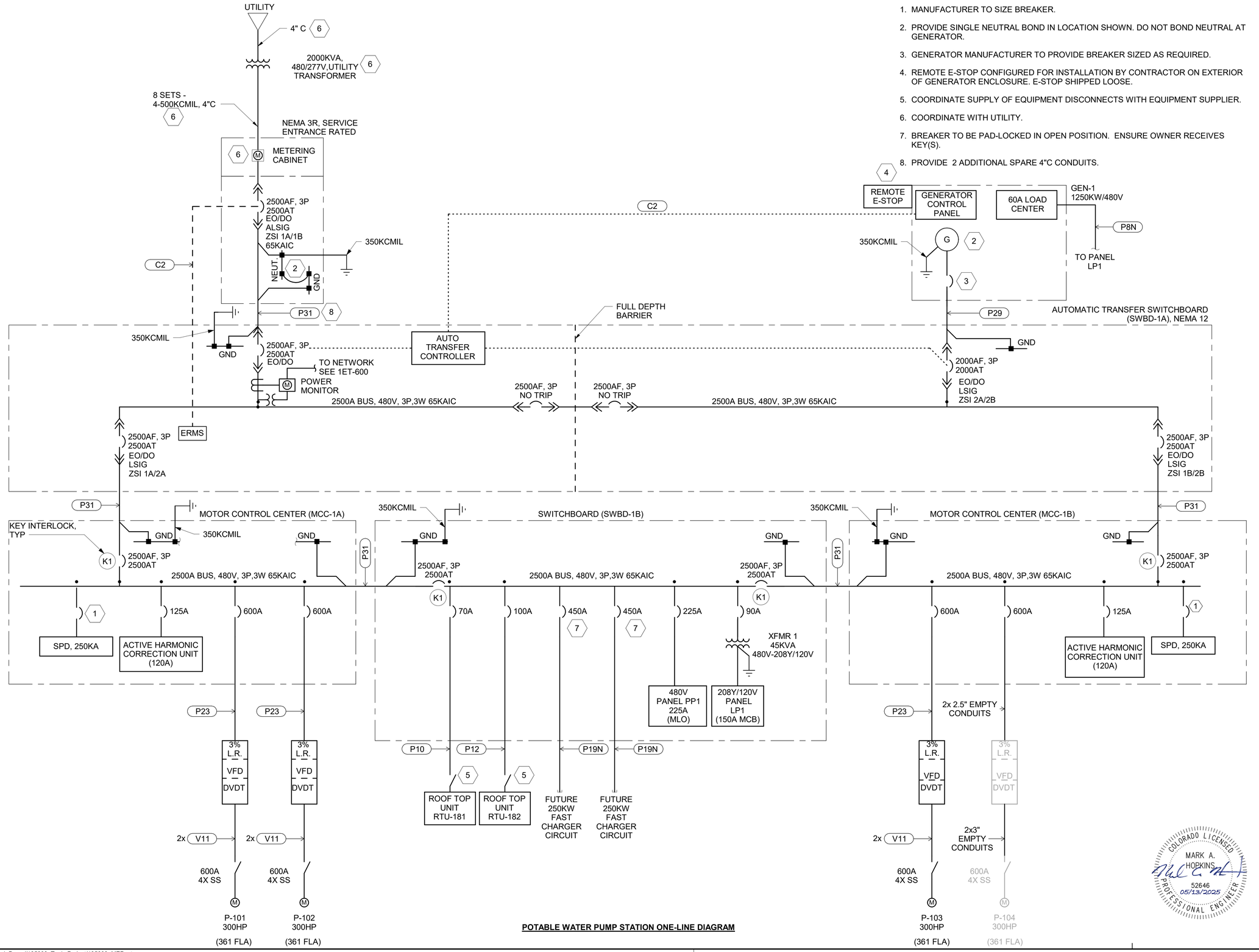

POTABLE WATER PUMP STATION ONE-LINE DIAGRAM

KEYED NOTES: (#)

1. MANUFACTURER TO SIZE BREAKER.
2. PROVIDE SINGLE NEUTRAL BOND IN LOCATION SHOWN. DO NOT BOND NEUTRAL AT GENERATOR.
3. GENERATOR MANUFACTURER TO PROVIDE BREAKER SIZED AS REQUIRED.
4. REMOTE E-STOP CONFIGURED FOR INSTALLATION BY CONTRACTOR ON EXTERIOR OF GENERATOR ENCLOSURE. E-STOP SHIPPED LOOSE.
5. COORDINATE SUPPLY OF EQUIPMENT DISCONNECTS WITH EQUIPMENT SUPPLIER.
6. COORDINATE WITH UTILITY.
7. BREAKER TO BE PAD-LOCKED IN OPEN POSITION. ENSURE OWNER RECEIVES KEY(S).
8. PROVIDE 2 ADDITIONAL SPARE 4"C CONDUITS.

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City and County Engineer (or Designee) Date

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
M. HOPKINS	V.PATWARI

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

POTABLE WATER ONE-LINE DIAGRAM

project	contract
135303	

drawing 1EP-600 — **rev.** 1

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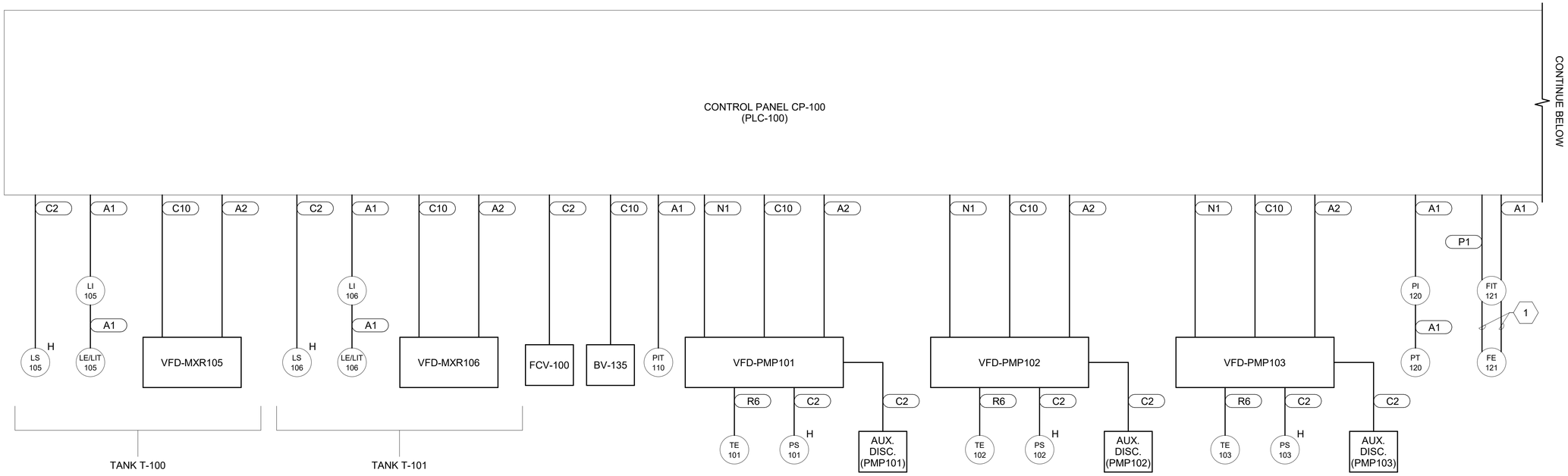
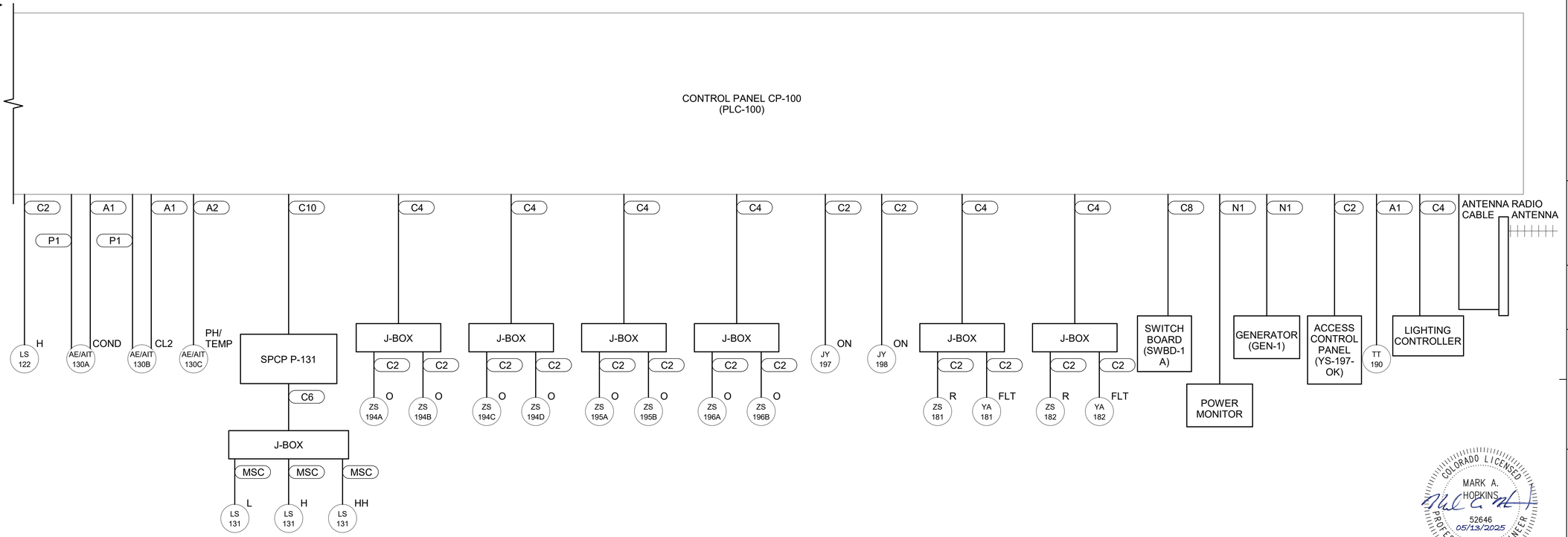


KEYED NOTES: (#)

1. COORDINATE WIRING REQUIREMENTS WITH MANUFACTURER.



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CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

POTABLE WATER CONNECTION DIAGRAM

project	contract
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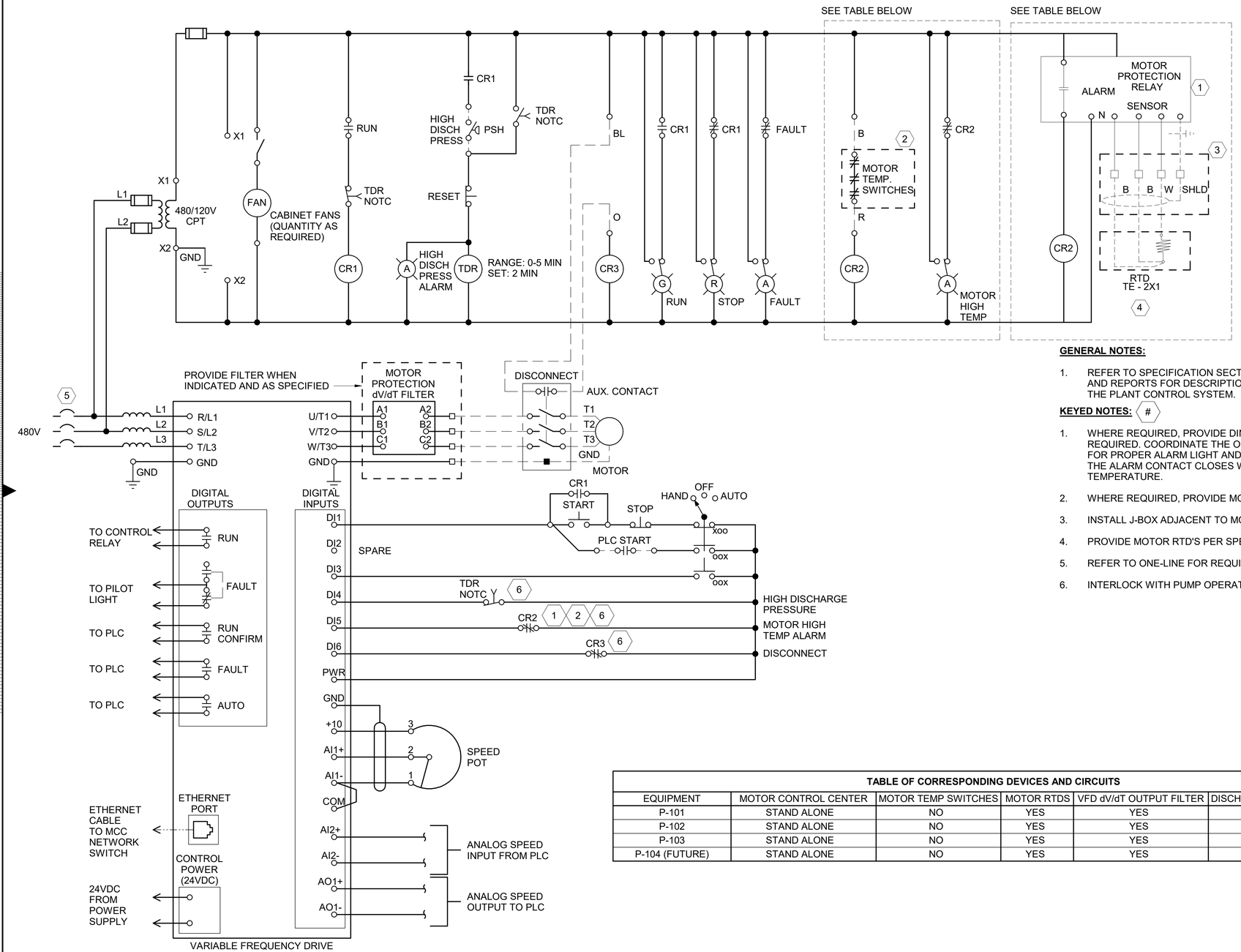

VFD SCHEMATIC

TABLE OF CORRESPONDING DEVICES AND CIRCUITS

EQUIPMENT	MOTOR CONTROL CENTER	MOTOR TEMP SWITCHES	MOTOR RTDS	VFD dV/dT OUTPUT FILTER	DISCHARGE PRESSURE SWITCH
P-101	STAND ALONE	NO	YES	YES	PS-101-H
P-102	STAND ALONE	NO	YES	YES	PS-102-H
P-103	STAND ALONE	NO	YES	YES	PS-103-H
P-104 (FUTURE)	STAND ALONE	NO	YES	YES	PS-104-H

GENERAL NOTES:

1. REFER TO SPECIFICATION SECTION 40 61 96 - PROCESS CONTROL SOFTWARE PROGRAMMING AND REPORTS FOR DESCRIPTION OF OPERATION AND I/O POINTS TO BE INTEGRATED INTO THE PLANT CONTROL SYSTEM.

KEYED NOTES: (#)

1. WHERE REQUIRED, PROVIDE DIN RAIL MOUNTED MOTOR PROTECTION RELAY. QUANTITY AS REQUIRED. COORDINATE THE OUTPUT RELAY CONTACT FUNCTIONS WITH RELAY SUPPLIED FOR PROPER ALARM LIGHT AND ALARM STATUS FUNCTION. INDICATED FUNCTION ASSUMES THE ALARM CONTACT CLOSES WITH POWER SUPPLIED AND OPENS ON PTC THERMISTOR HIGH TEMPERATURE.
2. WHERE REQUIRED, PROVIDE MOTOR TEMP SWITCHES, RELAY, AND PILOT LIGHT AS SHOWN.
3. INSTALL J-BOX ADJACENT TO MOTOR FOR TERMINATION OF MOTOR RTD'S.
4. PROVIDE MOTOR RTD'S PER SPECIFICATION 46 05 13.
5. REFER TO ONE-LINE FOR REQUIRED BREAKER SIZE.
6. INTERLOCK WITH PUMP OPERATION TO BE FUNCTIONAL IN BOTH HAND AND AUTO OPERATION.

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Burns & McDonnell Engineering Co. Inc

date: MAY 2025	detailed: A.BENSON
designed: M. HOPKINS	checked: V.PATWARI

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
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BROOMFIELD TANKS AND PUMP STATION

VFD SCHEMATIC

project: 135303	contract:
drawing: 1EP-620	rev.: 1
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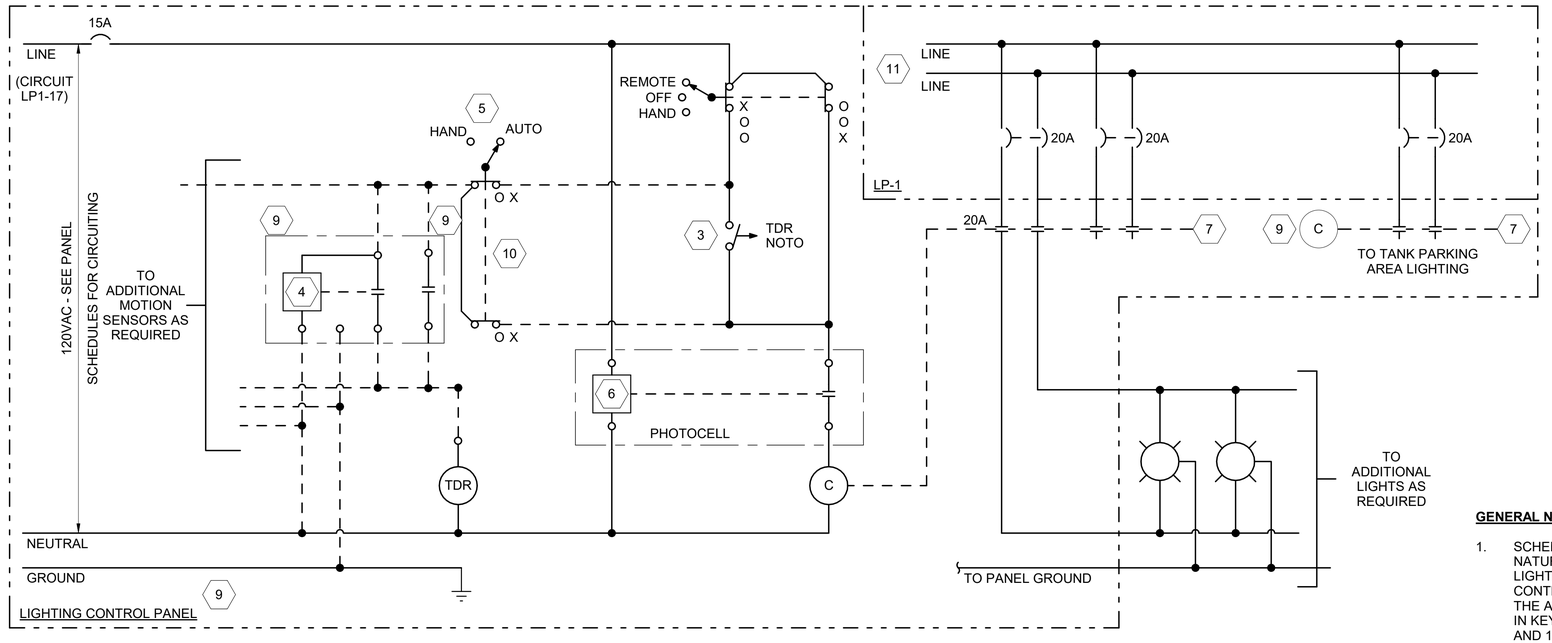
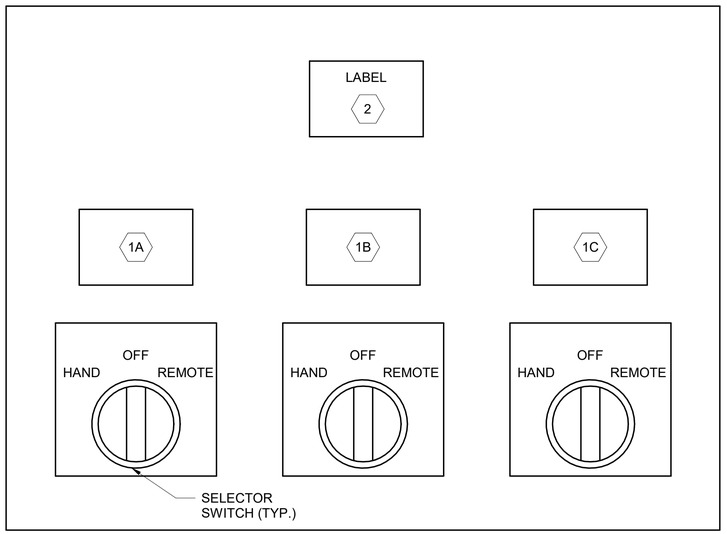


LIGHTING CONTROL DIAGRAM



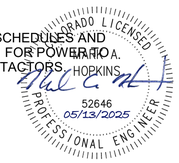
POTABLE LIGHTING CONTROL PANEL - FRONT

GENERAL NOTES:

1. SCHEMATIC SHOWN IS PARTIAL AND INTENDED TO BE GENERAL IN NATURE. PROVIDE PANEL AS SHOWN BELOW, POWERED BY LIGHTING PANEL CIRCUITS IDENTIFIED. ADDITIONAL LIGHTING CONTROL AND CONTACTORS TO BE PROVIDED AND POWERED FROM THE APPROPRIATE LIGHTING CIRCUIT FOR THE SYSTEMS IDENTIFIED IN KEYED NOTE 1 (POTABLE WATER LIGHTING CONTROL PANEL = 1A AND 1B). SEE KEYED NOTE 11.

KEYED NOTES: (#)

1. PROVIDE PANEL LABEL:
   A. POTABLE WATER TANK PERIMETER LIGHTING.
   B. TANK PARKING AREA LIGHTING
   C. PUMP STATION PARKING AREA LIGHTING
2. WARNING LABEL(S) AS REQUIRED.
3. SET TIME FOR ACTIVATION BY MOTION SENSORS AT 10 MINUTES.
4. MOTION SENSING CIRCUITRY BY MOTION SENSOR MANUFACTURER.
5. PEDESTAL MOUNTED HAND / AUTO SWITCH MOUNTED NEAR VEHICLE ENTRANCE AT TANKS. REFER TO DRAWING 2ES-101 FOR LOCATION.
6. PHOTOCELL UNIT. REFER TO 1EL-101 FOR LOCATION. PHOTOCELLS TO OVERIDE ALL CONTROL MODES.
7. PROVIDE MINIMUM 2 SPARE CONTACTOR POLES.
8. SET TIME FOR ACTIVATION BY PLC OUTPUT AT 60 MINUTES.
9. SCHEMATIC SHOWN IS FOR TANK PERIMETER LIGHTING SYSTEM. PROVIDE SEPARATE CONTROL CIRCUITS AND CONTACTORS IN LIGHTING CONTROL PANEL FOR TANK PERIMETER LIGHTING, TANK PARKING AREA LIGHTING, AND PUMP STATION PARKING AREA LIGHTING SYSTEMS. UTILIZE OUTPUT CONTACT FROM PLC PANEL INSTEAD OF MOTION SENSORS FOR THE "TANK PARKING AREA LIGHTING" PANEL. SEE CONNECTION DIAGRAM FOR JY-196E-ON.
10. PER SHEET 2ES-101, PROVIDE SEPARATE SWITCHES FOR SYSTEMS IDENTIFIED IN KEYED NOTE 1.
11. REFER TO LIGHTING PANEL SCHEDULES AND SHEETS 1ES-101 AND 2ES-101 FOR POWER TO APPROPRIATE LIGHTING CONTACTORS.



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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

LIGHTING CONTROL SCHEMATIC

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ELECTRICAL EQUIPMENT	VOLTAGE (Y/V)	PHASE	WIRE	MAIN BUS (A)	MAIN BREAKER	MOUNTING	LOCATION	NEMA RATING	SHORT CIRCUIT (KAIC)	FED VIA
SWBD-1A, SWBD-1B, MCC-1A, MCC-1B	480	3	3	4000	4000	HOUSEKEEPING PAD	INDOORS	NEMA 12	65	TX-40100

LOAD DESCRIPTION	PHASE	RPM	ENCLOSURE	HP	VOLTS	CURRENT	KVA	LOAD TYPE	CONTINUOUS/ INTERMITTENT/ SPARE	STARTER TYPE	DEMAND FACTOR	DEMAND KVA
P-101	3	1800		300	460	361.0	287.6	M	C	VFD	100%	287.6
P-102	3	1800		300	460	361.0	287.6	M	C	VFD	100%	287.6
P-103	3	1800		300	460	361.0	287.6	M	C	VFD	100%	287.6
P-104	3	1800		300	460	361.0	287.6	M	C	VFD	0%	0.0
RTU-181	3					43.4	36.1	B	C	FVNR	100%	36.1
RTU-182	3					60.3	50.1	B	C	FEEDER	100%	50.1
PP1	3	-		-	480	60.0	49.9	F	C	FEEDER	100%	49.9
FAST CHARGER #1	3	-		-	480	60.0	312.5	B	I	FEEDER	100%	312.5
FAST CHARGER #2	3	-		-	480	60.0	312.5	B	I	FEEDER	100%	312.5
XFMR-1/LP1	3	-		-	480	54.1	45.0	F	C	FEEDER	100%	45.0
ACTIVE HARMONIC FILTER (300A CORRECTION)	3					0.0	0.0	B	C		100%	0.0
ACTIVE HARMONIC FILTER (300A CORRECTION)	3					0.0	0.0	B	C		100%	0.0

* G = GASKETED

LOAD TYPES:
M = MOTOR C = CONTINUOUS
F = FEEDER I = INTERMITTENT
B = BRANCH S = STANDBY

TOTAL CONNECTED KVA:	1956.5	DEMAND (KVA):	1668.9
TOTAL CONNECTED AMPS:	1781.8	FEEDER CALC NEC 215 (KVA):	1929.9
		FEEDER CALC NEC 430 (KVA):	1786.1
MIN BUS SIZE:	2321.3	TOTAL FEEDER AMPS (A):	2321.3
BUS SIZE:	2500	TRANSFORMER SIZE:	2000
MAXIMUM FAULT CURRENT (Ka):	50242.8	TRANSFORMER FLA:	2405.6

GENERAL NOTE:

1. PROVIDE NEC REQUIRED WIRE SIZES ACCORDING TO OVERCURRENT PROTECTION DEVICE RATINGS.

PANELBOARD:	PP1	MAIN BUS:	225A		MAIN BREAKER/MLO:	MLO
VOLTS:	480V	PHASE:	3		SYM. A.I.C. MIN.:	65K AIC
FED FROM:	SWBD-1B	WIRE:	3		ENCLOSURE:	NEMA 1
LOCATION:	SWBD-1B				MOUNTING:	SWITCHBOARD

DESCRIPTION	NO. POLES	TRIP AMPS	POLE NO.		LOAD - VA A	LOAD - VA B	LOAD - VA C		POLE NO.	TRIP AMPS	NO. POLES	DESCRIPTION
BRIDGE CRANE	3	25	1	<--	5000.00				2	15	3	GARAGE DOOR
				-->	333.00							
			3	<--		5000.00			4			
				-->		333.00						
			5	<--			5000.00		6			
				-->			333.00					
VALVE BV-135	3	15	7	<--	250.00				8			SPACE
				-->	0.00							
			9	<--		250.00			10			
				-->		0.00						
			11	<--			250.00		12			
				-->			0.00					
SPARE	3	15	13	<--	0.00				14			SPACE
				-->	0.00							
			15	<--		0.00			16			
				-->		0.00						
			17	<--			0.00		18			
				-->			0.00					
SPARE	3	15	19	<--	0.00				20			SPACE
				-->	0.00							
			21	<--		0.00			22			
				-->		0.00						
			23	<--			0.00		24			
				-->			0.00					
SPACE			25	<--	0.00				26			SPACE
				-->	0.00							
			27	<--		0.00			28			
				-->		0.00						
			29	<--			0.00		30			
				-->			0.00					
SPARE	3	25	31	<--	0.00				32			SPACE
				-->	0.00							
			33	<--		0.00			34			
				-->		0.00						
			35	<--			0.00		36			
				-->			0.00					
SPARE	3	15	37	<--	0.00				38			SPD
				-->	0.00							
			39	<--		0.00			40	30	3	
				-->		0.00						
			41	<--			0.00		42			
				-->			0.00					

Total kVA Per Phase Load (Including Existing) =	5.58	5.58	5.58	Demand Factor	100.0%
Unbalance load =	0.0%	0.0%	0.0%		
Maximum Unbalance load =	0.0%	0.0%	0.0%		

Total Connected Load		Est. Demand Load	
16.75 kVA	20.15 A	16.75 kVA	20.15 A

PANELBOARD:	LP1	MAIN BUS:	150 A		MAIN BREAKER/MLO:	100 A
VOLTS:	208Y/120V	PHASE:	3		SYM. A.I.C. MIN.:	22K AIC
FED FROM:	XFMR-1	WIRE:	4		ENCLOSURE:	NEMA 1
LOCATION:	SWBD-1B				MOUNTING:	SWITCHBOARD

DESCRIPTION	NO. POLES	TRIP AMPS	POLE NO.		LOAD - VA A	LOAD - VA B	LOAD - VA C		POLE NO.	TRIP AMPS	NO. POLES	DESCRIPTION
PUMP STATION CONTROL PANEL	1	20	1	<--	1800.00				2	20	1	ELECT./CONTROL ROOM LIGHTS
				-->	650.00							
ACCESS CONTROL PANEL	1	20	3	<--		1500.00			4	20	1	PUMP ROOM LIGHTS
				-->		1900.00						
SUMP PUMP CONTORL PANEL	2	20	5	<--			1500.00		6	20	1	EXTERIOR MOUNTED LIGHTS
				-->			600.00					
			7	<--	1500.00				8	20	1	SPARE
				-->	0.00							
GENERATOR LOAD CENTER	2	60	9	<--		5000.00			10	20	1	SPARE
				-->		0.00						
			11	<--			5000.00		12	20	1	EXTERIOR RECEPTACLES
				-->			360.00					
SPARE	1	15	13	<--	0.00				14	20	1	TANK RECEPTACLES
				-->	360.00							
SPARE	1	15	15	<--		0.00			16	15	2	PUMP STATION PARKING AREA & SIGNAGE LIGHTING
				-->		500.00						
LIGHTING CONTROL PANEL	1	15	17	<--			500.00		18			
				-->			500.00					
TANK PERIMETER LIGHTING	2	20	19	<--	493.50				20	20	2	TANK PARKING AREA LIGHTING
				-->	500.00							
			21	<--		493.50			22			
				-->		500.00						
TANK PERIMETER LIGHTING	2	20	23	<--			458.25		24	15	1	ROOF RECPTACLES
				-->			360.00					
			25	<--	458.25				26	15	1	TANK MIXER (VFD-MXR106)
				-->	1000.00							
TANK MIXER (VFD-MXR 105)	1	20	27	<--		1000.00			28		1	
				-->		0.00						
	1		29	<--			0.00		30	20	1	ELECTRICAL/CONTROL ROOM RECEPTACLES
				-->			720.00					
	1		31	<--	0.00				32	20	1	PUMP ROOM RECEPTACLES
				-->	720.00							
	1		33	<--		0.00			34		1	
				-->		0.00						
	1		35	<--			0.00		36		1	
				-->			0.00					
	1		37	<--	0.00				38			
				-->	0.00							
	1		39	<--		0.00			40	30	3	SPD
				-->		0.00						
	1		41	<--			0.00		42			
				-->			0.00					

Total kVA Per Phase Load (Including Existing) =	7.48	10.89	10.00	Demand Factor	100.0%
Unbalance load =	20.9%	15.2%	5.7%		
Maximum Unbalance load =	20.9%				

Total Connected Load		Est. Demand Load	
28.37 kVA	78.76 A	28.37 kVA	78.76 A

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CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
POTABLE WATER
LOAD CALCULATIONS AND PANEL SCHEDULES

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DUCTBANK	FROM (FIELD)	TO	CABLE DESIGNATOR	NOTES
A	TANK PARKING/DRIVE LIGHTS	LP1	P5	NOTE 2, NOTE 6
	POTABLE WATER TANK PERIMETER LIGHTS	LP1	P3	NOTE 2, NOTE 6
	POTABLE WATER TANK PERIMETER LIGHTS	LP1	P3	NOTE 2, NOTE 6
	POTABLE WATER LIGHTING CONTROLS	POTABLE LIGHITING CONTROL PANEL	C8	NOTE 3
	LIGHTING CONTROLS (PEDESTAL)	POTABLE LIGHTING CONTROL PANEL	C12	NOTE 8
	MIXER (MXR-105)	VFD-MXR105	V5	NOTE 4
	MIXER (MXR-106)	VFD-MXR106	V5	NOTE 4
	MAN GATE CONTACT SWITCHES	PLC-100	C2	NOTE 5
	VEHICLE GATE CONTACT SWITCHES	PLC-100	C2	NOTE 5
	CARD ACCESS READER	CARD ACCESS PANEL	NOTE 6, 1" C	NOTE 5
	LS-105-H	PLC-100	C2	NOTE 5
	LS-106-H	PLC-100	C2	NOTE 5
	LIT-105	PLC-100	A1	NOTE 5
	LIT-106	PLC-100	A1	NOTE 5
	RECEPTACLES - POTABLE WATER TANKS	PANEL LP1	P11	NOTE 7
	SPARE - POWER HANDHOLE	POTABLE WATER ELECTRICAL ROOM	2" CONDUIT	
	SPARE - LV/CONTROLS HANDHOLE	POTABLE WATER ELECTRICAL ROOM	2" CONDUIT	

NOTES:

1. COORDINATE WITH CARD READER MANUFACTURER ON CABLE TYPE REQUIRED.
2. LIGHTING CIRCUITS MAY BE COMBINED INTO SINGLE CONDUIT.
3. LIGHTING CONTROL CIRCUITS MAY BE COMBINED INTO A SINGLE CONDUIT.
4. MIXER CIRCUITS MUST REMAIN IN DEDICATED CONDUITS.
5. LOW VOLTAGE INSTRUMENTATION AND CONTROLS CIRCUITS CAN BE COMBINED INTO A SINGLE CONDUIT.
6. COORDINATE CABLE REQUIREMENTS WITH CARD READER MANUFACTURER.
7. RECEPTACLE CIRCUITS MUST REMAIN IN DEDICATED CONDUITS.
8. TANK PERIMETER LIGHTING TO USE #4 AWG WIRE SIZE FROM LIGHTING CONTROL PANEL LOCATED IN PUMP STATION BUILDING TO 4'x4' POWER HANDHOLE (HH6) LOCATED INSIDE TANK FENCED AREA. FOLLOW WIRE SIZE INDICATED ABOVE FROM HANDHOLE (HH6) TO LUMINAIRES. #12 WIRE.

GENERAL NOTES:

1. CONDUITS FROM ELECTRICAL ROOMS TO FIRST HANDHOLE, AND FROM FIRST HANDHOLE TO SECOND HANDHOLE TO BE 2" DIA. CONDUIT SIZES ACCORDING TO ALPHANUMERIC DESIGNATOR TO BE USED FROM SECOND HANDHOLE TO FIELD EQUIPMENT.

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designed	**checked**
M. HOPKINS	V.PATWARI

CITY AND COUNTY OF BROOMFIELD • COLORADO •

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

DUCTBANK SCHEDULE

project	contract
135303	

drawing **1EP-632** — rev. **1**

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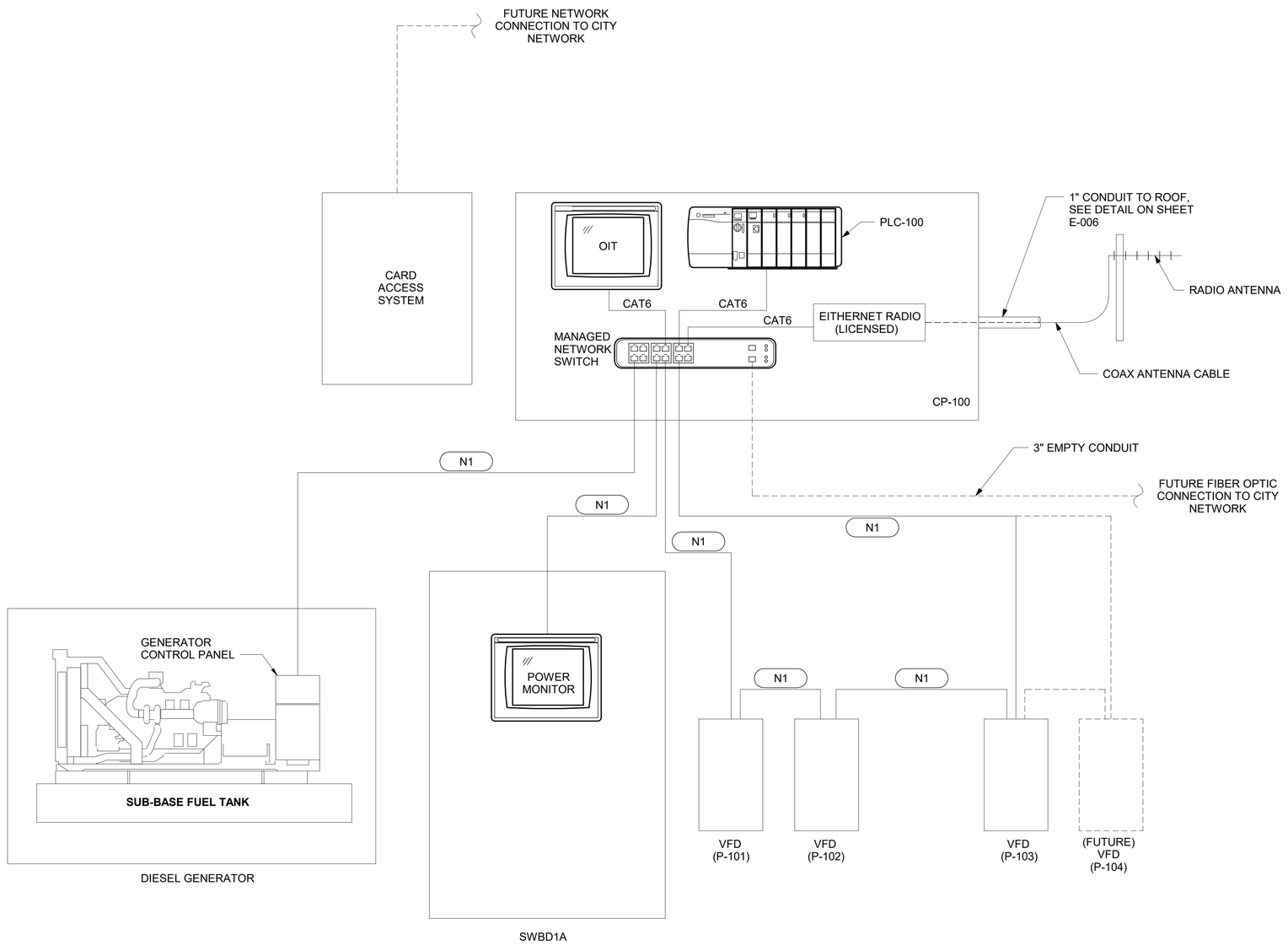

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City and County Engineer (or Designee) Date

N

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co. Inc

date	detailed
MAY 2025	A.BENSON
designed	**checked**
M. HOPKINS	V.PATWARI

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

POTABLE WATER - NETWORK ARCHITECTURE

project	contract
135303	

drawing 1ET-600 — **rev.** 1

sheet of **sheets**

file

COLORADO LICENSED
MARK A. HOPKINS
52646
05/13/2025
PROFESSIONAL ENGINEER

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PROCESS SYMBOLS

- GLOBE VALVE
- GATE VALVE
- BUTTERFLY VALVE
- CHECK VALVE
- DUCK BILL CHECK VALVE
- PLUG VALVE
- 3-WAY VALVE
- PRESSURE AND VACUUM RELIEF VALVE
- PRESSURE RELIEF VALVE
- BALL VALVE
- DIAPHRAGM VALVE
- SLIDE GATE
- CORPORATION STOP
- AIR RELEASE VALVE
- AIR RELEASE AND VACUUM VALVE
- BP BACKFLOW PREVENTER
- DEMISTER
- STOP PLATE
- RUPTURE PLATE
- CALIBRATION COLUMN
- FLOW THROUGH CELL
- BUBBLE TRAP
- FLUME
- WEIR
- DIAPHRAGM SEAL
- ANNULAR SEAL
- DIFFUSER
- EJECTOR/EDUCTOR
- FLEXIBLE HOSE
- EXPANSION ELEMENT (JOINT)
- FLEXIBLE BALL JOINT
- BASKET TYPE STRAINER
- TEE TYPE STRAINER
- Y-TYPE STRAINER
- CONICAL STRAINER
- DUPLEX STRAINER
- PIPE WITH HEAT TRACE CABLE
- REDUCING TEE
- CONCENTRIC REDUCER
- ECCENTRIC REDUCER
- DISCHARGE ELBOW ASSEMBLY
- HOSE CONNECTION
- REMOVABLE PLUG
- REMOVABLE CAP
- WELDED CAP
- BF BLIND FLANGE
- CO CLEANOUT
- YH YARD HYDRANT
- AC AIR COCK
- WH WALL HYDRANT
- QUICK DISCONNECT COUPLING
- DRAIN
- PULSATION DAMPENER

MOTOR STARTER SYMBOLS

- VFD VARIABLE FREQUENCY DRIVE
- FVNR FULL VOLTAGE - NON-REVERSING
- FVR FULL VOLTAGE - REVERSING
- RVSS REDUCED VOLTAGE SOLID-STATE STARTER
- MOTOR

VALVE OPERATORS

- S SOLENOID
- PNEUMATIC
- M M MOTOR
- DIAPHRAGM
- CHAINWHEEL
- VANE

PROCESS EQUIPMENT

- PERISTALTIC PUMP
- DIAPHRAGM METERING PUMP (XXX)
- CENTRIFUGAL PUMP
- BLOWER
- GRINDER
- ROTARY LOBE PUMP
- SUBMERSIBLE PUMP
- AGITATOR/MIXER
- POSITIVE DISPLACEMENT BLOWER
- PROGRESSIVE CAVITY PUMP
- VERTICAL TURBINE PUMP
- CHEMICAL TOTE
- SCALE
- WETTING CONE
- STRAINER
- SEDIMENTATION BASIN
- AIR RECEIVER TANK
- ULTRAVIOLET DISINFECTION BANK
- COMPRESSOR
- DEWATERING DRUM OR SCREW PRESS
- SCREEN
- SURFACE AERATOR
- MEMBRANE FILTER
- SAFETY SHOWER/ EYE WASH STATION

INSTRUMENTATION SYMBOLS

- LEVEL TRANSMITTER
  WHERE * IS: R = RADAR
  U = ULTRASONIC
- GUIDED WAVE RADAR LEVEL TRANSMITTER
- FLOAT SWITCH
- ROTAMETER
- SIGHT FLOW INDICATOR
- AVERAGING PITOT TUBE FLOW ELEMENT
- TURBINE OR PROPELLER TYPE FLOW ELEMENT
- POSITIVE-DISPLACEMENT FLOW METER
- VORTEX FLOW SENSOR
- M MAGNETIC FLOWMETER
- SONIC FLOWMETER DOPPLER OR TRANSIT TIME
- THERMAL MASS FLOW METER

SELF-ACTUATED REGULATORS AND VALVES

- PRESSURE-REDUCING REGULATOR, SELF-CONTAINED, WITH HANDWHEEL ADJUSTABLE SET POINT
- PRESSURE-REDUCING REGULATOR WITH EXTERNAL PRESSURE TAP
- DIFFERENTIAL-PRESSURE-REDUCING REGULATOR WITH INTERNAL AND EXTERNAL PRESSURE TAP
- BACKPRESSURE REGULATOR, SELF CONTAINED
- BACKPRESSURE REGULATOR WITH EXTERNAL PRESSURE TAP
- PI PRESSURE-REDUCING REGULATOR WITH INTEGRAL OUTLET PRESSURE RELIEF VALVE AND OPTIONAL PRESSURE INDICATOR

P&IDs LINE TYPES AND EXAMPLES

- OPEN TROUGH
- DIRECTION OF FLOW
- SIGNAL CONNECTION
- CROSSOVER - NO CONNECTION
- X X BROKEN SIGNAL LINE WHERE X IS SAME DESTINATION NO.
- I CONTROL INTERLOCK
- 1 EXAMPLE SOMEWHERE OFF-SHEET REFERENCE, INCLUDING SHEET DESTINATION NO.

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BURNS McDONNELL
9191 S. JAMAICA STREET
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Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	J. DAVIS
designed by	**checked by**
M. HOPKINS	N. RACHELSON

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
LEGEND I P&ID

project	contract
135303	

drawing **0I-001** rev. **1**

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TAGGING SCHEME

EQUIPMENT TAG BN-BBB-XYZZ

BN	-	BUILDING NAME (MAY NOT ALWAYS BE REQUIRED)
BBBB	-	EQUIPMENT, INSTRUMENT, AND VALVE IDENTIFIERS. ASME AND ISA FUNCTIONAL DESIGNATIONS (ONE TO FOUR LETTERS)
X	-	PROCESS SYSTEM IDENTIFICATION (ONE DIGIT)
Y	-	PROCESS TRAIN IDENTIFICATION (ONE DIGIT)
ZZ	-	LOOP NUMBER - NUMBER TO CORRELATE PRIMARY AND FINAL CONTROL ELEMENTS, CONDUIT AND COMPONENTS. (ONE OR TWO DIGITS)

AS INDICATED ON THE DRAWINGS FOR INSTRUMENTS, CONTROL DEVICES:

PLANT IDENTIFIERS 'XX' IS NOT SHOWN BUT IMPLIED FOR ALL INSTRUMENT TAGS INDICATED ON THESE DRAWINGS

****	-	OPTIONAL INDICATORS MAY BE INCLUDED TO ADD CLARITY TO THE DRAWINGS.

ADDITIONAL CLARIFIERS

AS	-	ARSENIC
DISC	-	DISCONNECT AUX
ES	-	EMERGENCY STOP
FCL	-	FREE CHLORINE
FLT	-	FAULT
FOR*	-	FORWARD / OFF / REVERSE
FWD	-	FORWARD
JAM	-	JAM/HIGH CURRENT SENSED
H, HH	-	HIGH, HIGH-HIGH
HOA*	-	HAND / OFF / AUTO
L, LL	-	LOW, LOW-LOW
LOR*	-	LOCAL / OFF / REMOTE
LSR	-	LOCAL / STOP / REMOTE
ORP	-	OXIDATION REDUCTION POTENTIAL
OSC*	-	OPEN / STOP / CLOSE
pH	-	pH
PWR	-	POWER
REV	-	REVERSE
RC	-	RUN CONFIRM
RUN	-	RUN
SIL	-	SILENCE
SPD	-	SPEED
TCL	-	TOTAL CHLORINE
TURB	-	TURBIDITY

* INDICATORS MAY BE USED INDIVIDUALLY OR IN DIFFERENT COMBINATIONS

SYSTEM IDENTIFICATION (X)

1 _ _	-	POTABLE SYSTEM

PROCESS TRAIN IDENTIFICATION (Y)

_00	-	SYSTEM COMMON EQUIPMENT
_10	-	PUMP SUCTION
_20	-	PUMP DISCHARGE
_30	-	SYSTEM COMMON EQUIPMENT
_80	-	HEATING VENTILATION AND AIR CONDITIONS (HVAC)
_90	-	ELECTRICAL AND CONTROLS

VALVE IDENTIFIER (BBB)

ARV	-	AIR RELEASE VALVE
BP	-	BACKFLOW PREVENTER
FCV	-	FLOW CONTROL VALVE
PRV	-	PRESSURE REGULATING VALVE
SG	-	SLIDE GATE
SV	-	SOLENOID VALVE
V	-	VALVE (ALL TYPES)

EQUIPMENT IDENTIFIER (BBBB)

AC	-	AUR COMPRESSOR
B	-	BLOWER
CC	-	CALIBRATION COLUMN
CGD	-	COMBUSTIBLE GAS DETECTOR
CU	-	CONDENSING UNIT
DRY	-	DESICCANT DRYER
EF	-	EXHAUST FAN
F	-	FAN
FCU	-	FAN COIL UNIT
FLC	-	FLOCCULATOR
FLT	-	FILTER OR FAULT
FVNR	-	FULL VOLTAGE REVERSING
FVR	-	FULL VOLTAGE NON-REVERSING
G	-	GENERATOR
HTR	-	HEATER
IPS	-	INCLINED PLATE SETTLERS
LP	-	120VAC PANEL BOARD
LCP	-	LOCAL CONTROL PANEL
LV	-	LOUVER
M	-	MOTOR, ELECTRIC
MAU	-	MAKEUP AIR UNIT
MCC	-	MOTOR CONTROL CENTER
MXR	-	MIXER
P	-	PUMP
PP	-	480VAC PANEL BOARD
RTU	-	ROOF TOP UNIT
RVSS	-	REDUCED VOLTAGE SOLID-STATE (MOTOR STARTER)
SF	-	SUPPLY FAN
SC	-	SLUDGE COLLECTOR
SED	-	PLATE SETTLER
SKD	-	SKID EQUIPMENT
SWB	-	SWITCH BOARD
T	-	TANK OR BASIN
TS	-	TOTE SCALE
UH	-	UNIT HEATER
VFD	-	VARIABLE FREQUENCY DRIVE
XFMR		TRANSFORMER

PLC / RIO IDENTIFICATION

PLC-100	POTABLE PUMP STATION

P&IDs LINETYPES

- PROCESS LINE
- EXISTING PROCESS LINE
- FUTURE PROCESS LINE
- PROCESS HEAVY LINES
- HEAVY LINES
- MEDIUM LINES
- ELECTRICAL SIGNAL (ANALOG)
- ELECTRICAL SIGNAL (DISCRETE)
- ENCLOSURE BOUNDARY
- EQUIPMENT
- EQUIPMENT - INSTRUMENTS
- EQUIPMENT - VALVES
- MISCELLANEOUS
- MISCELLANEOUS LINE WORK
- NOTE
- NOTE - ITEMS
- ELECTRICAL (POWER)
- SOFTWARE, DATA LINK, OR BUS
- MANUFACTURER'S CABLE
- PNEUMATIC TUBING
- SKID / VENDOR BOUNDARY
- TEXT

INSTRUMENT IDENTIFIER (BBBB)

A__	-	ANALYZER
F__	-	FLOW
H__	-	MANUAL PUSH BUTTON OR SWITCH
I__	-	CURRENT
J__	-	POWER (DIGITAL COMMAND OR OUTPUT)
L__	-	LEVEL
M__	-	MOISTURE
P__	-	PRESSURE
S__	-	SPEED
T__	-	TEMP
V__	-	VOLTAGE
V__	-	VIBRATION
W__	-	TORQUE OR WEIGHT
X__	-	MISCELLANEOUS OR COMMON
Y__	-	EVENT
Z__	-	POSITION
_A_	-	ALARM
_B_	-	BUTTON
_C_	-	CONTROL (ANALOG DEMAND)
_D_	-	DIFFERENTIAL
_E_	-	PROBE OR DIRECT MEASUREMENT ELEMENT
_G_	-	GAUGE
_I_	-	INDICATOR
_Q_	-	TOTALIZER
_S_	-	SWITCH OR SETPOINT
_T_	-	TRANSMITTER (ANALOG FEEDBACK)
_Y_	-	RELAY (IF DIGITAL) OR CALCULATION (IF ANALOG)
_ _I	-	INDICATION (ANALOG FEEDBACK)
_ _T	-	TRANSMITTER (ANALOG FEEDBACK)

INSTRUMENT DEVICE AND FUNCTION SYMBOLS

DISPLAY OR CONTROL	DEVICES (INSTRUMENTS, SELECTOR SWITCHES, ETC.)	PHYSICAL STATUS INDICATION LIGHT MOUNTED ON PANEL	ACCESSABILITY	
*** BBBB XYZZ PPPP	*** BBBB XYZZ PWR	*** BBBB XYZZ	ACCESSIBLE IN FIELD	FIELD MOUNTED (INSTRUMENTS, VALVES, ETC.)
*** BBBB XYZZ PPPP	*** BBBB XYZZ PWR	*** BBBB XYZZ	ACCESSIBLE TO OPERATOR	MAIN CONTROL ROOM (HMI), OR CONTROL PANEL (OIT)
*** BBBB XYZZ PPPP	*** BBBB XYZZ PWR	*** BBBB XYZZ	INSIDE OR BEHIND PANEL DOOR	
*** BBBB XYZZ PPPP	*** BBBB XYZZ PWR	*** BBBB XYZZ	ACCESSIBLE TO OPERATOR	REMOTE/LOCAL CONTROL PANEL (OIT), MOTOR CONTROL CENTER,VFDS, ETC.
*** BBBB XYZZ PPPP	*** BBBB XYZZ PWR	*** BBBB XYZZ	INSIDE OR BEHIND PANEL DOOR	

NOTES:
1. *** - REFER TO ADDITIONALCLARIFIERS IN "TAGGING SCHEME" TABLE ON I002
2. HMI AND OIT DISPLAY OR CONTROL, SYSTEMS INTEGRATOR (SI) SHALL STORE POINTS INDICATED IN THE HISTORIAN AND MAKE AVAILABLE ACROSS THE SCADA NETWORK AND THROUGH SYSTEM GRAPHICS.
3. PPPP = PLC SUFFIX NAME
4. PWR = POWER REQUIREMENTS AS IDENTIFIED

GENERAL NOTES:

GENERAL NOTES
1. REFER TO THE CONTROL NARRATIVE SPECIFIED IN THE SECTION 40 91 60. FOR PROGRAMING OF THE EQUIPMENT INDICATED ON THE P&IDS.
2. WHERE USED, PLC XX INDICATES THE CONTROLLER FOR THE HARDWIRED INPUT TO SCADA SYSTEM. XX MAY USE MORE THAN TWO CHARACTERS.
3. PROGRAM COMPLETE TAG NUMBER FOR EACH HARD AND SOFT POINT, WITH PREFIX "WE-" FOR THE CITY TO KEEP THE TAGS SEPARATE FROM THE SOUTH END WATER TREATMENT PLANT.

KEY NOTES

KEY NOTES:
1. AN "A" IN THE TAG IDENTIFIER MEANS THE POINT IS PROGRAMMED AS AN ALARM, DISPLAYING ON THE GRAPHICS AND ON THE SYSTEM ALARM SCREENS. ALARM STATE SHALL BE AS DEFINED IN THE I/O LIST.

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MARK A. HOPKINS
52646
05/08/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date: MAY 2025	detailed by: J. DAVIS
designed by: M. HOPKINS	checked by: N. RACHELSON

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
LEGEND II P&ID

project: 135303	contract:
drawing: **0I-002**	rev: **1**
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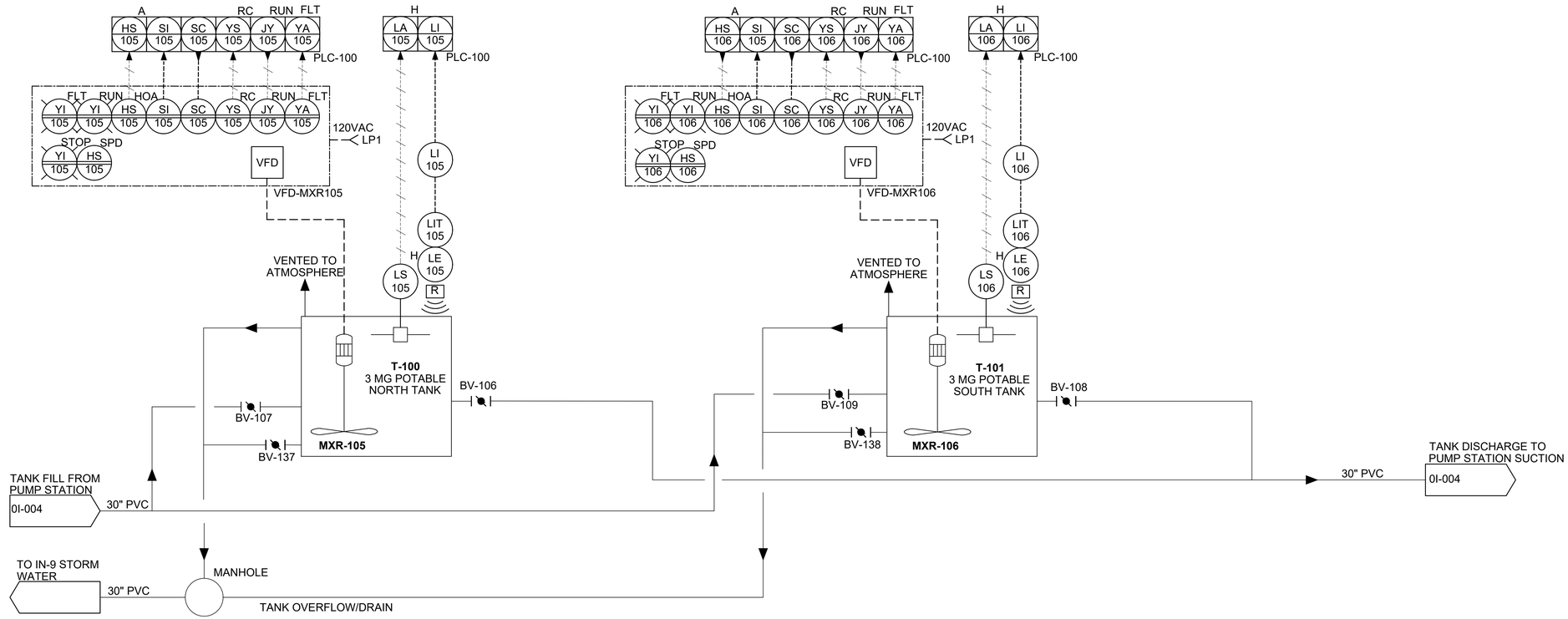

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CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
POTABLE TANK P&ID

project	contract
135303	

drawing **0I-003** — rev. **1**

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20" DISTRIBUTION EXISTING
BV-150
20" DISTRIBUTION EXISTING
BV-151
20" PVC
BV-133
24" DISTRIBUTION EXISTING
BV-152
24" DISTRIBUTION EXISTING
BV-153
24" PVC
BV-139
30" PVC
VALVE VAULT PW-01
BV-132
BV-103
BV-102
POTABLE PUMP STATION DISCHARGE
0I-005
30" PVC
OC REM OC FLT
JY 135 HS 135 ZS 135 YA 135
PLC-100
OSC OC LOR OC FLT
HS 135 JY 135 HS 135 ZS 135 YA 135
M
480VAC PP1
BV-135
OC
ZS 100
PLC-100
OC
ZS 100
FCV-100 20"
BV-136
30" PVC
TO POTABLE WATER TANKS
0I-003
RC RUN FLT A H H
YS 101 JY 101 YA 101 HS 101 SC 101 SI 101 TA 101 PA 101
PLC-100
FLT RC RC RUN FLT HOA
YI 101 YI 101 YS 101 JY 101 YA 101 HS 101 SC 101 SI 101
STOP SPD
YI 101 HS 101
VFD
480VAC MCC1A
VFD-P101
RC RUN FLT A H H
YS 102 JY 102 YA 102 HS 102 SC 102 SI 102 TA 102 PA 102
PLC-100
FLT RC RC RUN FLT HOA
YI 102 YI 102 YS 102 JY 102 YA 102 HS 102 SC 102 SI 102
STOP SPD
YI 102 HS 102
VFD
480VAC MCC1A
VFD-P102
DISCHARGE CONTINUED
30" DIP
0I-005
PI 110
PLC-100
PIT 110
OC
ZS 134
PLC-100
OC
ZS 134
30" DIP
BV-112
FCV-134 16"
16" DIP
30" DIP BV-111
BV-122
CV-121
16" DIP
PI 101
PS 101
H
TE 101
P-101
BV-113
18" DIP
BV-124
CV-123
16" DIP
PI 102
PS 102
H
TE 102
P-102
BV-114
18" DIP
FROM POTABLE TANKS
0I-003
30" PVC
SUCTION CONTINUED
30" DIP
0I-005
COND
AE 130A
PLC-100
CL2
AE 130B
PLC-100
TEMP PH
AE 130C AE 130C
PLC-100
AIT 130A
120VAC
AE 130A
COND.
AIT 130B
120VAC
AE 130B
CL2
AIT 130C
AE 130C
PH/TEMP.
CONT. RUN FLT HH
YS 131 YA 131 LA 131
PLC-100
CONT RUN FLT
YI 131 ZS 131 YA 131
208VAC LP1
FVNR
SPCP P-131
LS 131
L
LS 131
H
LS 131
HH
P-131
SUMP PUMP PIT
SANITARY DRAIN

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BROOMFIELD TANKS AND PUMP STATION
POTABLE PUMP STATION I P&ID

project	contract
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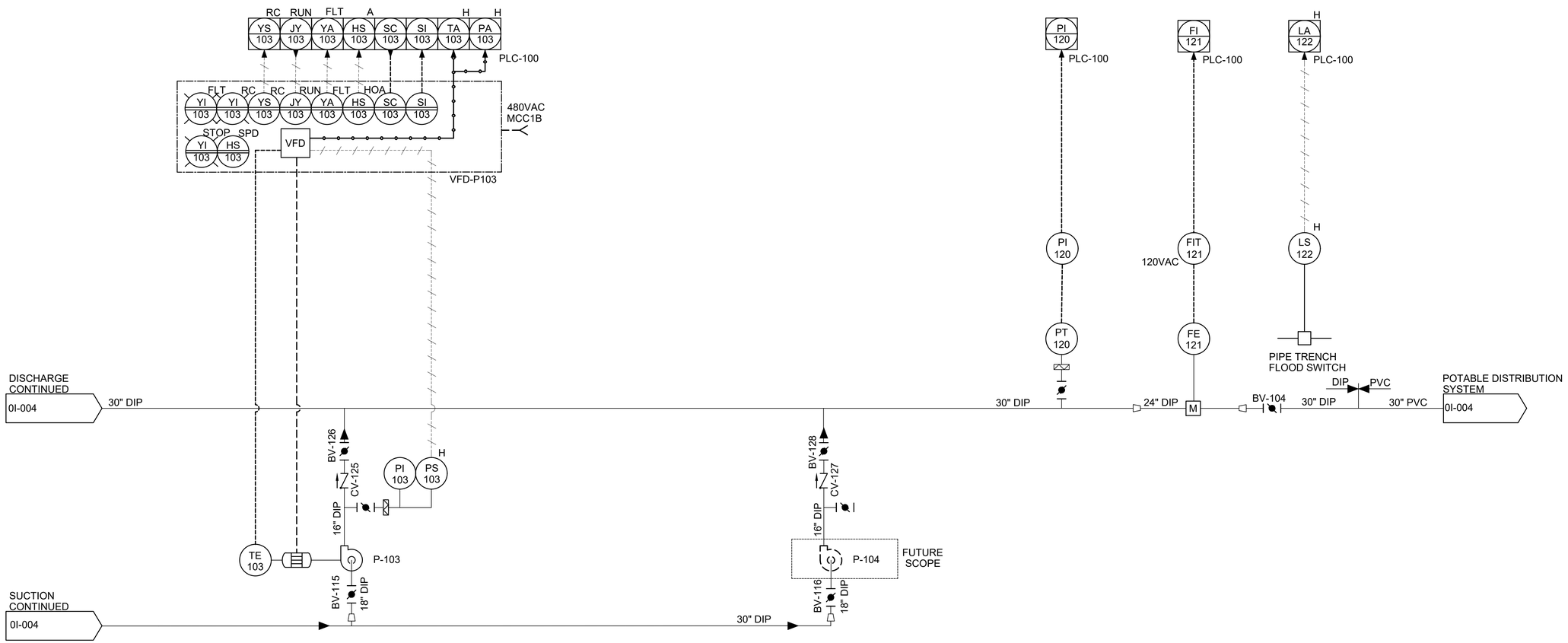

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BROOMFIELD TANKS AND PUMP STATION
POTABLE PUMP STATION II P&ID

project	contract
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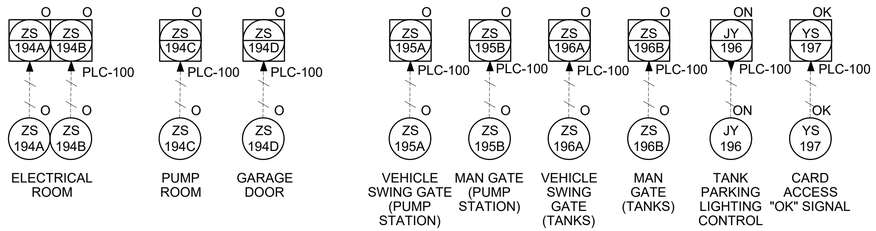
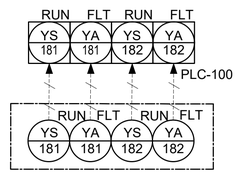
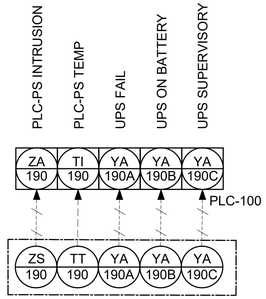


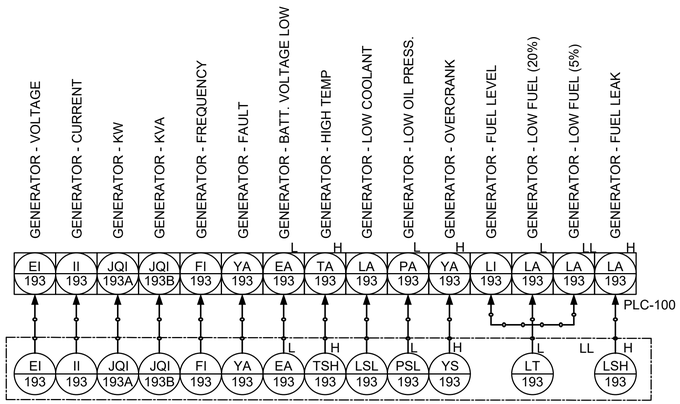
PUMP STATION DOOR CONTACTS & CARD ACCESS



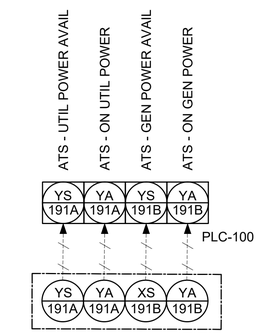
HVAC STATUS



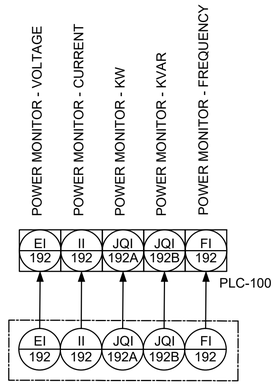
CONTROL PANEL & UPS STATUS



GENERATOR STATUS



AUTOMATIC TRANSFER CONTROLLER STATUS (SWBD-1A)



POWER MONITOR (SWBD-1A)

no.	date	by	ckd	description
0	01/28/25	JHD	NKR	ISSUED FOR CONSTRUCTION
1	05/06/25	JHD	NKR	ISSUED FOR CONSTRUCTION

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements.
THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."

City and County Engineer (or Designee) Date

COLORADO LICENSED
MARK A. HOPKINS
52646
05/08/2025
PROFESSIONAL ENGINEER

BURNS McDONNELL
9191 S. JAMAICA STREET
ENGLEWOOD, CO 80112
Burns & McDonnell Engineering Co, Inc

date	detailed by
MAY 2025	M. HOPKINS
designed by	**checked by**
M. HOPKINS	V. PATWARI

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
POTABLE WATER INSTRUMENTATION P&ID

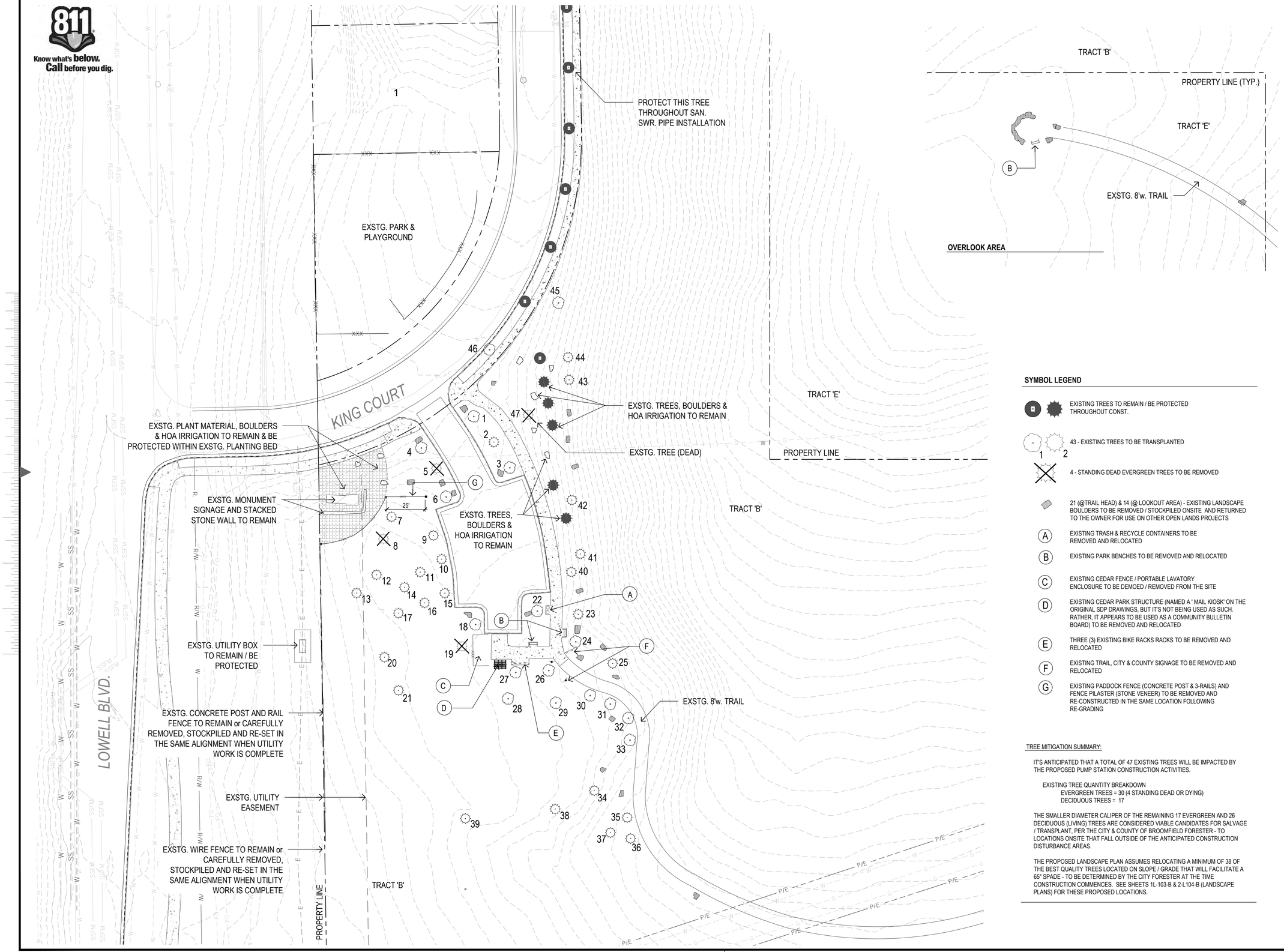
project	contract
135303	

drawing **0I-006** – rev. **1**

sheet of sheets
file

Scale For Microfilming
Millimeters
Inches

Z:\CLIENTS\WTR\BROOMFIELDCO\135303_TANKSPROJECT\DESIGN\CADD\PROC\PROD_DWGS\0I-006.DWG 4/14/2025 4:27 PM EWOODWARD



SYMBOL LEGEND

- EXISTING TREES TO REMAIN / BE PROTECTED THROUGHOUT CONST.
- 43 - EXISTING TREES TO BE TRANSPLANTED
- 4 - STANDING DEAD EVERGREEN TREES TO BE REMOVED
- 21 (@TRAIL HEAD) & 14 (@ LOOKOUT AREA) - EXISTING LANDSCAPE BOULDERS TO BE REMOVED / STOCKPILED ONSITE AND RETURNED TO THE OWNER FOR USE ON OTHER OPEN LANDS PROJECTS
- (A) EXISTING TRASH & RECYCLE CONTAINERS TO BE REMOVED AND RELOCATED
- (B) EXISTING PARK BENCHES TO BE REMOVED AND RELOCATED
- (C) EXISTING CEDAR FENCE / PORTABLE LAVATORY ENCLOSURE TO BE DEMOED / REMOVED FROM THE SITE
- (D) EXISTING CEDAR PARK STRUCTURE (NAMED A ' MAIL KIOSK' ON THE ORIGINAL SDP DRAWINGS, BUT IT'S NOT BEING USED AS SUCH. RATHER, IT APPEARS TO BE USED AS A COMMUNITY BULLETIN BOARD) TO BE REMOVED AND RELOCATED
- (E) THREE (3) EXISTING BIKE RACKS RACKS TO BE REMOVED AND RELOCATED
- (F) EXISTING TRAIL, CITY & COUNTY SIGNAGE TO BE REMOVED AND RELOCATED
- (G) EXISTING PADDOCK FENCE (CONCRETE POST & 3-RAILS) AND FENCE PILASTER (STONE VENEER) TO BE REMOVED AND RE-CONSTRUCTED IN THE SAME LOCATION FOLLOWING RE-GRADING

TREE MITIGATION SUMMARY:

IT'S ANTICIPATED THAT A TOTAL OF 47 EXISTING TREES WILL BE IMPACTED BY THE PROPOSED PUMP STATION CONSTRUCTION ACTIVITIES.

EXISTING TREE QUANTITY BREAKDOWN
EVERGREEN TREES = 30 (4 STANDING DEAD OR DYING)
DECIDUOUS TREES = 17

THE SMALLER DIAMETER CALIPER OF THE REMAINING 17 EVERGREEN AND 26 DECIDUOUS (LIVING) TREES ARE CONSIDERED VIABLE CANDIDATES FOR SALVAGE / TRANSPLANT, PER THE CITY & COUNTY OF BROOMFIELD FORESTER - TO LOCATIONS ONSITE THAT FALL OUTSIDE OF THE ANTICIPATED CONSTRUCTION DISTURBANCE AREAS.

THE PROPOSED LANDSCAPE PLAN ASSUMES RELOCATING A MINIMUM OF 38 OF THE BEST QUALITY TREES LOCATED ON SLOPE / GRADE THAT WILL FACILITATE A 65" SPADE - TO BE DETERMINED BY THE CITY FORESTER AT THE TIME CONSTRUCTION COMMENCES. SEE SHEETS 1L-103-B & 2-L104-B (LANDSCAPE PLANS) FOR THESE PROPOSED LOCATIONS.

no.	date	by	ckd	description
0	01/28/25	BHA	JAK	ISSUED FOR CONSTRUCTION
1	04/23/25	BHA	JAK	ISSUED FOR CONSTRUCTION

JEFFREY A. KROEGER LA-292 01/01/2006 Original Date of Licensure 04.23.25 STATE OF COLORADO LICENSED LANDSCAPE ARCHITECT

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements.
THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."

City and County Engineer (or Designee) Date

N

0' 30' 60'

NOTE: VIEWPORT SCALE IS HALF OF BAR SCALE FOR HALFSIZE

date	detailed
JANUARY 2025	
designed	checked
BHA	JAK

CITY AND COUNTY OF BROOMFIELD · COLORADO ·
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
EXISTING LANDSCAPE / SITE REMOVALS PLAN

project	contract
2245	

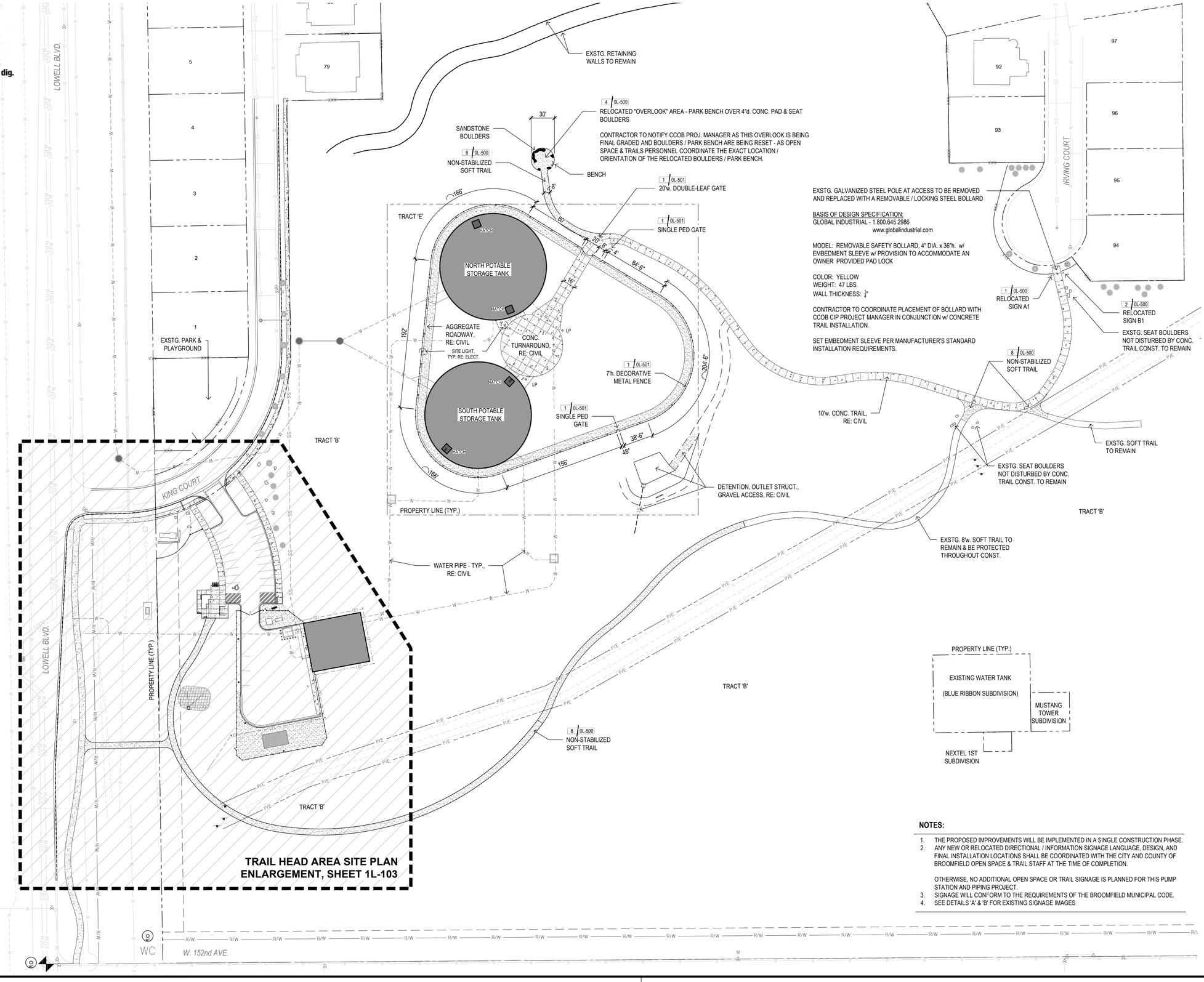
drawing **0L-100** – rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

Scale For Microfilming
Millimeters
Inches

Know what's below. Call before you dig.



NOTES:

1. THE PROPOSED IMPROVEMENTS WILL BE IMPLEMENTED IN A SINGLE CONSTRUCTION PHASE.
2. ANY NEW OR RELOCATED DIRECTIONAL / INFORMATION SIGNAGE LANGUAGE, DESIGN, AND FINAL INSTALLATION LOCATIONS SHALL BE COORDINATED WITH THE CITY AND COUNTY OF BROOMFIELD OPEN SPACE & TRAIL STAFF AT THE TIME OF COMPLETION.

   OTHERWISE, NO ADDITIONAL OPEN SPACE OR TRAIL SIGNAGE IS PLANNED FOR THIS PUMP STATION AND PIPING PROJECT.
3. SIGNAGE WILL CONFORM TO THE REQUIREMENTS OF THE BROOMFIELD MUNICIPAL CODE.
4. SEE DETAILS 'A' & 'B' FOR EXISTING SIGNAGE IMAGES

no.	date	by	ckd	description
0	01/28/25	BHA	JAK	ISSUED FOR CONSTRUCTION
1	04/23/25	BHA	JAK	ISSUED FOR CONSTRUCTION

JEFFREY A. KROEGER LA-292 01/01/2008 Original Date of Licensure 04.23.25 STATE OF COLORADO LICENSED LANDSCAPE ARCHITECT

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City and County Engineer (or Designee) Date

N

0' 60' 120'

NOTE: VIEWPORT SCALE IS HALF OF BAR SCALE FOR HALFSIZE

date	detailed
JANUARY 2025	
designed	checked
BHA	JAK

CITY AND COUNTY OF BROOMFIELD COLORADO

BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

OVERALL SITE PLAN

project 2245	contract
drawing 0L-101	rev. 1
sheet	of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

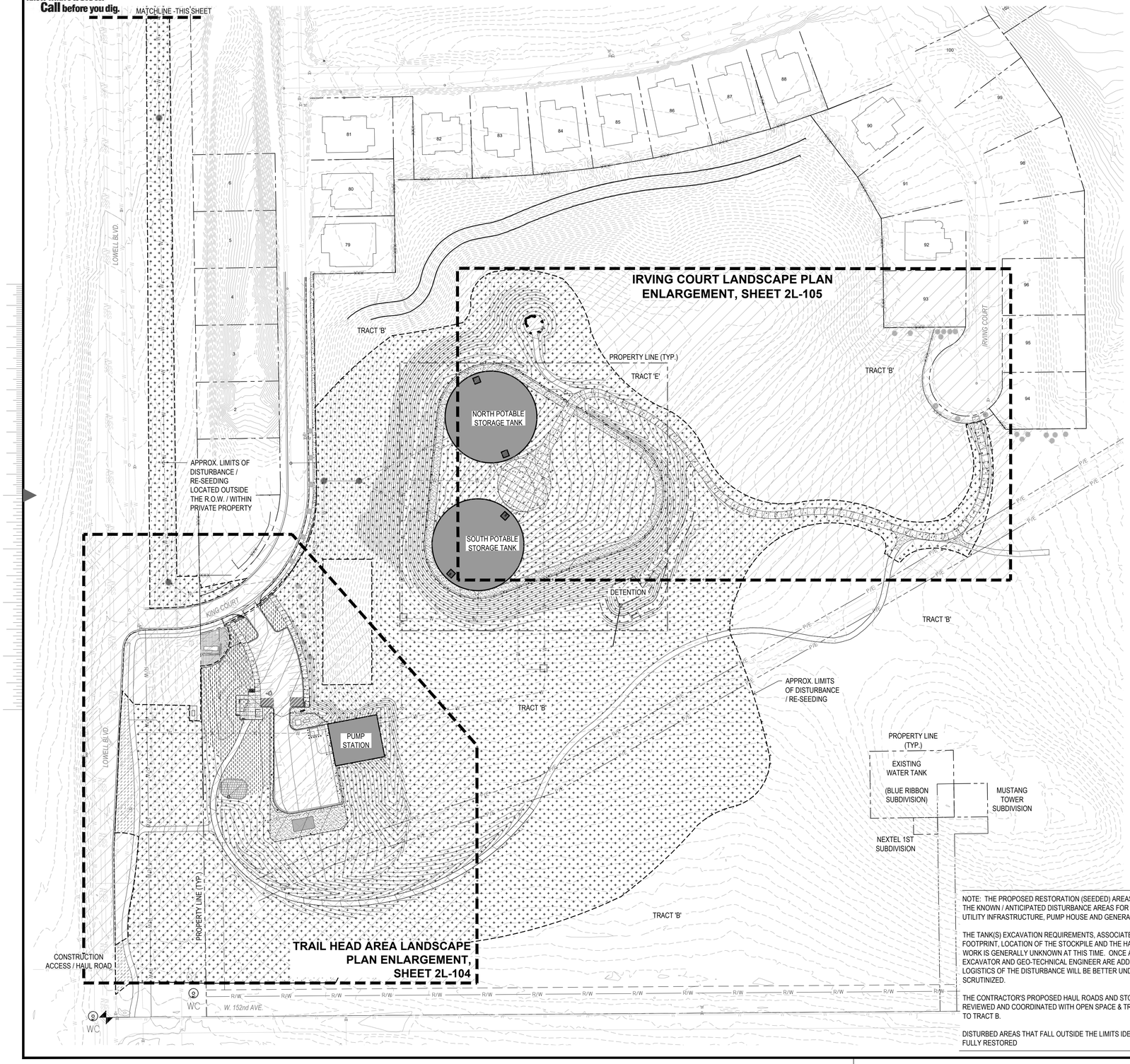
Millimeters

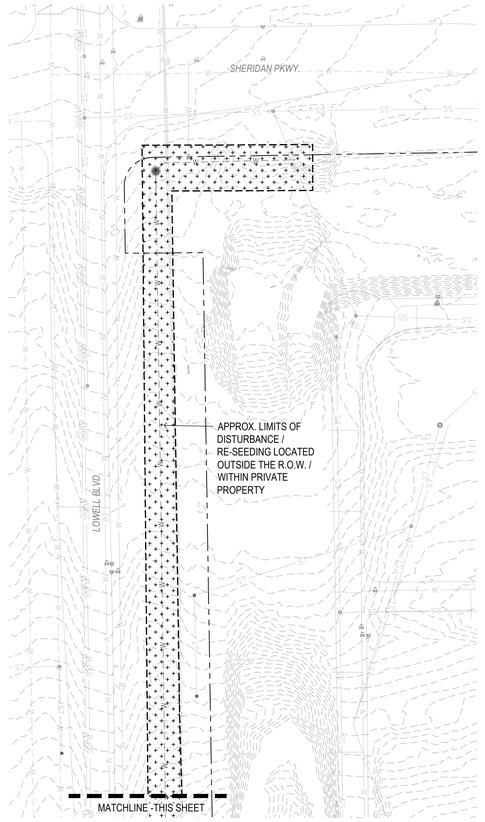
Scale For Microfilming

Inches

Know what's **below.** **Call** before you dig.

MATCHLINE -THIS SHEET





GENERAL NOTES:

1. AS INDICATED ON THE GRADING PLAN - APPROX. 12"d. OF EXISTING TOPSOIL WILL BE STRIPPED AND STOCKPILED. FOLLOWING TANK AND UTILITY INSTALLATION COMPLETION AND PRIOR TO RE-SEEDING / LANDSCAPING, THE STOCKPILED TOPSOIL WILL BE RE-DISTRIBUTED / COMPACTED THROUGHOUT DISTURBED AREAS
2. FINAL LANDSCAPING TO BE COORDINATED WITH THE CITY AND COUNTY OF BROOMFIELD PARKS AND OPEN SPACE & TRAILS STAFF
3. MINOR ADJUSTMENTS TO LANDSCAPING LOCATION AND MATERIAL MAY BE MADE IN COORDINATION WITH CCOB PARKS AND OPEN SPACE & TRAILS STAFF BASED ON FINAL FIELD CONDITIONS AND RECOMMENDATIONS FROM THE BUTTERFLY PAVILION.

GROUNDCOVER SYMBOL LEGEND

NON-STABILIZED 5"d. CRUSHER FINES - NO GEO-TEXTILE, COLOR TO MATCH EXSTG.

TYPE 1 SEED MIX - NON-IRRIGATED

NATIVE PRAIRIE MIX @ 36 LBS. PLS / ACRE

SAND BLUESTEM	3.5 LBS. PLS / ACRE
SIDEOATS GRAMA	3.0 LBS. PLS / ACRE
BUFFALOGRASS	4.0 LBS. PLS / ACRE
PRAIRIE SANDREED	3.0 LBS. PLS / ACRE
BLUE GRAMA	6.4 LBS. PLS / ACRE
SWITCHGRASS	4.0 LBS. PLS / ACRE
WESTERN WHEATGRASS	5.0 LBS. PLS / ACRE
LITTLE BLUESTEM	3.0 LBS. PLS / ACRE
SAND DROPSEEP	2.0 LBS. PLS / ACRE
NEEDLE & THREAD GRASS	2.0 LBS. PLS / ACRE

TYPE 2 SEED MIX - IRRIGATED

ENHANCED NATIVE MIX @ 42 LBS. PLS / ACRE

SIDEOATS GRAMA	4 LBS. PLS / ACRE
BLUE GRAMA	4 LBS. PLS / ACRE
BUFFALOGRASS	4 LBS. PLS / ACRE
SWITCHGRASS	6 LBS. PLS / ACRE
LITTLE BLUESTEM	6 LBS. PLS / ACRE
ALKALI SACATON	6 LBS. PLS / ACRE
SAND BLUESTEM	6 LBS. PLS / ACRE
SAND LOVEGRASS	3 LBS. PLS / ACRE
SAND DROPSEEP	3 LBS. PLS / ACRE

TYPE 3 SEED MIX - IRRIGATED

NO MOW MIX @ 1.5 PLS / ACRE

BLUE GRAMA - Bouteloua gracilis
SIDEOATS GRAMA - Bouteloua curtipendula
REGREEN - Triticum aestivum x Elytrigia elongata

NOTE: THE PROPOSED RESTORATION (SEEDED) AREAS INDICATED HERE REPRESENT THE KNOWN / ANTICIPATED DISTURBANCE AREAS FOR THE INSTALLATION OF THE UTILITY INFRASTRUCTURE, PUMP HOUSE AND GENERAL RE-GRADING OF THE PROJECT.

THE TANK(S) EXCAVATION REQUIREMENTS, ASSOCIATED TEMPORARY SOIL STOCKPILING FOOTPRINT, LOCATION OF THE STOCKPILE AND THE HAUL ROUTES TO FACILITATE THIS WORK IS GENERALLY UNKNOWN AT THIS TIME. ONCE A GENERAL CONTRACTOR, EXCAVATOR AND GEO-TECHNICAL ENGINEER ARE ADDED TO THE TEAM, THE LIMITS / LOGISTICS OF THE DISTURBANCE WILL BE BETTER UNDERSTOOD AND FURTHER SCRUTINIZED.

THE CONTRACTOR'S PROPOSED HAUL ROADS AND STOCKPILING LOCATIONS WILL BE REVIEWED AND COORDINATED WITH OPEN SPACE & TRAILS STAFF TO MINIMIZE IMPACTS TO TRACT B.

DISTURBED AREAS THAT FALL OUTSIDE THE LIMITS IDENTIFIED ON THIS PLAN WILL BE FULLY RESTORED

no.	date	by	ckd	description
0	01/28/25	BHA	JAK	ISSUED FOR CONSTRUCTION
1	04/23/25	BHA	JAK	ISSUED FOR CONSTRUCTION

JEFFREY A. KROEGER LA-292 01/01/2006 Original Date of Licensure 04.23.25 STATE OF COLORADO LICENSED LANDSCAPE ARCHITECT

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City and County Engineer (or Designee) Date

N

0' 80' 160'

NOTE: VIEWPORT SCALE IS HALF OF BAR SCALE FOR HALFSIZE

date	detailed
JANUARY 2025	
designed	checked
BHA	JAK

CITY AND COUNTY OF BROOMFIELD • COLORADO •
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
OVERALL GRADING & RESTORATION PLAN

project	contract
2245	

drawing **0L-102** rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

Scale For Microfilming
Millimeters
Inches

Know what's below. Call before you dig.

2 / 0L-501
SIGN DETAIL D, SHT. 0L-500
REST CONC. PADDOCK FENCE AND PILASTER

EXSTG. NEIGHBORHOOD MONUMENT SIGNAGE & ADJACENT LANDSCAPE PLANTINGS TO REMAIN & BE PROTECTED THROUGHOUT CONST.

EXSTG. CONC. PADDOCK FENCE w/ STONE PILASTERS TO REMAIN & BE PROTECTED THROUGHOUT CONST.

~15'
FIELD VERIFY EXSTG. POST SPACING

NEW 8'w. SIDEWALKS

SEE CIVIL FOR PARKING LOT DESIGN / LAYOUT

NEW SAN. SWR., RE: CIVIL

3 / 0L-500
RELOCATED CEDAR TRAIL KIOSK

1 / 0L-500
RELOCATED SIGN A1

RELOCATED BIKE RACKS (x3)- SURF. MNT.

VAN ACCESSIBLE PARKING STALL w/ RAMP, RE: CIVIL

5 / 0L-500 1 / 0L-500
NEW PORTABLE LAVATORY ENCLOSURE + RELOCATED SIGNS A2 & A3

SIDEWALK / ADA RAMP, RE: CIVIL

1 / 0L-501
SINGLE PED GATE

ADA RAMP

SANDSTONE FACILITY SIGNAGE, RE: CIVIL

RELOCATED PARK BENCHES (x2), SURF. MNT.

RELOCATED TRASH & RECYCLE CONTAINERS, SURF. MNT.

1 / 0L-500
RELOCATED SIGNS A4 & A5

2 / 0L-500
RELOCATED SIGN B1

8 / 0L-500
NON-STABILIZED SOFT TRAIL

1 / 0L-501
DOUBLE GATE

LIGHT POLE

ELECTRICAL EQUIPMENT

PUMP STATION

1 / 0L-501
7'h. DECORATIVE METAL FENCE, TYP.

NEW ASPHALT PAVING, RE: CIVIL

LIGHT POLE

LIGHT POLE

BACKUP GENERATOR

LIGHT POLE

1 / 0L-501
SINGLE PED GATE

EXSTG. 8'w. CONCRETE TRAIL

EXSTG. CONC. PADDOCK FENCE w/ STONE PILASTERS TO REMAIN & BE PROTECTED THROUGHOUT CONST.

RAIN GARDEN, RE: CIVIL

8 / 0L-500
NON-STABILIZED SOFT TRAIL

3 / 0L-501
WIRE FENCE (REPLACE / REINSTALL EXSTG. WIRE FENCE RUN DISTURBED BY CONST. ACTIVITIES)

UTILITY EASEMENT

NEW CULVERT w/ FES, RE: CIVIL

UTILITY EASEMENT

LOWELL BLVD.

Scale For Microfilming
Millimeters
Inches

no.	date	by	ckd	description
0	01/28/25	BHA	JAK	ISSUED FOR CONSTRUCTION
1	04/23/25	BHA	JAK	ISSUED FOR CONSTRUCTION

JEFFREY A. KROEGER
LA-292
01/01/2006
Original Date of Licensure
04.23.25
STATE OF COLORADO
LICENSED LANDSCAPE ARCHITECT

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N

0' 20' 40'
NOTE: VIEWPORT SCALE IS HALF OF BAR SCALE FOR HALFSIZE

date	detailed
JANUARY 2025	
designed	checked
BHA	JAK

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
TRAIL HEAD AREA
SITE PLAN ENLARGEMENT

project	contract
2245	

drawing **0L-103** rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

REFER TO CITY & COUNTY OF BROOMFIELD'S STANDARDS & SPECIFICATIONS DETAIL NUMBER 1000-30 FOR NON-STABILIZED SOFT TRAIL INSTALLATION DETAIL

8 NON-STABILIZED SOFT TRAIL - 8' or 10' WIDE, SEE PLAN

SCALE: NONE

REFER TO CITY & COUNTY OF BROOMFIELD'S STANDARDS & SPECIFICATIONS DETAILS NUMBER 1000-27 AND 1000-26 FOR DECIDUOUS AND EVERGREEN TREE INSTALLATION DETAIL

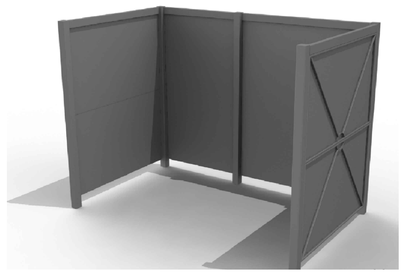
7 TREE PLANTINGS DETAIL

SCALE: NONE

REFER TO CITY & COUNTY OF BROOMFIELD'S STANDARDS & SPECIFICATIONS DETAIL NUMBER 1000-28 FOR SHRUB PLANTING INSTALLATION DETAIL

6 TREE PLANTINGS DETAIL

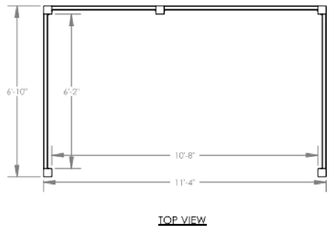
SCALE: NONE



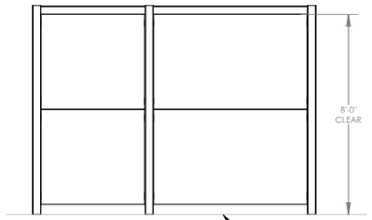
SPECIFICATIONS:
BASIS OF DESIGN:
POLIGON
www.poligon.com
616.399.1963

MODEL: PRV-CUSTOM PORTABLE LAVATORY ENCLOSURE - ROOFLESS
SIZE: 6'-10" DEEP x 11'-4" WIDE (FACE TO FACE)
COLOR: SINGLE COLOR SELECTED FROM THE MANUFACTURER'S STANDARD COLOR PALETTE.
MOUNTING: MANUFACTURER TO PROVIDE STAMPED STRUCTURAL DESIGN DRAWINGS FOR BASE PLATE MOUNT AND / OR FOOTING -DRILLED PIER, ETC.

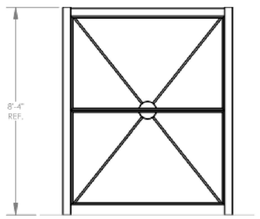
NOTES:
1. CONTRACTOR TO PROVIDE SHOP DRAWINGS FOR CCOB REVIEW / COLOR SELECTION, PRIOR TO ORDERING / DELIVERY TO THE JOB SITE.
2. NOTE LOCATION ON THE PLANS. "OPENING" TO FACE EAST / TOWARDS PUMP STATION.
3. COORDINATE FINAL LOCATION / RELATIONSHIP TO ADJACENT CONCRETE EDGE w/ OWNER'S REPRESENTATIVE PRIOR TO PLACING FOUNDATIONS.



TOP VIEW



FRONT VIEW



SIDE VIEW

5 PORTABLE LAVATORY ENCLOSURE

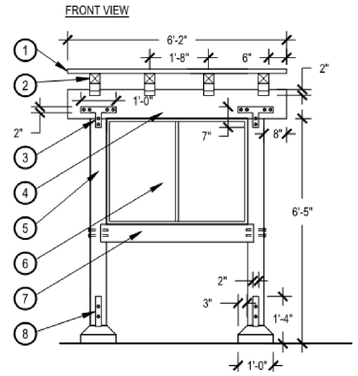
SCALE: NONE

NOTES:
1. IMAGE HERE IS AN ACTUAL PHOTO OF THE EXISTING INSTALLATION.
2. CONTRACTOR TO SALVAGED / STOCKPILE THE BOULDERS AND PARK BENCH AND RESET IN THIS SAME APPROXIMATE CONFIGURATION IN THE PROPOSED NEW LOCATION.
3. OPEN SPACE AND TRAILS HAS REQUESTED THAT THE FINAL / NEW PARK BENCH LOCATION BE "APPROVED" BY OPEN SPACE PERSONNEL PRIOR TO FINAL PLACEMENT - MAXIMIZING THE VIEW.
4. BENCH TO BE SURFACE MOUNTED TO A 4"D. (MINIMUM) CONCRETE SLAB. EXTEND SLAB A MIN, OF 6" BEYOND THE 4 SIDES OF THE BENCH.
5. REPLACE / RESET BOULDERS WITH TOP OF BOULDERS LOCATED BETWEEN 12" AND 16" ABOVE ADJACENT FINISH GRADE - AS SHOWN IN THIS IMAGE. TOP OF BOULDERS CAN VARY FROM BOULDER TO BOULDER.

4 EXISTING 'HILLTOP' OVERLOOK FURNISHINGS - TO BE RELOCATED

SCALE: NONE

FRONT VIEW



1. 2 X 4 ROUGH SAWN WOOD JOIST
2. 4 X 8 ROUGH SAWN WOOD RAFTER
3. BLACK METAL T-STRAP
4. 6 X 10 WOOD BEAM
5. 6 X 6 ROUGH SAWN WOOD POST
6. TRAIL SIGNAGE PER CITY AND COUNTY OF BROOMFIELD OPEN SPACE, PARKS, TRAILS SIGN PROGRAM.
7. 6X6 WOOD BEAM
8. 1/2" THICK X 2" WIDE X 22" LONG EMBEDDED IN CONCRETE FOOTING ON BOTH SIDES OF THE POST. PAINTED BLACK AND ATTACHED TO POST BY TWO, THROUGH BOLTED 5/8" BOLTS, PAINTED BLACK.

3 EXISTING CEDAR TRAIL KIOSK (TO BE SALVAGED AND RELOCATED-REINSTALLED)

SCALE: NONE

2 EXISTING DIRECTIONAL SIGN - TO BE RELOCATED

SCALE: NONE

A1

A2 & A3

A4 & A5

1 EXISTING INFORMATION SIGNAGE - TO BE RELOCATED

SCALE: NONE

no.	date	by	ckd	description
0	01/28/25	BHA	JAK	ISSUED FOR CONSTRUCTION
1	04/23/25	BHA	JAK	ISSUED FOR CONSTRUCTION

JEFFREY A. KROEGER
LA-292
01/01/2008
Original Date of Licensure
04.23.25
STATE OF COLORADO
REGISTERED LANDSCAPE ARCHITECT

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City and County Engineer (or Designee) Date

date	detailed
JANUARY 2025	
designed	checked
BHA	JAK

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
SITE DETAILS

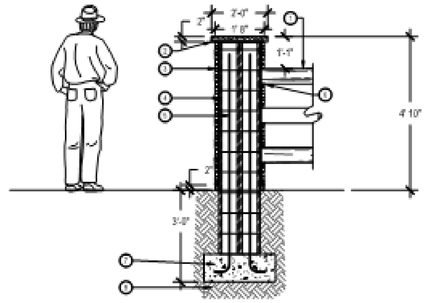
project	contract
2245	

drawing **0L-500** – rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

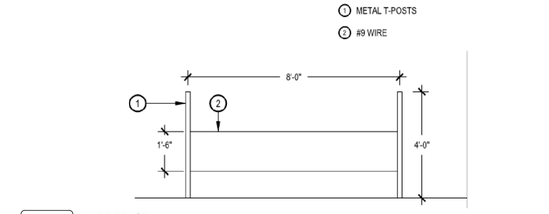
Millimeters
Inches
Scale For Microfilming



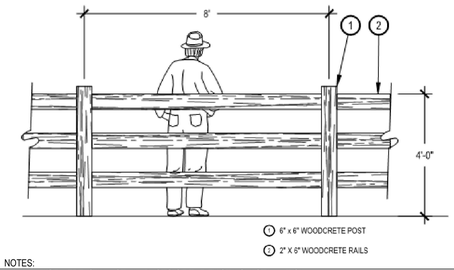
NOTES:
1. THIS DETAIL IS PROVIDED FOR REFERENCE AND COST PURPOSES ONLY. NORRIS DESIGN IS NOT RESPONSIBLE FOR STRUCTURAL DESIGN AND CALCULATIONS ASSOCIATED WITH THIS DETAIL. SHOP DRAWINGS SHOWING THE ACTUAL INSTALLATION AND ASSEMBLY SHALL BE PROVIDED FOR REVIEW AND APPROVAL.
2. REFER TO PLANS FOR COLUMN SPACING
3. MINIMUM 18" BETWEEN FENCE POST AND COLUMN
4. ALL CONCRETE SHALL HAVE A MINIMUM COMPRESSIVE STRENGTH OF 4,000 PSI AT 28 DAYS
5. MINIMUM BURY DEPTH ON ALL REBAR SHALL BE 2 1/2"
6. UNLESS OTHERWISE NOTED, ALL REBAR SHALL BE #4 SIZE.

A. PADDOCK FENCE
B. 22" LONG X 22" WIDTH X 2" HT. PRECAST CAP FROM SUNSET STONE (303-791-1233). COLOR TO MATCH EXISTING COLUMNS IN ANTHEM NEIGHBORHOOD
C. SUNSET STONE, LEDGE STONE "CHEYENNE" CULTURED STONE VENEER. GROUT COLOR TO MATCH EXISTING COLUMNS
D. 8"x8"x16" CMU BLOCK, FULLY GROUT CELLS IN TOP COURSE OF CMU BLOCK
E. #4 REBAR SPACED 8", TO BE ON CENTER OF CMU COLUMN, FULLY GROUT CELLS CONTAINING REBAR.
F. 2"X2" ANGLE IRON ATTACHED TO CMU AT BOTTOM OF FENCE RAILS
G. CONCRETE FOOTING REINFORCED WITH 3 - #4 REBAR CONTINUOUS FOR LENGTH. MINIMUM OVERLAP OF 18" AT SPLICES. MINIMUM BURY DEPTH OF REBAR SHALL BE 2 1/2".
H. SUBGRADE COMPACTED TO 95% STANDARD PROCTOR DENSITY.

2 PADDOCK FENCE PILASTER and PADDOCK FENCE
SCALE: NONE

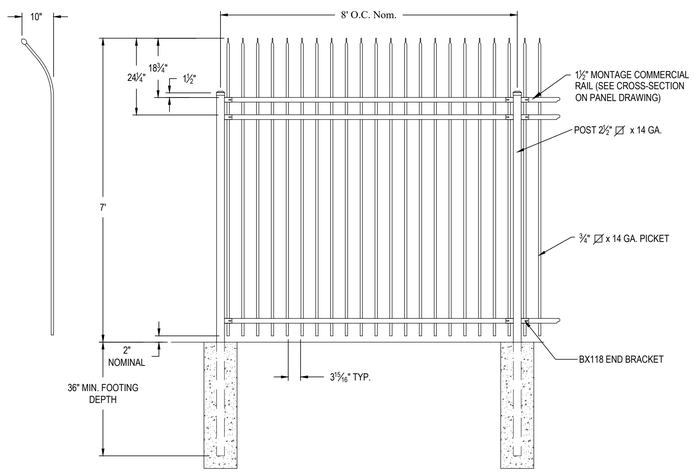


3 WIRE FENCE
SCALE: NONE

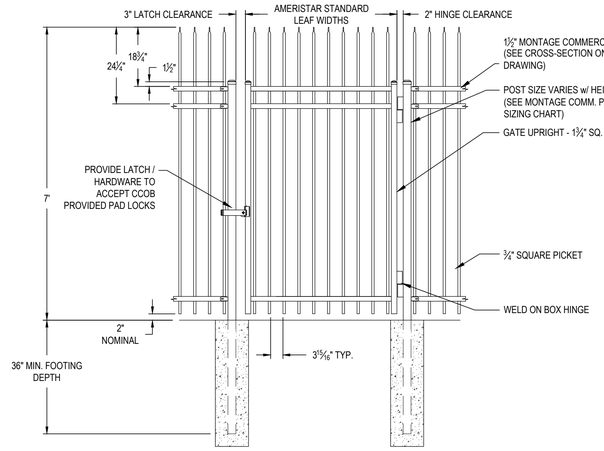


NOTES:
1. IMAGE HERE IS AN ACTUAL PHOTO OF THE EXISTING INSTALLATION.
2. CONTRACTOR TO SALVAGED / STOCKPILE THE BOULDERS AND PARK BENCH AND RESET IN THIS SAME APPROXIMATE CONFIGURATION IN THE PROPOSED NEW LOCATION.
3. OPEN SPACE AND TRAILS HAS REQUESTED THAT THE FINAL / NEW PARK BENCH LOCATION BE "APPROVED" BY OPEN SPACE PERSONNEL PRIOR TO FINAL PLACEMENT - MAXIMIZING THE VIEW.
4. BENCH TO BE SURFACE MOUNTED TO A 4"D. (MINIMUM) CONCRETE SLAB. EXTEND SLAB A MIN. OF 6" BEYOND THE 4 SIDES OF THE BENCH.
5. REPLACE / RESET BOULDERS WITH TOP OF BOULDERS LOCATED BETWEEN 12" AND 16" ABOVE ADJACENT FINISH GRADE - AS SHOWN IN THIS IMAGE. TOP OF BOULDERS CAN VARY FROM BOULDER TO BOULDER.

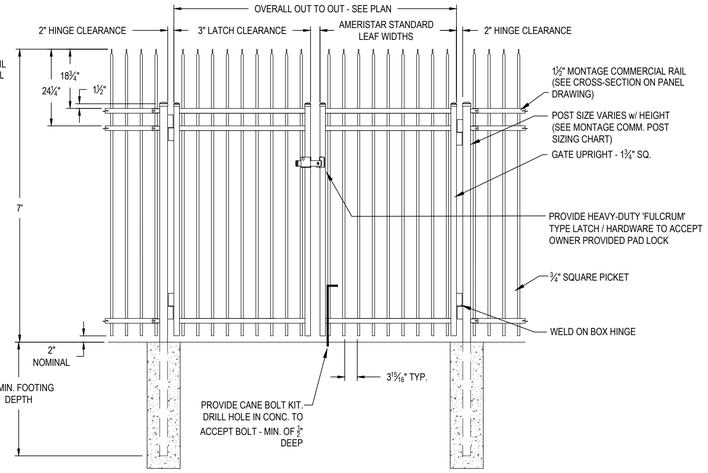
NOTES:
1. POST SIZE DEPENDS ON FENCE HEIGHT, WEIGHT AND WIND LOADS. SEE MONTAGE COMMERCIAL SPECIFICATIONS FOR POST SIZING CHART.
2. SEE AMERISTAR GATE TABLE FOR STANDARD OUT TO OUTS. CUSTOM GATE OPENINGS AVAILABLE FOR SPECIAL OUT TO OUT / LEAF WIDTHS.
3. ADDITIONAL STYLES OF GATE HARDWARE ARE AVAILABLE ON REQUEST - WHICH COULD CHANGE THE LATCH & HINGE CLEARANCE.
4. A FOURTH RAIL IS NOT REQUIRED.



SINGLE FENCE PANEL



SINGLE PED GATE



DOUBLE LEAF GATE

1 7'h. AMERISTAR - MONTAGE COMMERCIAL STRENGTH, WELDED, STEEL 'INVINCIBLE' 3-RAIL FENCE, SINGLE PED GATE & DOUBLE LEAF GATE
SCALE: 1/2"=1'-0"

no.	date	by	ckd	description
0	01/28/25	BHA	JAK	ISSUED FOR CONSTRUCTION
1	04/23/25	BHA	JAK	ISSUED FOR CONSTRUCTION

JEFFREY A. KROEGER LA-292 01/01/2008 Original Date of Licensure 04.23.25 STATE OF COLORADO LICENSED LANDSCAPE ARCHITECT

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
SITE DETAILS

project	contract
2245	

drawing **0L-501** – rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

1 04/23/25 BHA JAK ISSUED FOR CONSTRUCTION

Millimeters
Inches
Scale For Microfilming

Know what's **below.** **Call** before you dig.

SYMBOL LEGEND

- EXISTING TREES, TO REMAIN AND BE PROTECTED
- NEW DECIDUOUS SHADE TREE
- NEW DECIDUOUS ORNAMENTAL TREE
- NEW EVERGREEN TREE
- T — TRANSPLANT DECIDUOUS TREE
- T — TRANSPLANT EVERGREEN TREE
- EXSTG. LANDSCAPE BOULDERS TO REMAIN
- NON-STABILIZED 5"d. CRUSHER FINES - NO GEO-TEXTILE, COLOR TO MATCH EXSTG.

TYPE 1 SEED MIX - NON-IRRIGATED

NATIVE PRAIRIE MIX @ 36 LBS. PLS / ACRE	
SAND BLUESTEM	3.5 LBS. PLS / ACRE
SIDEOATS GRAMA	3.0 LBS. PLS / ACRE
BUFFALOGRASS	4.0 LBS. PLS / ACRE
PRAIRIE SANDREED	3.0 LBS. PLS / ACRE
BLUE GRAMA	6.4 LBS. PLS / ACRE
SWITCHGRASS	4.0 LBS. PLS / ACRE
WESTERN WHEATGRASS	5.0 LBS. PLS / ACRE
LITTLE BLUESTEM	3.0 LBS. PLS / ACRE
SAND DROPSEEP	2.0 LBS. PLS / ACRE
NEEDLE & THREAD GRASS	2.0 LBS. PLS / ACRE

TYPE 2 SEED MIX - IRRIGATED

ENHANCED NATIVE MIX @ 42 LBS. PLS / ACRE	
SIDEOATS GRAMA	4 LBS. PLS / ACRE
BLUE GRAMA	4 LBS. PLS / ACRE
BUFFALOGRASS	4 LBS. PLS / ACRE
SWITCHGRASS	6 LBS. PLS / ACRE
LITTLE BLUESTEM	6 LBS. PLS / ACRE
ALKALI SACATON	6 LBS. PLS / ACRE
SAND BLUESTEM	6 LBS. PLS / ACRE
SAND LOVEGRASS	3 LBS. PLS / ACRE
SAND DROPSEEP	3 LBS. PLS / ACRE

TYPE 3 SEED MIX - IRRIGATED

NO MOW MIX @ 1.5 PLS / ACRE
BLUE GRAMA - Bouteloua gracilis
SIDEOATS GRAMA - Bouteloua curtipendula
REGREEN - Triticum aestivum x Elytrigia elongata

GENERAL NOTES:

1. WAYFINDING SIGNAGE LANGUAGE, DESIGN, AND FINAL INSTALLATION LOCATIONS SHALL BE COORDINATED WITH THE CITY AND COUNTY OF BROOMFIELD PARKS AND OPEN SPACE & TRAILS STAFF
2. FINAL LANDSCAPING TO BE COORDINATED WITH THE CITY AND COUNTY OF BROOMFIELD PARKS AND OPEN SPACE & TRAILS STAFF
3. MINOR ADJUSTMENTS TO LANDSCAPING LOCATION AND MATERIAL MAY BE MADE IN COORDINATION WITH CCOB PARKS AND OPEN SPACE & TRAILS STAFF BASED ON FINAL FIELD CONDITIONS AND RECOMMENDATIONS FROM THE BUTTERFLY PAVILION.

PLANT LIST - ONLY TRANSPLANTS SUMMARIZED HERE (ALSO SEE SHEET 0L-100)

EVERGREEN TREES

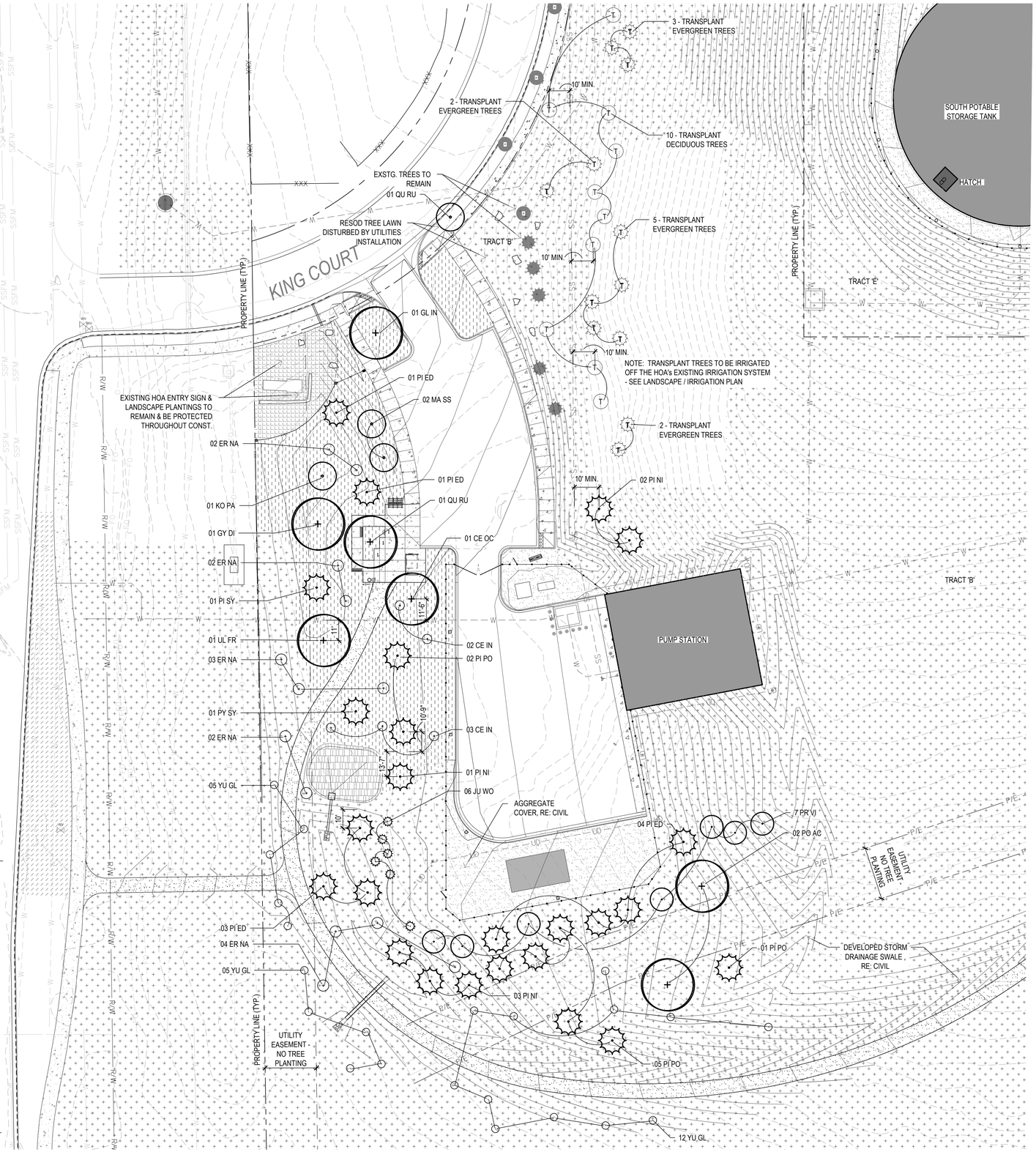
8	TRANSPLANTS MOVING TO THE EAST SIDE OF THE PROJECT
12	TRANSPLANTS MOVING TO THE SLOPE NORTH OF THE PARKING LOT
20	

DECIDUOUS TREES

8	TRANSPLANTS MOVING TO THE EAST SIDE OF THE PROJECT
10	TRANSPLANTS MOVING TO THE SLOPE NORTH OF THE PARKING LOT
18	
38	**TOTAL TRANSPLANT TREES**

PLANT LIST - ONLY NEW PLANTS SUMMARIZED HERE (NO TRANSPLANTS)

ABBR	COMMON NAME	SCIENTIFIC NAME	SIZE	ROOT	QTY.	MATURE SIZE
EVERGREEN TREES						
PI PO	PONDEROSA PINE	Pinus ponderosa	6'h.	CONT.	8	60-80' h. x 30-40' spread
PI ED	PINON PINE	Pinus edulis	6'h.	CONT.	7	20-30' h. x 10-20' spread
PI NI	AUSTRIAN PINE	Pinus nigra	6'h.	CONT.	6	40-60' h. x 30-40' spread
PI SY	SCOTCH PINE	Pinus sylvestris	6'h.	CONT.	2	30-50' h. x 20-30' spread
JU WO	WOODWARD ROCKY MOUNTAIN JUNIPER	Juniperus scopulorum 'Woodward'	#5	CONT.	6	15-20' h. x 2-4' spread
					25	
DECIDUOUS TREES						
CE OC	WESTERN HACKBERRY	Celtis occidentalis	2" cal.	CONT.	1	50-60' h. x 40-50' spread
GL IN	SHADEMASTER HONEYLOCUST	Gleditsia triacanthos inermis 'Shademaster'	2" cal.	CONT.	1	40-50' h. x 30-40' spread
GY DI	KENTUCKY COFFEETREE	Gymnocladus dioicus 'Expresso'	2" cal.	CONT.	1	50-60' h. x 40-50' spread
KO PA	GOLDENRAIN TREE	Koelreuteria paniculata	2" cal.	CONT.	1	20-30' h. x 20-30' spread
MA SS	SPRING SNOW CRABAPPLE	Malus x 'Spring Snow'	2" cal.	CONT.	2	20-25' h. x 20-25' spread
PO AC	LANCELEAF COTTONWOOD	Populous x acuminata	2" cal.	CONT.	2	40-60' h. x 30-40' spread
PR VI	NATIVE CHOKEBERRY	Prunus virginia melanocarpa	#5	CONT.	7	8-20' h. x 8-12' spread
QU RU	NORTHERN RED OAK	Quercus rubra	2" cal.	CONT.	2	40-60' h. x 40-40' spread
UL FR	FRONTIER ELM	Ulumus 'Frontier'	2" cal.	CONT.	1	25-35' h. x 15-25' spread
					22	
DECIDUOUS NATIVE SHRUBS						
CE IN	CERCOCARPUS INTRICATUS	Littleleaf Mountain Mahogany	#5	CONT.	5	3-6' h. x 3-5' spread
ER NA	TALL RABBITBRUSH	Ericameria nauseosa var.nauseosa	#5	CONT.	13	2-6' h. x 4-6' spread
YU GL	SOAPWEED	Yucca glauca	#5	CONT.	22	2-4' h. x 2-4' spread
					40	



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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
LANDSCAPE PLAN ENLARGEMENT @ TRAIL HEAD

project	contract
2245	

drawing **2L-104** rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

Scale For Microfilming
Millimeters
Inches

NOTES:

1. ALL LANDSCAPING WILL BE IRRIGATED WITH THE EXCEPTION OF TYPE 1 NATIVE SEED AREAS
2. ALL PUBLIC LANDSCAPING AND IRRIGATION WILL COMPLY WITH THE BROOMFIELD STANDARDS & SPECIFICATIONS, CURRENT EDITION.
3. **ALL NATIVE SEEDING TO BE STRAW MULCHED & CRIMPED. HYDROMULCHING WILL NOT BE ALLOWED.**
4. TRANSPLANT TREES TO BE IRRIGATED OFF THE HOA's EXISTING IRRIGATION SYSTEM. SEE IRRIGATION PLAN(S).
5. TREE SPECIES AT EACH PROPOSED LOCATION TO BE COORDINATED / DETERMINED BETWEEN LANDSCAPE ARCHITECT AND CCOB FORESTER DURING TRANSPLANTING.
6. SEE CCOB STANDARDS & SPECIFICATIONS, CURRENT EDITION FOR:
   SECTION 1030.0 FOR SEEDING AND HYDROMULCHING SPECIFICATIONS
   SECTION 1062.01 FOR TREE MULCHING SPECIFICATIONS
   SECTION 1064.0 FOR PLANTING SPECIFICATIONS
   SECTION 1062.02 & 1064.06 FOR TREE STAKING & GUYING SPECIFICATIONS

SYMBOL LEGEND

EXISTING TREES, TO REMAIN AND BE PROTECTED

NEW DECIDUOUS SHADE TREE

NEW DECIDUOUS ORNAMENTAL TREE

NEW EVERGREEN TREE

TRANSPLANT DECIDUOUS TREE

TRANSPLANT EVERGREEN TREE

NON-STABILIZED 5"d. CRUSHER FINES - NO GEO-TEXTILE, COLOR TO MATCH EXSTG.

TYPE 1 SEED MIX - NON-IRRIGATED

NATIVE PRAIRIE MIX @ 36 LBS. PLS / ACRE	
SAND BLUESTEM	3.5 LBS. PLS / ACRE
SIDEOATS GRAMA	3.0 LBS. PLS / ACRE
BUFFALOGRASS	4.0 LBS. PLS / ACRE
PRAIRIE SANDREED	3.0 LBS. PLS / ACRE
BLUE GRAMA	6.4 LBS. PLS / ACRE
SWITCHGRASS	4.0 LBS. PLS / ACRE
WESTERN WHEATGRASS	5.0 LBS. PLS / ACRE
LITTLE BLUESTEM	3.0 LBS. PLS / ACRE
SAND DROPSEEP	2.0 LBS. PLS / ACRE
NEEDLE & THREAD GRASS	2.0 LBS. PLS / ACRE

NOTE: ONCE THE TANKS ARE CONSTRUCTED AND ROUGH GRADING IS COMPLETED, THE OPEN SPACE AND TRAILS STAFF AFTER CONSULTATION WITH THE OPEN SPACE AND TRAILS ADVISORY COMMITTEE WILL CONFIRM THE LOCATION FOR THE OVERLOOK PRIOR TO FINALIZING GRADING, RE-SETTING EXISTING BENCH AND BOULDERS - SO THAT VIEW CORRIDORS CAN BE ACCESSED ACCURATELY.

RELOCATED LANDSCAPE BOULDERS

RELOCATED PARK BENCH

R15'

8'w. CRUSHER FINES TRAIL

PROPERTY LINE (TYP.)

TRACT 'B'

TRACT 'E'

HATCH

NORTH POTABLE STORAGE TANK

HATCH

HATCH

SOUTH POTABLE STORAGE TANK

HATCH

SEE CIVIL FOR AGGREGATE SURFACE COURSE MATERIAL

SEE SHEET OL-102 FOR OVERALL TRACT 'E' GRADING AND RESTORATION PLAN

10'w. CONC. TRAIL

TRACT 'B'

93

IRVING COURT

TRACT 'B'

8 - TRANSPLANT DECIDUOUS TREES (TYP.)

EXSTG. EVERGREEN TREES TO REMAIN

8 - TRANSPLANT EVERGREEN TREES (TYP.)

3 - EXSTG. DECIDUOUS TREES TO REMAIN

NOTE:
1. TRANSPLANT TREES TO BE IRRIGATED OFF THE HOA's EXISTING IRRIGATION SYSTEM.
2. TREE SPECIES AT EACH PROPOSED LOCATION TO BE COORDINATED / DETERMINED BETWEEN LANDSCAPE ARCHITECT AND CCOB FORESTER DURING TRANSPLANTING

EXSTG. LANDSCAPE BOULDERS TO REMAIN OR IF DISTURBED DUE TO TURNING RADII MAINTENANCE ACCESS IMPROVEMENTS BOULDERS WILL RELOCATED ADJ. IMPROVED TRAIL

EXSTG. LANDSCAPE BOULDERS TO REMAIN / BE PROTECTED THROUGHOUT CONST.

N

0' 30' 60'

NOTE: VIEWPORT SCALE IS HALF OF BAR SCALE FOR HALFSIZE

Millimeters

Scale For Microfilming

Inches

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BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

LANDSCAPE PLAN ENLARGEMENT @ IRVING COURT

project	contract
2245	

drawing **2L-105** — rev. **1**

sheet of sheets

file CCOB Tanks_2 Tanks_IFC.dwg

Irrigation Equipment and Materials Schedule

SYMBOL	MANUFACTURER	MODEL NO.	DESCRIPTION	CC of BROOM. DETAIL NO.	COMMENTS
●R	RAIN BIRD	RD06-S-P30-F-NP W/ SPEC'D. NOZZ.	POP-UP SPRAY HEAD	1000-9	PURPLE LETTERING
◣■■■◢	RAIN BIRD	RD12-S-P30-F-NP W/ SPEC'D. NOZZ.	HI-POP SPRAY HEAD	1000-9	PURPLE LETTERING
R18◣■◢R18	RAIN BIRD	RD12-S-P45-F-NP W/ R-VAN18 NOZZ.	HI-POP SPRAY HEAD	1000-9	PURPLE LETTERING
■ R18F	RAIN BIRD	RD12-S-P45-F-NP W/ R-VAN18-360 NOZZ.	HI-POP SPRAY HEAD	1000-9	PURPLE LETTERING
R24◣■◢R24	RAIN BIRD	RD12-S-P45-F-NP W/ R-VAN24 NOZZ.	HI-POP SPRAY HEAD	1000-9	PURPLE LETTERING
■ R24F	RAIN BIRD	RD12-S-P45-F-NP W/ R-VAN24-360 NOZZ.	HI-POP SPRAY HEAD	1000-9	PURPLE LETTERING
R14◣■◢R14	RAIN BIRD	RD12-S-P45-F-NP W/ R-VAN14 NOZZ.	HI-POP SPRAY HEAD	1000-9	PURPLE LETTERING
◖◗	MATCO-NORCA	10RT - LINE SIZE	GATE VALVE	1000-16	2 & 4/SHT. 0I-108
Ⓢ	TORO	SENTINEL - EXISTING	ELECTRIC CONTROLLER		TWO-WIRE SYSTEM
Ⓢ	TORO	SB-BLA	TWO-WIRE SURGE ARRESTOR	1/SHT. 0I-108	
▼	RAIN BIRD	5 NP	QUICK COUPLING VALVE	1000-13	
◓	RAIN BIRD	PES-B SERIES W/ TORO SB-DAC-1 TWO-WIRE DECODER	ELECTRIC CONTROL VALVE	1000-7	
———		DR11 (200 PSI) - 4" DIA.	HDPE MAINLINE	1000-12	
———		CLASS 200 SOLVENT WELD - 1" DIA. UNLESS NOTED OTHERWISE	PVC LATERAL	1000-12	
———		CLASS 200 SOLVENT WELD 2 1/2" & SMALLER	PVC MAINLINE	1000-12	
———		CLASS 200 GASKETED - 4" DIA.	PVC MAINLINE	1000-12	
═══		CLASS 200 SOLVENT WELD	PVC SLEEVING		
— — —		CLASS 200 SOLVENT WELD - 1" DIA. UNLESS NOTED OTHERWISE	PVC LATERAL SHRUB SPRAY ZONES	1000-12	

(station no. / valve size) — CONTROLLER & STATION NO. / CONTROL VALVE SIZE

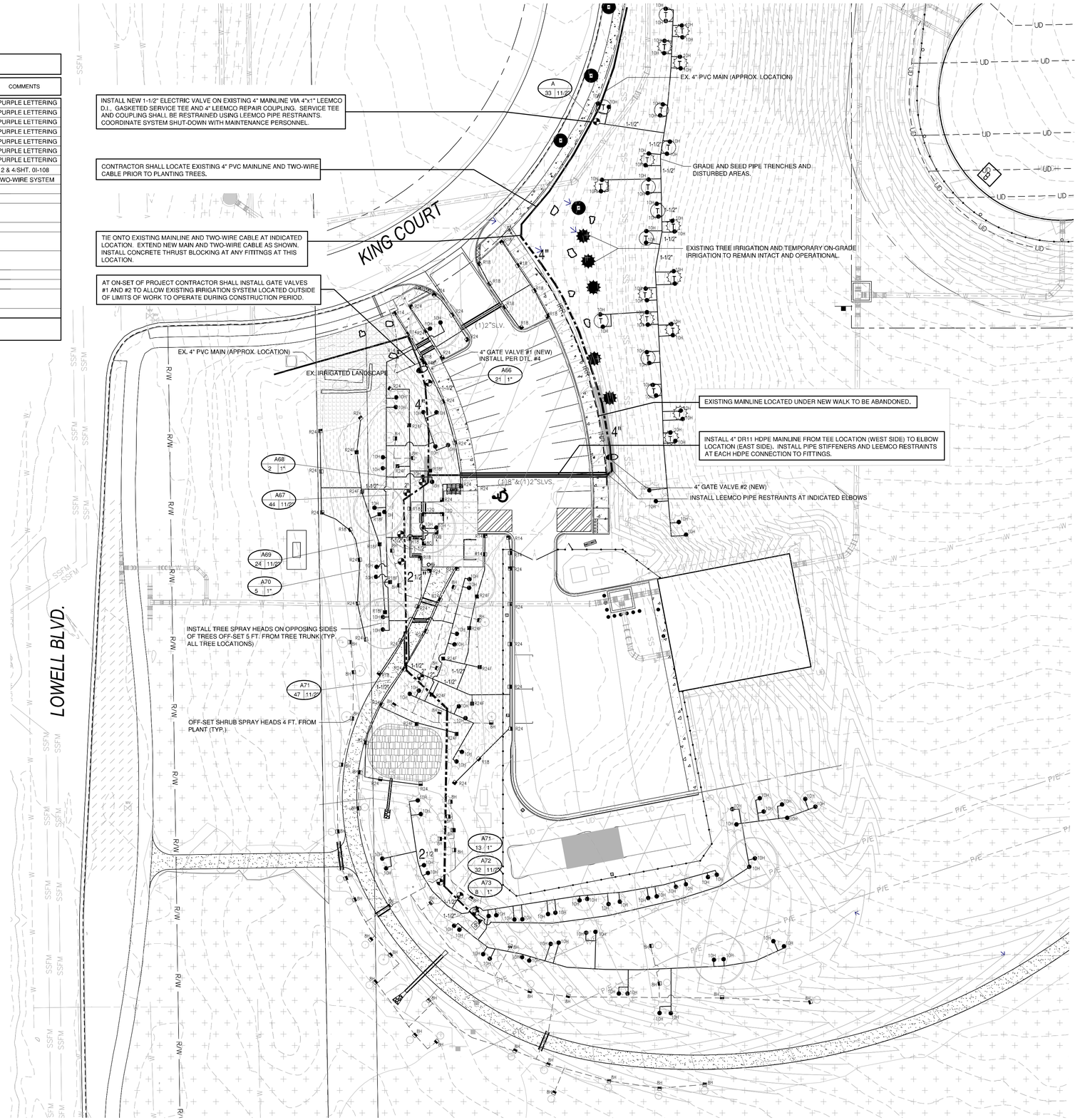
ALL VALVE BOXES TO HAVE PURPLE LIDS.

Irrigation Construction Notes

1. ALL BASE INFORMATION HAS BEEN TAKEN FROM DRAWINGS PREPARED BY BHA DESIGN.
2. REFER TO TECHNICAL SPECIFICATIONS AND CONSTRUCTION DETAILS FOR INSTALLATION PROCEDURES.
3. CONTRACTOR SHALL COORDINATE INSTALLATION OF SLEEVING WITH INSTALLATION OF CONCRETE FLATWORK AND PAVING. ALL SLEEVING IS BY CONTRACTOR UNLESS OTHERWISE NOTED. UNLESS NOTED OTHERWISE ON IRRIGATION PLANS INSTALL SLEEVING BASED ON SLEEVE SIZING GUIDE BELOW:

PIPE SIZE OR WIRE QUANTITY	REQUIRED SLEEVE
1" PIPING	1-2" PVC SLEEVE
1-1/2" - 2" PIPING	1-4" PVC SLEEVE
2-1/2" - 3" PIPING	1-6" PVC SLEEVE
4" PIPING	1-8" PVC SLEEVE
TWO-WIRE CABLE	1-2" PVC SLEEVE

   NOTE: EACH LENGTH OF SLEEVED PIPE SHOWN SHALL BE ROUTED THROUGH SEPARATE SLEEVE. IRRIGATION WIRE BUNDLE SHALL BE ROUTED IN SEPARATE SLEEVE/CONDUIT WITHOUT IRRIGATION PIPING
4. REFER TO PLANTING PLAN FOR EXACT TREE LOCATIONS AND QUANTITIES. TREES SHOWN ON IRRIGATION PLANS ARE APPROXIMATE.
5. CONTRACTOR SHALL REPAIR OF REPLACE ANY EXISTING IRRIGATION EQUIPMENT, TURF, PLANT MATERIAL OR SITE FEATURES DAMAGED DURING NEW INSTALLATION. REPLACEMENT OR REPAIR OF DAMAGED EQUIPMENT OR MATERIAL SHALL BE DETERMINED BY THE OWNER AND THE CONSULTANT.
6. VALVE BOXES SHALL BE LOCATED 36" MINIMUM FROM CENTERLINE OF ALL SWALES, 24" MINIMUM FROM EDGES OF ALL WALKS, CURBS, DRIVES AND OTHER HARD SURFACE AREAS.
7. REFER TO IRRIGATION TECHNICAL SPECIFICATIONS FOR PLANTING AND IRRIGATION LAY-OUT REQUIREMENTS, COORDINATION AND PRIORITIES.
8. LATERAL PIPING DIAMETERS SHALL INCLUDE 1", 1 1/2" AND 2". 3/4" AND 1 1/4" DIAMETER LATERAL PIPE IS NOT ACCEPTABLE.
9. ALL VALVE BOXES SHALL BE RAIN BIRD VB SERIES WITH PURPLE LIDS INDICATING NON-POTABLE WATER. INSTALL RAIN BIRD VBJMB BOXES FOR ALL NEW ELECTRIC VALVES.
10. ALL ALL TWO-WIRE CABLE TO BE TORO 14 GA. TW-CAB-14 WITH TW-SPLICE-14 WIRE SPLICE KITS. COLOR OF CABLE TO MATCH EXISTING CABLE.
11. CONTRACTOR SHALL RE-PROGRAM DECODERS FOR ALL EXISTING VALVES STARTING WITH "A74" SO THAT STATION NUMBERING REFLECTS THE INTRODUCTION OF NEW VALVES INTO CONTROLLER PROGRAMMING SEQUENCE. ASSIGNING NEW VALVES TO END OF CONTROLLER STATIONING IS NOT PERMITTED AND WILL NOT BE ACCEPTED.
12. CONTRACTOR SHALL MOVE EXISTING VALVE BOX LIDS AS REQUIRED TO REFLECT NEW STATION NUMBERS FOR EXISTING VALVES.
13. REFER TO "CITY AND COUNTY OF BROOMFIELD 2022 STANDARDS AND SPECIFICATIONS" SECTION 1000 FOR ADDITIONAL INFORMATION AND DETAILS.



no.	date	by	ckd	description
0	01/28/25	DZ	DZ	ISSUED FOR CONSTRUCTION
1	04/23/25	DZ	DZ	ISSUED FOR CONSTRUCTION

"All work shall be constructed to City and County of Broomfield STANDARDS AND SPECIFICATIONS. This drawing has been reviewed and found to be in general compliance with these STANDARDS AND SPECIFICATIONS and other Broomfield requirements. **THE ENGINEERING DESIGN AND CONCEPT REMAINS THE RESPONSIBILITY OF THE PROFESSIONAL ENGINEER WHOSE STAMP AND SIGNATURE APPEAR HEREON."**

City and County Engineer (or Designee) Date

N

0' 30' 60'

Avocet IRRIGATION DESIGN
11757 W. KEN CARYL AVE., SUITE F-508
LITTLETON, COLORADO 80127
303-562-5698
avocet@wispertel.net

date	detailed
JANUARY 2025	
designed	checked
DZ	DZ

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION
IRRIGATION PLAN
@ TRAIL HEAD

project | contract

drawing | rev.
0I-106 — 1

sheet of sheets
file

Scale For Microfilming
Millimeters
Inches

IARY LOCATION FOR THE
ITURE OVERLOOK

93

IRVING COURT

96

95

94

EXISTING "A80" IRRIGATION SYSTEM TO EX. TREES AT BACK OF LOTS TO REMAIN INTACT AND OPERATIONAL

EXISTING "A80" IRRIGATION SYSTEM TO EX. TREES TO REMAIN INTACT AND OPERATIONAL (TYP.)

EXIST. 1-1/2" ELECTRIC VALVE "A80" - TO REMAIN

1-1/2"

GRADE AND SEED ALL IRRIGATION TRENCHES AND DISTURBED AREAS. LIGHT RAKE NATIVE SEED MIX INTO SOIL

1-1/2" ELECTRIC VALVE EXISTS AT INDICATED LOCATION. RE-PLUMB VALVE WITH 2" FITTINGS AND 2" PIPING EXITING VALVE. CONNECT EXISTING LATERAL PIPING AND NEW LATERAL PIPING TO 2" LATERAL PIPING.

N

0' 30' 60'

no.	date	by	ckd	description
0	01/28/25	DZ	DZ	ISSUED FOR CONSTRUCTION
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designed	checked
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CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

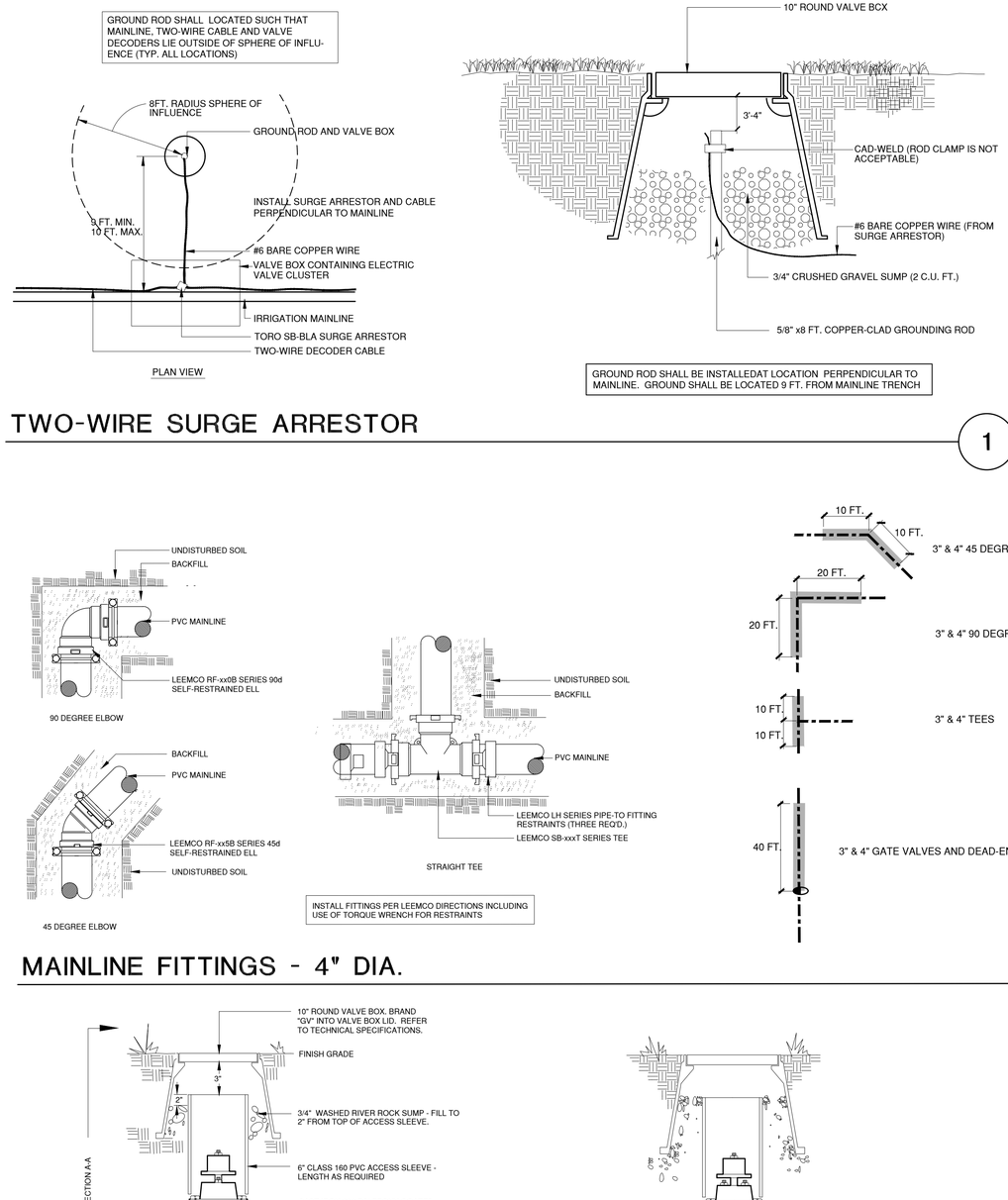
BROOMFIELD TANKS AND PUMP STATION
IRRIGATION PLAN
@ IRVING COURT

project | contract

drawing **0I-107** rev. **1**

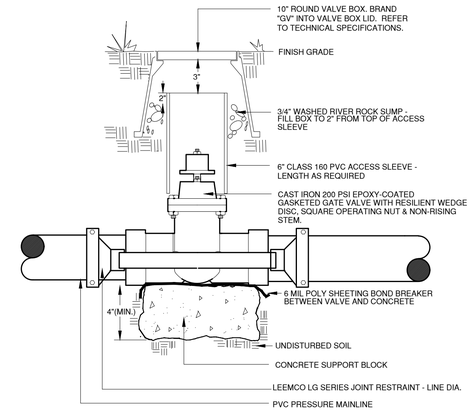
sheet of sheets
file

Millimeters
Scale For Microfilming
Inches



TWO-WIRE SURGE ARRESTOR

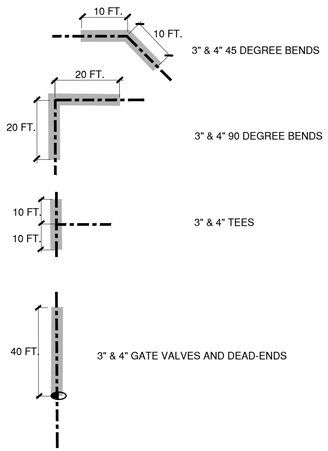
1



GATE VALVE - 3" and LARGER

2

INSTALL FITTINGS PER LEEMCO DIRECTIONS INCLUDING USE OF TORQUE WRENCH FOR RESTRAINTS

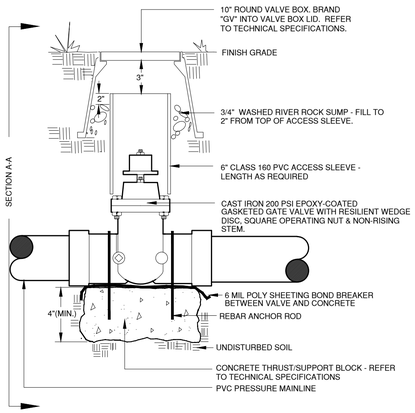


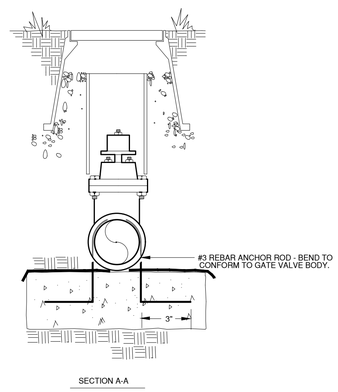
MAINLINE FITTINGS - 4" DIA.

3

MECHANICAL MAINLINE PIPE RESTRAINTS

INDICATES MAINLINE PIPING TO BE SECURED VIA MECHANICAL PIPE RESTRAINTS. ALL PIPE-TO-PIPE JOINTS, FITTINGS (I.E. CHANGES IN DIRECTION), SERVICES TEES AND/OR GATE VALVES THAT FALL WITHIN INDICATED DISTANCE SHALL BE RESTRAINED. REFER TO DETAILS. RESTRAINTS SHALL BE MANUFACTURED BY LEEMCO.
ALL DISTANCES SHOWN BELOW ARE TYPICAL.





GATE VALVE LOCATION #1

4

no.	date	by	ckd	description
0	01/28/25	DZ	DZ	ISSUED FOR CONSTRUCTION
1	04/23/25	DZ	DZ	ISSUED FOR CONSTRUCTION

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JANUARY 2025	
designed	checked
DZ	DZ

CITY AND COUNTY OF BROOMFIELD COLORADO
BROOMFIELD, COLORADO

IRRIGATION DETAILS

project	contract

drawing 0I-108 — rev. 1

sheet of sheets

file

Scale For Microfilming
Millimeters
Inches

CITY AND COUNTY OF BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ISSUED FOR CONSTRUCTION

TECHNICAL SPECIFICATIONS

BURNS & MCDONNELL PROJECT NO. 135303

JANUARY 2025

BURNS McDONNELL

CITY AND COUNTY OF BROOMFIELD, COLORADO

BROOMFIELD TANKS AND PUMP STATION

ISSUED FOR CONSTRUCTION

TECHNICAL SPECIFICATIONS

BURNS McDONNELL

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CLIENT NAME City and County of Broomfield
PROJECT NAME Broomfield Tanks and Pump Station
PROJECT NO. 135303

DOCUMENT 00 01 07 – INDEX AND CERTIFICATION PAGE

SPECIFICATION INDEX

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02	Existing Conditions
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04	Masonry
05	Metals
06	Wood and Plastics
07	Thermal and Moisture Protection
08	Openings
09	Finishes
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CERTIFICATION(S)

DIV 04, 06, 07, 08, 09, 10, 12

DIV 03, 05, 41 and 31 63 29

DIV 22, 23

DIV 02, 31, 32, and 33 41 00 (except 31 63 29)

DIVISIONS 26, 28 & 40

DIV 01, 13, 33, 46

END OF DOCUMENT 00 01 07

DIVISION 01 - GENERAL REQUIREMENTS

SECTION 01 11 00 - SUMMARY OF WORK

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section summarizes the Work covered in detail in the complete Contract Documents.

B. Owner: The City and County of Broomfield, Colorado is contracting for Work described in the Contract Documents.

1. Contract Identification: Broomfield Tanks and Pump Station
2. Work Site Location: 3473 W 152ND AVE Broomfield, CO 80023

C. Engineer: The Contract Documents were prepared by Burns & McDonnell Engineering Company, Inc., 9191 S. Jamaica Street, Englewood, CO 80112

1.02 PROJECT DESCRIPTION:

A. Description of Project: The Contract provides for the construction of two (2) 3-million gallon potable water storage tanks, one (1) 4-million gallon reuse water storage tank, and a single building containing separate pump stations for the potable and reuse water systems. The building will include a 17 million gallon per day pump station for the potable system, a 6.63 million gallon per day pump station for the reuse system, and associated electrical buildings. Additional ancillary items which are part of the Work include, but are not limited to: piping, vaults, valves, instrumentation/controls, electrical equipment, fencing, gates, landscaping, and irrigation.

1. Work By Others:
    a. BHA Design Incorporated

1.03 RELATED REQUIREMENTS

A. For measurement and payment: 01 29 00.

1.04 CONTRACTOR'S USE OF PREMISES:

A. Exclusive Use: During the construction period, Contractor shall confine construction activities, other than the portion of the Work shown on the yard piping site plan and the landscape plan, to the limits of construction shown on the site plan. Use of premises within the indicated limits of construction (refer to 0CS-102) is limited only by Owner's right to perform duties and functions as stated in the GENERAL CONDITIONS and in this Section.

1.05 OWNER'S USE OF PREMISES:

A. Full Owner Occupancy: Cooperate with the Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the Owner's operations.

1.06 WORK SEQUENCE:

A. General: Construction sequence shall be determined by Contractor subject to Owner's need for continuous operation of existing facilities. Sequence shall generally consider the following:

1. Yard piping construction shall be coordinated with the Owner and sequenced in a manner consistent with the guidance located on Drawing 0D-100.
2. The pump station shall be constructed concurrently with the tank.

1.07 COPIES OF DOCUMENTS:

A. Furnished Copies: After execution of Agreement, Contractor will be furnished at no cost, an electronic set of Contract Documents consisting of full-size Contract Drawings, and the Project Manual, in addition to those used in execution of the Agreement.

1.08 LIST OF DRAWINGS (AND SCHEDULES):

A. Contract Drawings:
   1. Individual sheet numbers and titles are as stated on index sheet under "Contract Drawings".

B. Reference Drawings:
   1. The following Reference Drawings are available as electronic copies:
      a. City and County of Broomfield Lowell Boulevard Offsite 24" Waterline and 16" Reuse Water Line (Carter Burgess)
      b. City and County of Broomfield Lowell Boulevard Offsite Sanitary Sewer Gravity Force Mains and Raw Water Line (Carter Burgess)
      c. City and County of Broomfield Lowell Infrastructure (Carter Burgess)
   2. Other Documents:
      a. Topographic and Boundary Line Survey (Encompass, 2022)
      b. Preliminary Geotechnical Investigation Anthem Colorado at Broomfield (CTL Thompson, 2022)

1.09 PERMITS

A. The Contractor shall obtain and adhere to all required permits necessary to perform Work including, but not limited to:
   1. The Engineer, acting as a consultant, agent, or employee of the engineer, shall act as Special Inspector for post-installed anchor and rebar inspections. All other special inspections shall be the responsibility of the Contractor.
   2. The Contractor shall be responsible for obtaining all building inspections required by the City and County of Broomfield.
   3. City and County of Broomfield – Open Spaces Permit – Obtained by Contractor if needed.
   4. City and County of Broomfield, Grading, Erosion, Sediment Control Permit – Obtained by Contractor if needed.
   5. City and County of Broomfield Right-of-Way Use and/or Construction Permit – Obtained by Contractor if needed.
   6. City and County of Broomfield Building Permit for the pump station – Obtained by Contractor if needed.
   7. City and County of Broomfield Construction, Hydrant, and Temporary Water Permit – Obtained by Contractor if needed.
   8. City and County of Broomfield Fence Permit – Obtained by Contractor if needed.
   9. City and County of Broomfield Temporary Electric Service Permit – Obtained by Contractor if needed.
   10. City and County of Broomfield Upgrade Electric Service Permit – Obtained by Contractor if needed.
   11. City and County of Broomfield Building Permit for the pump station – Obtained by Contractor if needed.
   12. Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division, Construction Dewatering Permit – Obtained by Contractor if needed.

a. Unless indicated in the Contract Documents, work required to include source water analytical results in the Construction Dewatering Permit application and any short-term remediation activities required by CDPHE shall be considered Extra Work.
b. To prevent project delays, it is recommended that the Contractor apply for a Construction Dewatering permit with the State of Colorado as soon as the Project is awarded. Approval of a Construction Dewatering Permit may take at least 30 days after the application is received. Application is to be made to the CDPHE with permit fees paid by the Contractor. All cost associated with the acquisition of this permit shall be considered incidental to the Project work and there shall be no additional payment for this item. Contact CDPHE's website (http://www.cdphe.state.co.us/permits.html) for more information.
c. The Contractor shall obtain approval of the proposed discharge location from the City and of County of Broomfield prior to applying for the Dewatering Permit.

13. CDPHE Asbestos Abatement Permit – Obtained by Contractor if needed.
    a. All costs associated with tests required to determine necessity for CDPHE permits shall be considered a subsidiary obligation of Contractor and all costs in connection therewith shall be included in the prices bid for various items of work.
14. CDPHE Lead Abatement Permit – Obtained by Contractor if needed.
15. CDPHE, Water Quality Control Division, General Permit for Stormwater Discharges Associated with Construction Activities – Obtained by Contractor.
    a. Both the City acting as the Owner and Contractor acting as the Operator must apply as co-permittees for the permit. The Contractor shall apply as the first Responsible Official "first RO" for the CDPHE permit in the Colorado Environmental Online System (CEOS). The Contractor shall prepare and complete the submittal and pay all permit fees for the facilities as necessary for this Contract.
    b. A copy of the permit is required to be submitted to the City and County of Broomfield prior to Project mobilization.
    c. The Contractor is required to complete inspections in accordance with the CDPHE Construction Activity Permit using certified Stormwater Pollution Control (SPC) inspectors and keep a full record of all inspections on-site for City review upon request. A copy of the SPC Inspector's certification is required prior to Project mobilization.
    d. Close out of the permit is the responsibility of the Contractor – the City will not assume responsibility for any permit requirements. A copy of the closed permit is needed prior to Final Acceptance of the Project.
    e. The Contractor shall be responsible for compliance with the CDPHE Construction Activity Permit. Refer to Special Conditions Section, Paragraph 24.0 - STORMWATER QUALITY.
16. CDPHE Demolition Notification Application Form, as required, for each building to be demolished on the Project.

B. The Contractor shall obtain and submit to the Owner a copy of all required permits before mobilization. The Contractor shall keep a full record of all inspections on-site for Owner review upon request. Copies of inspection records shall be submitted to the Owner with each pay application. The Contractor is responsible for closing/terminating all permits. The Owner will not assume responsibility for any permit requirements. The Contractor shall submit to the Owner copies of closed/terminated permits prior to the Construction Acceptance of the Project.

C. All costs associated with obtaining necessary permits shall be considered a subsidiary obligation of the Contractor and all costs in connection therewith shall be included in the prices

bid for the various items of work. Contractor shall comply with the requirements of all applicable permits for all projects unless otherwise noted.

D. Fees for City issued permits, not including a contractor license, shall be waived for this Project.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION – NOT APPLICABLE.

END OF SECTION 01 11 00

SECTION 01 25 00 – SUBSTITUTIONS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements for handling requests for substitutions made after award of the Contract.

1.02 RELATED REQUIREMENTS:

A. Requirements for submitting Contractor's construction progress schedule and the Submittal schedule: Sections 01 32 00 and 01 33 00.

B. Requirements governing Contractor's selection of products: Section 01 60 00.

1.03 DEFINITIONS:

A. Definitions in this Article do not change or modify the meaning of other terms used in the Contract Documents.

B. Substitutions: Changes in products, Materials, Equipment, and methods of construction required by the Contract Documents proposed by the Contractor after award of the Contract are considered to be requests for substitutions. The following are not considered to be requests for substitutions:

1. Revisions to the Contract Documents requested by Owner or Engineer.
2. Specified options of products and construction methods included in the Contract Documents.

1.04 SUBMITTALS:

A. Substitution Request Submittal: Engineer will consider written requests for substitution if received within 60 days after commencement of the Work. Requests received more than 60 days after commencement of the Work may be considered or rejected at the discretion of Engineer.

1. Submit requests in the form and according to procedures required for Field Order proposals. Requests for substitution shall not be submitted in the form of a Request for Information (RFI).
2. Identify the Equipment or Material, the fabrication, or installation method to be replaced in each request. Include related Specification Section/Article and Drawing numbers.
3. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    a. Statement indicating why specified product or method of construction cannot be provided.
    b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate the proposed substitution.
    c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
    d. Product data, including drawings and descriptions of products and fabrication and installation procedures.
    e. Samples, where applicable or requested.
    f. Identification of available sales, maintenance, repair, and replacement services.
    g. A statement indicating the effect of the substitution on Contractor's construction progress schedule compared to the schedule without approval of the substitution.

Indicate the effect of the proposed substitution on the overall Contract Times. If specified product cannot be provided within the Contract Times, provide letter from manufacturer, on manufacturer's letterhead, stating lack of availability or delay in delivery.

h. An itemized estimate of costs that will result directly or indirectly from approval of the substitution, including:
   (1) A proposal of the net change, if any, in the Contract Price.
   (2) Costs of redesign required by the proposed change.
      (a) Engineer will evaluate and recommend responsibility for cost of redesign based on circumstances surrounding substitution. If originally specified products are readily available, Contractor shall be responsible for redesign costs.
   (3) Costs of resulting claims as determined in coordination with other contractors having work on the Project affected by the substitution.

i. Statement indicating whether or not incorporation or use of the substitute is subject to payment of any license fee or royalty.

j. Contractor's certification that the proposed substitution conforms to requirements in the Contract Documents, will perform adequately the functions and achieve the results called for by the general design, is similar in substance to that specified, and is suitable for same use as that indicated and specified.

k. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.

4. Engineer's Action: If necessary, Engineer will request additional information or documentation for evaluation. Engineer will notify Contractor of acceptance or rejection of the substitution. Acceptance will be in the form of a Field Order with Engineer's documentation attached.

PART 2 - PRODUCTS

2.01 SUBSTITUTIONS:

A. Conditions: Engineer will receive and consider Contractor's request for substitution when one or more of the following conditions are satisfied, as determined by Engineer. If the following conditions are not satisfied, Engineer will return the requests without action except to record noncompliance with these requirements.

1. Extensive revisions to the Contract Documents are not required.
2. Proposed substitution is in keeping with the general intent of the Contract Documents and will produce indicated results.
3. Substitution request is timely, fully documented, and properly submitted.
4. The specified product or method of construction cannot be provided within the Contract Times. Engineer will not consider the request if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
5. The requested substitution offers Owner a substantial advantage, in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Owner must assume. Owner's additional responsibilities may include compensation to Engineer for redesign and evaluation services, increased cost of other construction by Owner, and similar considerations.
6. The specified product or method of construction cannot receive necessary approval by a governing authority, and the requested substitution can be approved.

7. The specified product or method of construction cannot be provided in a manner that is compatible with other materials and where Contractor certifies that the substitution will overcome the incompatibility.
8. The specified product or method of construction cannot be coordinated with other materials and where Contractor certifies that the proposed substitution can be coordinated.
9. The specified product or method of construction cannot provide a warranty required by the Contract Documents and where Contractor certifies that the proposed substitution provides the required warranty.

B. Engineer's review and acceptance of Submittals shall not relieve Contractor from responsibility for any variation from the requirements of the Contract Documents. Engineer's acceptance of Submittals not complying with the Contract Documents does not constitute an acceptable or valid request for substitution, nor does it constitute approval of a substitute. Acceptance by Engineer shall not relieve Contractor from responsibility for errors or omissions in the Submittals.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 01 25 00

SECTION 01 31 00 – PROJECT COORDINATION AND MEETINGS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:
   1. Coordination drawings.
   2. Project meetings.
   3. Requests for information (RFIs).

1.02 RELATED REQUIREMENTS:

A. For preparing and submitting Contractor's construction progress schedule: Section 01 32 00.
B. For Submittal Requirements: Section 01 33 00.
C. For coordinating closeout of the Contract: Section 01 78 00.

1.03 DEFINITIONS:

A. RFI: Request for information prepared by Contractor and submitted to Engineer seeking interpretation or clarification of the Contract Documents.

1.04 COORDINATION:

A. The Contractor shall coordinate the completion of their activities with work performed by the Owner and other entities, to facilitate proper installation and construction. This includes all requirements specified in each Section of the contract.
   1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
   2. Coordinate installation of different components with other subcontractors and entities to allow optimum accessibility for required maintenance, service, and repair.
   3. Make adequate provisions to accommodate items scheduled for later installation.
   4. Where availability of space is limited, coordinate installation of different components to allow optimum performance and accessibility for required maintenance, service, and repair of all components, including mechanical and electrical.
B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.
   1. Prepare similar memoranda for Owner and subcontractors if coordination of their Work is required.
C. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of others to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:
   1. Preparation of construction progress schedule.
   2. Preparation of the schedule of values.
   3. Installation and removal of temporary facilities and controls.
   4. Delivery and processing of Submittals.
   5. Progress meetings.
   6. Preinstallation conferences.
   7. Project closeout activities.
   8. Startup and adjustment of systems.
   9. Project closeout activities.

1.05 SUBMITTALS:

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Content: Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
   a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, process, and electrical systems.
   b. Indicate required installation sequences.
   c. Indicate dimensions shown on the Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted Equipment and minimum clearance requirements. Provide alternate sketches to Engineer for resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.
   d. Crane or other construction equipment placement and motion space required.
2. Sheet Size: At least 8-1/2 by 11 inches but no larger than 30 by 40 inches.
3. Number of Copies: Submit one electronic copy of each Submittal to Engineer. Engineer will return comments electronically.
4. Refer to individual Sections for coordination drawing requirements for Work in those Sections.

1.06 PROJECT MEETINGS:

A. Preconstruction Conference:

1. Engineer will conduct a meeting within 10 days after the Notice to Proceed, to review items stated in the following agenda and to establish a working understanding between the parties as to their relationships during performance of the Work.
2. Preconstruction conference shall be attended by:
   a. Representative(s) of Contractor including Contractor’s superintendent and Project Manager.
   b. Engineer and Resident Project Representative.
   c. Representative(s) of Owner.
   d. At Owner's option, representatives of principal Subcontractors and Suppliers.
3. Meeting Agenda:
   a. Construction schedules.
   b. Phasing.
   c. Critical Work sequencing and long-lead items.
   d. Designation of key personnel and their duties; lines of communication.
   e. Project coordination.
   f. Procedures and Processing of:
      (1) RFIs.
      (2) Field decisions.
      (3) Substitutions.
      (4) Submittals.
      (5) Change Orders.
      (6) Applications for Payment.
   g. Procedures for testing.
   h. Procedures for preparing and maintaining record documents.

i. Use of Premises:
(1) Office, work, storage, laydown, and parking areas.
(2) Owner's requirements.
(3) Work restrictions and hours.
j. Construction facilities, controls, and construction aids.
k. Temporary utilities.
l. Safety and first-aid.
m. Security.
n. Deliveries of Equipment and Materials.

4. Location of Meeting: At or near the Project Site.
5. Reporting:
a. Within five working days after the meeting, Engineer will prepare and distribute minutes of the meeting to Owner and Contractor.
b. Contractor shall provide copies to Subcontractors and major Suppliers.

B. Coordination Schedules:
1. Contractor shall submit proposed Baseline Schedule within 30 days of Notice To Proceed. Schedule shall be provided to the Owner and Engineer. Payment Applications will be withheld until a Baseline Schedule is provided by Contractor.

C. Construction Progress Meetings:
1. Engineer will schedule and conduct a meeting at least weekly and at other times requested by Engineer. Representatives of the Owner, Engineer, and Contractor shall be present at each meeting. With Engineer's concurrence, Contractor may request attendance by representatives of Subcontractors, Suppliers, or other entities concerned with current program or involved with planning, coordination, or performance of future activities. All participants in the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
2. Contractor and each Subcontractor represented shall be prepared to discuss the current construction progress report and any anticipated future changes to the schedule. Each Subcontractor shall comment on the schedules of Contractor and other Subcontractors and advise if their current progress or anticipated activities are compatible with that Subcontractor's Work.
3. If one Subcontractor is delaying another, Contractor shall issue such directions as are necessary to resolve the situation and promote construction progress.
4. Meeting Agenda:
a. Review of construction progress since previous meeting.
b. Field observations, interface requirements, conflicts.
c. Issues which may impede construction schedule.
d. Off-Site fabrication.
e. Delivery schedules.
f. Submittal schedules and status.
g. Site use; coordination with other contractors.
h. Temporary facilities, controls, and services.
i. Hours of Work.
j. Hazards and risks.
k. Housekeeping.
l. Quality and Work standards.
m. RFIs.
n. Status of Change Orders.
o. Documentation of information for payment requests.

p. Corrective measures and procedures to regain construction schedule if necessary.
q. Revisions to construction schedule.
r. Review of proposed activities for succeeding Work period.
s. Review proposed Contract modifications for:
(1) Effect on construction schedule and on completion date.
t. Other business.

5. Location of Meetings: At or near Project Site and in accordance with latest City COVID-19 protocols.
6. Reporting:
a. Within one week after each meeting, Engineer will prepare and distribute minutes of the meeting to Owner and Contractor.
b. Contractor shall distribute copies to principal Subcontractors and Suppliers.

D. Preinstallation Conferences:
1. Contractor shall conduct a preinstallation conference at the Project Site before each construction activity that requires coordination with other construction and where required in Divisions 02 through 46.
2. Installer and representatives of manufacturers and fabricators, of products furnished by this Contract or by others, involved in or affected by the installation Work and its coordination or integration with other materials and installations, shall attend the meeting. Advise Engineer of scheduled meeting dates.
3. Review the progress of other construction activities and preparations for the particular activity under consideration at each preinstallation conference, including installation procedures and requirements for the following:
a. Contract Documents.
b. Options.
c. Related Change Orders.
d. Purchases.
e. Deliveries.
f. Shop Drawings, product data, and quality control Samples.
g. Review of mockups.
h. Possible conflicts.
i. Compatibility problems.
j. Time schedules.
k. Weather limitations.
l. Manufacturer's recommendations.
m. Warranty requirements.
n. Acceptability of substrates.
o. Temporary facilities and controls.
p. Space and access limitations.
q. Governing regulations.
r. Safety.
s. Inspecting and testing requirements.
t. Required performance results.
u. Recording requirements.
v. Protection of construction, personnel, and adjacent work.
4. Record significant discussions and agreements and disagreements of each conference. Distribute the minutes of the meeting within one week after the meeting to everyone concerned, including Owner and Engineer.

5. Do not proceed with the installation if disagreements arise during the conference which cannot be successfully resolved at the time. Contractor shall take actions necessary to resolve impediments to performance of Work and reconvene the conference at the earliest feasible date.
6. Location of Meetings: At or near the Project Site.
7. Reporting:
    a. Within three working days after each meeting, Engineer will prepare and distribute minutes of the meeting to Owner and contractors.
    b. Contractors shall distribute copies to affected Subcontractors and Suppliers.

E. Startup Coordination Meetings:
1. Engineer will conduct daily startup coordination meetings at the Site with prime contractors. Regular meetings will be held starting when Contractor's Work begins commissioning and startup activities and will continue until Substantial Completion is achieved. Contractor and its major Subcontractors shall attend and participate in the meetings.
2. Agenda:
    a. Review of commissioning progress.
    b. Safety, hazard, and risk consideration.
    c. Startup observations and deviations from procedures.
    d. Coordination among multiple prime contractors as applicable.
    e. Issues that may impede startup.
    f. Construction interfaces affecting startup.
    g. Delivery schedules.
    h. Performance and acceptance testing.
    i. Quality assurance and quality control issues.
    j. Corrective and/or warranty issues.
    k. Other items as appropriate.

1.07 REQUESTS FOR INFORMATION (RFI):

A. Procedure: Promptly on discovery of the need for interpretation of the Contract Documents, and if not possible to request interpretation at Project meeting, prepare and submit an RFI with the content specified.
1. RFIs shall originate with Contractor. RFIs submitted by entities other than Contractor will be returned with no response.
2. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's Work or work of Subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing interpretation and the following:
1. Project name.
2. Date.
3. Name of Contractor.
4. Contract number and title.
5. Name of Engineer.
6. RFI number, numbered sequentially.
7. Specification Section number and title and related paragraphs, as appropriate.
8. Drawing number and detail references, as appropriate.
9. Field dimensions and conditions, as appropriate.
10. Contractor's suggested solution(s). If Contractor's solution(s) impact the Contract Times or the Contract Price, Contractor shall state impact in the RFI.

11. Contractor's signature.
12. Attachments: Include drawings, descriptions, measurements, photos, product data, Shop Drawings, and other information necessary to fully describe items needing interpretation.

C. Software-Generated RFIs: Software-generated form with substantially the same content as indicated above.
   1. Attachments shall be electronic files in Adobe Acrobat PDF format.

D. Engineer's Action: Engineer will review each RFI, determine action required, and return it. To make changes to the Contract, the Engineer's Action will be issued as a Field Order with the Engineer's documentation attached to the Field Order. To make changes to Contract Time or Price, a Change Order will be issued.
   1. The following RFIs will be returned without action:
      a. Requests for approval of Submittals.
      b. Requests for approval of substitutions.
      c. Requests for coordination information already indicated in the Contract Documents.
      d. Requests for adjustments in the Contract Times or the Contract Price.
      e. Requests for interpretation of Engineer's actions on Submittals.
      f. Incomplete RFIs or RFIs with numerous errors.
   2. Multiple RFIs addressing similar or identical issues may be addressed by Engineer with a single broad response.
   3. Engineer's action may include a request for additional information, in which case Engineer's time for response will start again upon Contractor's response and resubmittal.
   4. If Contractor believes the RFI response warrants change in the Contract Times or the Contract Price, notify Engineer in writing within ten days of receipt of the RFI response.

E. On receipt of Engineer's action, update the RFI log and promptly distribute the RFI response to affected parties. Review response and notify Engineer within seven days if Contractor disagrees with response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Electronic log with not less than the following:
   1. Project name.
   2. Name and address of Contractor.
   3. Contractor representative name and telephone number.
   4. Name and address of Engineer.
   5. RFI number including RFIs that were dropped and not submitted.
   6. RFI description.
   7. Date the RFI was submitted.
   8. Date Engineer's response was received.
   9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION - NOT APPLICABLE

END OF SECTION 01 31 00

SECTION 01 32 00 – CONSTRUCTION PROGRESS SCHEDULES AND REPORTS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:
   1. Preliminary construction progress schedule.
   2. Construction progress schedule.
   3. Schedule of Submittals.
   4. Construction progress reports.
   5. Daily construction reports.
   6. Equipment and Material location reports.
   7. Field condition reports.

1.02 RELATED REQUIREMENTS:

A. For submitting and distributing meeting and conference minutes: Section 01 31 00 – "Project Coordination and Meetings."
B. For submitting schedules and reports: Section 01 33 00 – "Submittals."
C. For submitting construction photographs: Section 01 32 33 – "Construction Photographs."
D. For schedule of values: Section 01 29 00 – “Measurement and Payment.”

1.03 DEFINITIONS:

A. Activity: A discrete part of a contract that can be identified for planning, scheduling, monitoring, and controlling the construction Work. Activities included in a construction schedule consume time and resources, but shall not include planned work stoppages. Activities shall not normally reflect the Work of more than one trade.
   1. Critical activities are activities on the critical path and have zero or negative float. Critical activities must start and finish on the planned early start and finish times.
   2. Predecessor Activity: An activity that precedes another activity in the network.
   3. Successor Activity: An activity that follows another activity in the network.
B. "Baseline" schedule: The schedule submitted and accepted by Engineer for the Work.
C. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Contract duration and contains no float.
D. Event: The starting or ending point of an activity. An event has no duration.
E. Float: The measure of leeway in starting and completing an activity.
   1. Float time belongs to Owner.
   2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
   3. Total float is the measure of leeway in starting or completing an activity without adversely affecting an intermediate deadline or the planned Contract completion date.
F. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.
G. Milestone: A key or critical point in time for reference or measurement. A milestone has no duration.
H. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships.

1.04 SUBMITTALS:

A. Qualification Data: For scheduling consultant.

B. Schedule of Submittals: Submit in specified electronic format copies of schedule. Arrange the following information in a tabular format:
   1. Scheduled date for first submittal.
   2. Specification Section number and title.
   3. Submittal category (technical or informational).
   4. Name of Subcontractor or Supplier.
   5. Description of the Work covered.
   6. Scheduled date for Engineer's final release or approval.

C. Preliminary Construction Progress Schedule: Submit in specified electronic format.
   1. Acceptance of cost-loaded preliminary construction schedule will not constitute acceptance of schedule of values for cost-loaded activities.

D. Construction Progress Schedule: Submit initial schedule, large enough to show entire schedule for entire construction period to Engineer for review and acceptance.
   1. Submit electronically, using software indicated, labeled to comply with requirements for Submittals. Include type of schedule (Initial or Updated) and date.

E. Schedule of Values: Submit with initial construction progress schedule to Engineer for review and approval in specified electronic format.

1.05 COORDINATION:

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate contractors.

B. Coordinate construction progress schedule with the schedule of values, list of subcontracts, schedule of Submittals, Material and Equipment procurement, progress reports, payment requests, and other required schedules and reports.
   1. Secure time commitments for performing critical elements of the Work from parties involved.
   2. Coordinate each construction activity in the network with other activities and schedule them in proper sequence.

PART 2 - PRODUCTS

2.01 SCHEDULE OF SUBMITTALS:

A. Preparation: Submit a schedule of Submittals, arranged in chronological order by dates required by construction progress schedule. Include time required for review, resubmittal, ordering, manufacturing, fabrication, and delivery when establishing dates as required in Section 01 33 00 – "Submittals."
   1. Coordinate Submittals schedule with list of subcontracts, the schedule of values, and "Baseline" construction progress schedule.
   2. Initial Submittal: Submit concurrently with preliminary bar-chart schedule. Include Submittals required during the first 60 days of construction. List those required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
   3. Final Submittal: Submit concurrently with the first complete submittal of construction progress schedule.

2.02 CONTRACTOR'S CONSTRUCTION PROGRESS SCHEDULE, GENERAL:

A. Time Frame: Extend schedule from date established for commencement of the Work to date of Substantial Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Change Order.

B. Activities: Treat each building or separate area as a separate numbered activity for each principal element of the Work. Comply with the following:
   1. Activity Duration: Define activities so no activity is longer than 30 calendar days, unless specifically allowed by Engineer.
   2. Procurement Activities: Include procurement process activities for the following long lead items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, Submittals, approvals, purchasing, fabrication, and delivery.
      a. Horizontal End-Suction Pump
      b. Custom Fabricated Steel Pipe Fittings
      c. Electrical Equipment
   3. Submittal Review Time: Include review and resubmittal times indicated in Section 01 33 00 – "Submittals" in schedule. Coordinate Submittal review times in Contractor's construction progress schedule with schedule of Submittals.
   4. Startup and Testing Time: Include not less than five (5) days for startup and testing.
   5. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for Engineer's administrative procedures necessary for certification of Substantial Completion.

C. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.
   1. Work Restrictions: Show the effect of the following items on the schedule:
      a. Coordination with existing construction.
      b. Limitations of continued occupancies.
      c. Use of premises restrictions.
      d. Seasonal variations.
      e. Environmental control.

D. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion, and Final Completion.

E. Contract Modifications: For each proposed Contract modification and concurrent with its submission, prepare a time-impact analysis using fragnets to demonstrate the effect of the proposed change on the overall schedule.

2.03 PRELIMINARY CONSTRUCTION PROGRESS SCHEDULE:

A. Bar-Chart Schedule: Submit preliminary horizontal bar-chart-type construction schedule within seven days of date established in the Notice to Proceed.
   1. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first 60 days of construction. Include skeleton diagram for the remainder of the Work.

2.04 CONSTRUCTION PROGRESS SCHEDULE (GANTT CHART):

A. Gantt-Chart Schedule: After submittal of preliminary construction progress schedule as stated above, submit a detailed baseline construction progress schedule within 30 days after the Notice to Proceed. Base the schedule on the preliminary construction progress schedule and incorporate review comments and other feedback.

B. The schedule shall show the Work in a horizontal bar chart or other graphic format suitable for displaying scheduled and actual progress.

1. The schedule shall indicate phases of the Work, starting date, interim milestones, and dates of Substantial Completion and Final Completion.
2. Breakdown Work phases into separate time bar for each significant construction activity entry, with dates Work is expected to begin and be completed. Within each time bar, indicate estimated completion percentage in 10% increments.
3. Scale and spacing shall allow room for notation and revisions.
4. Sheet Size: Minimum 11 x 17 inches.

C. Provide subschedules to define in more detail critical portions of schedules, including inspections and tests.

D. Coordinate construction progress schedule with schedule of values, schedule of Submittals schedule, procurement schedule, progress reports, and payment requests.

E. Engineer will review and comment on construction progress schedule and, upon agreement between Engineer and Contractor on necessary changes:
1. Contractor shall distribute copies as specified of the accepted "baseline" schedule to Engineer. Contractor shall provide additional copies to Subcontractors and other parties required to comply with scheduled dates, one copy to each party.

F. Revise the construction progress schedule after each meeting, event, or activity where revisions have been recognized and accepted to reflect impacts of new developments on the schedule.

G. Update and submit electronic copy to Engineer of the revised schedule at least once each month to show actual progress compared to the originally accepted "baseline" schedule and any proposed changes in the schedule of remaining Work. Include with construction progress report.

2.05 REPORTS:

A. Construction Progress Reports:
1. Submit a report on actual construction progress on a weekly basis. More frequent reports may be required should the Work fall behind the accepted schedule.
   a. Submit a weekly report (and three-week look-ahead schedule) to coordinate with and supplement the monthly construction progress report and which details Work scheduled for the following one-week interval, including:
      (1) Work activities which will occur.
      (2) Number and size of crews.
      (3) Construction equipment on Site.
      (4) Major items of Equipment and Material to be installed.
   b. Format shall be on 8-1/2 x 11-inch paper, submitted to Engineer electronically.
2. Construction progress reports shall consist of the revised construction progress schedule and a narrative report which shall include but not be limited to the following:
   a. Comparison of actual progress to planned progress shown on originally accepted schedule.
   b. Summary of activities completed since the previous construction progress report.
   c. Summary of activities planned for next reporting period.
   d. Planned, earned, and spent earned value analysis for the month.
   e. Identification of problem areas.
   f. A description of current and anticipated delaying factors, if any.
   g. Impact of possible delaying factors.
   h. Proposed corrective actions.
3. If a schedule update reveals that, through no fault of Owner, the Work is likely to be completed later than the Contract completion date, Contractor shall:
   a. Establish a plan for making up lost time.

b. Submit plan to Owner and Engineer before implementing the plan.
c. Take actions as necessary to get the Work back on schedule at no additional cost to Owner.

B. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project Site:
1. List of Subcontractors at Project Site.
2. Approximate count of personnel at Project Site, and breakdown by craft.
3. Equipment at Project Site.
4. Material deliveries.
5. High and low temperatures and general weather conditions.
6. Accidents.
7. Meetings and significant decisions.
8. Stoppages, delays, shortages, and losses.
9. Emergency procedures.

C. Equipment and Material Location Reports: At bi-weekly intervals, prepare and submit a comprehensive list of Equipment and Materials delivered to and stored at Project Site. List shall be cumulative, showing Equipment and Materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for Materials or items of Equipment fabricated or stored away from Project Site.

D. Field Condition Reports: Promptly on discovery of a difference between field conditions and the Contract Documents, prepare and submit a detailed report. Submit with a request for information (RFI). Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

PART 3 - EXECUTION

3.01 CONSTRUCTION PROGRESS SCHEDULE:

A. Construction Progress Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled construction progress meeting.
1. Revise schedule immediately after each meeting or other activity where revisions have been recognized or made. Issue updated schedule concurrently with the report of each such meeting.
2. Include a report with updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. As the Work progresses, indicate actual completion percentage for each activity.

B. Distribution: Distribute copies of accepted schedule to Engineer, Owner, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.
1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

END OF SECTION 01 32 00

SECTION 01 32 33 – CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section specifies administrative and procedural requirements for construction photographs.

1.02 SUBMITTALS:

A. Submit prints as specified in Section 01 33 00 – "Submittals" and in PART 3 - this Section.

PART 2 - PRODUCTS

2.01 PHOTOGRAPHIC REQUIREMENTS: SPECIFIED IN PART 3, THIS SECTION.

PART 3 - EXECUTION

3.01 PROGRESS SITE PHOTOGRAPHS:

A. Contractor shall be responsible for photographs of the Site to show the existing and general progress of the Work. Engineer will advise as to which views are of interest. Photographs shall be taken of the following areas and at the following times.
   1. Existing Site conditions before Site work is started. Number of views shall be adequate to cover the Site.
   2. Progress of the Work throughout construction. There shall be adequate photographs taken each month to clearly show construction progress.
   3. Finished Project after completion of Work. Number of views shall be adequate to show the finished Work.
   4. If Project is not completed during the Contract Time or authorized extensions, photographs shall continue to be taken at no increase in Contract Price.

B. Photographic Prints:
   1. Shall not be accepted.

C. Digital Images:
   1. Submit a complete set of digital image electronic files.
      a. Provide images in JPEG format, with minimum sensor size of 7.0 megapixels.
      b. Submit images that have same aspect ratio as the sensor, uncropped.
      c. Provide a descriptive file name for each photo image.
      d. Identify electronic media with date digital photographs were taken.
      e. Submit digital images to Engineer.
      f. Include an index documenting the photo number, location and description of the image.

3.02 AUDIO/VIDEO TAPE RECORDINGS:

A. Audio/video recordings shall be made of the entire Site showing the condition of the Site or terrain previous to any alterations by Contractor and before disturbing of the Site is started. A second audio/video recording shall be produced after completion of all construction operations, showing the same view or views as close as possible, to illustrate "before" and "after" conditions. This is the responsibility of Contractor. Three days' notice shall be given to Engineer and Owner prior to this Work to allow them to accompany electrographer.

B. The principal reason for producing video tapes is so that conditions of site or other problems along the construction route may be more clearly shown and recorded. This will to some

degree preclude the possibility of post construction litigation with property owners adjacent to the Work.

C. All required equipment, accessories, materials, and labor for the timely production of this documentation shall be arranged/furnished through Contractor.
   1. The audio/video system shall be capable of producing bright, sharp, clear visual images which render accurate colors free from imperfections and distortions that might obscure recorded information during playback. The simultaneous audio record shall be made directly onto the original tapes, and shall record narration of the electrographer clearly and audibly, with adequate volume, free from unnecessary interruptions and distortions that might eliminate recorded information during playback.

D. Zone of Influence: Unless otherwise indicated by Engineer or Owner, the "Zone of Influence" which might be affected by the construction operations and, therefore, shall be documented in these tape recordings, shall be whichever of the following includes the greatest area.
   1. All areas within 35 feet of the proposed improvements.
   2. All areas within the Project Site.

E. Audio/Video Tape Production Procedures:
   1. It is recommended that the audio/video tape recordings be produced while actually walking the construction Site - NOT through the use of wheeled vehicles.
   2. All video tape recordings shall display digital information continuously; this information shall include the current time and date, showing the month, day, and year. This information shall be audibly acknowledged by the electrographer at appropriate times during recording sequences.
   3. All recordings shall be completed during periods of adequate lighting and visibility. Sufficient lighting must be available to provide proper illumination of shadowed areas, and proper exposure adjustments shall be made where required. No taping shall be completed during precipitation, mist, fog, or when more than 10% of the ground surface has snow cover.

END OF SECTION 01 32 33

SECTION 01 33 00 – SUBMITTALS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes definitions, descriptions, transmittal, and review of Submittals.

1.02 RELATED REQUIREMENTS:

A. Section 01 31 00 – "Project Coordination and Meetings."
B. Section 01 32 33 – "Construction Photographs."
C. Section 01 78 00 – "Contract Closeout."

1.03 GENERAL INFORMATION:

A. Definitions:
   1. Shop Drawings, product data, and Samples are technical Submittals prepared by Contractor, Subcontractor, manufacturer, or Supplier and submitted by Contractor to Engineer as a basis for approval of the use of Equipment and Materials proposed for incorporation in the Work or needed to describe installation, operation, maintenance, or technical properties, as specified in each Division of the Specifications.
      a. Shop Drawings include custom-prepared data of all types including drawings, diagrams, performance curves, material schedules, templates, instructions, and similar information not in standard printed form applicable to other projects.
      b. Product data includes standard printed information on materials, products, and systems; not custom-prepared for this Project, other than the designation of selections from available choices.
      c. Samples include both fabricated and unfabricated physical examples of materials, products, and Work; both as complete units and as smaller portions of units of Work; either for limited visual inspection or (where indicated) for more detailed testing and analysis. Mock-ups are a special form of Samples which are too large to be handled in the specified manner for transmittal of Sample Submittals.
      d. Descriptions of submittal requirements (as applicable) are defined in Appendix B – Submittal Descriptions.
   2. Informational Submittals are those technical reports, administrative Submittals, certificates, and guarantees not defined as Shop Drawings, product data, or Samples.
      a. Technical reports include laboratory reports, tests, technical procedures, technical records, and Contractor's design analysis.
      b. Administrative Submittals are those nontechnical Submittals required by the Contract Documents or deemed necessary for administrative records. These Submittals include maintenance agreements, Bonds, Project photographs, physical work records, statements of applicability, copies of industry standards, Project record data, schedules, security/protection/safety data, and similar type Submittals.
      c. Certificates and guarantees are those Submittals on Equipment and Materials where a written certificate or guarantee from the manufacturer or Supplier is called for in the Specifications.
   3. Refer to ARTICLES 1.03 and 1.04 of this Part for detailed lists of Submittals and specific requirements.
B. Quality Requirements:
   1. Submittals such as Shop Drawings and product data shall be of suitable quality for legibility and reproduction purposes. Every line, character, and letter shall be clearly legible. Drawings such as reproducibles shall be useable for further reproduction to yield legible hard copy.

2. Documents submitted to Engineer that do not conform to specified requirements shall be subject to rejection by Engineer, and upon request by Engineer, Contractor shall resubmit conforming documents. If conforming Submittals cannot be obtained, such documents shall be retraced, redrawn, or photographically restored as may be necessary to meet such requirements. Contractor's or his Subcontractor's failure to initially satisfy the legibility quality requirements will not relieve Contractor or his Subcontractors from meeting the required schedule for Submittals.

C. Language and Dimensions:
   1. All words and dimensional units shall be in the English language.
   2. Metric dimensional unit equivalents may be stated in addition to the English units. However, English units of measurement shall prevail.

D. Submittal Completeness:
   1. Submittals shall be complete with respect to dimensions, design criteria, materials of construction, and other information specified to enable Engineer to review the information effectively.
   2. Where standard drawings are furnished which cover a number of variations of the general class of Equipment, each drawing shall be annotated to indicate exactly which parts of the drawing apply to the Equipment being furnished. Use hatch marks to indicate variations that do not apply to the Submittal. The use of "highlighting markers" will not be an acceptable means of annotating Submittals. Annotation shall also include proper identification of the Submittal permanently attached to the drawing.
   3. Reproductions or copies of Contract Drawings or portions thereof will not be accepted as complete fabrication or erection drawings. Contractor may use a reproduction of Contract Drawings for erection drawings to indicate information on erection or to identify detail drawing references. Whenever the Drawings are revised to show this additional Contractor information, Engineer's title block shall be replaced with Contractor's title block, and Engineer's professional seal shall be removed from the drawing. Contractor shall revise these erection drawings for subsequent Engineer revisions to the Contract Drawings.

E. Form of Submittals:
   1. Submittals and other Project documents shall be transmitted in electronic format as specified.
      a. Equipment instruction books and operating manuals shall be provided in paper copies in addition to specified electronic format.
   2. Electronic Format:
      a. Scanned Submittals and documents are not acceptable. Transmit Submittals and Project documents in:
         (1) Nonproprietary, native electronic format incorporating any necessary reference files, or
         (2) Adobe *PDF files created directly from native electronic format, or
         (3) Engineer-approved equal.
         (4) Each file will be right reading and orientation the same for all consecutive resubmissions.
         (5) For any given Submittal, the filename and format shall be consistent for initial submission and subsequent revisions of the same. Use consistent naming convention throughout. Reference to revision or dates shall not be included in a filename.
         (6) Nonconforming Submittals are subject to rejection by Engineer.

b. Provide "as-constructed" Submittals, record documents, Equipment instruction books and operating manuals, and other documents on USB in Adobe *PDF format as required and approved by Owner.
c. Equipment instruction books and operating and maintenance manuals shall be in Adobe *PDF format combined in one pdf file for the complete O&M manual, or divided into pdf files that represent entire volumes (corresponding to hardcopy volumes). The pdf files shall be completely bookmarked with links within the index sheet to the different sections within the manuals/volumes, corresponding to the defined tabs within the hardcopy version.

1.04 TECHNICAL SUBMITTALS:

A. Items shall include, but not be limited to, the following:
1. Manufacturer's specifications.
2. Catalogs, or parts thereof, of manufactured Equipment.
3. Shop fabrication and erection drawings.
4. General outline drawings of Equipment showing overall dimensions, location of major components, weights, and location of required building openings and floor plates.
5. Detailed Equipment installation drawings, showing foundation details, anchor bolt sizes and locations, baseplate sizes, location of Owner's connections; and all clearances required for erection, operation, and disassembly for maintenance.
6. Schematic diagrams for electrical items, showing external connections, terminal block numbers, internal wiring diagrams and one-line diagrams.
7. Bills of material and spare parts list.
8. Instruction books and operating manuals.
9. Material lists or schedules.
10. Performance tests on Equipment by manufacturers.
11. Concrete mix design information.
12. Samples and color charts.
13. All drawings, catalogs or parts thereof, manufacturer's specifications and data, Samples, instructions, and other information specified or necessary:
a. For Engineer to determine that Equipment and Materials conform to the design concept and comply with intent of the Contract Documents.
b. For proper erection, installation, operation, and maintenance of Equipment and Materials which Engineer will review for general content but not for basic details.
c. For Engineer to determine what supports, anchorages, structural details, connections, and services are required for Equipment and Materials, and effects on contiguous or related structures and Equipment and Materials.

B. Schedule of Submittals:
1. Prepare for Engineer's concurrence, a schedule for submission of all Submittals specified or necessary for Engineer's approval of the use of Equipment and Materials proposed for incorporation in the Work or needed for proper installation, operation, or maintenance. Submit the schedule with the procurement schedule and construction progress schedule. Schedule submission of all Submittals to permit review, fabrication, and delivery in time so as to not cause a delay in the Work of Contractor or his Subcontractors or any other contractors as described in the Contract Documents.
2. In establishing schedule for Submittals, allow 20 days in Engineer's office for reviewing original Submittals and 15 days in Engineer's office for reviewing resubmittals.
3. Submittals requiring revision shall be resubmitted within 15 days after receipt of Engineer's review notations.

4. The schedule shall indicate the anticipated dates of original submission for each item and Engineer's approval thereof, and shall be based upon at least one resubmission of each item.
5. Schedule all Submittals (Shop Drawings, product data, and Samples) required prior to fabrication or manufacture for submission within 90 days of the Notice to Proceed. Schedule Submittals pertaining to storage, installation, and operation at the Site for Engineer's approval prior to delivery of the Equipment and Materials.
6. Resubmit Submittals the number of times required for Engineer's "Submittal Approved." However, any need for resubmittals in excess of the number set forth in the accepted schedule, or any other delay in obtaining approval of Submittals, will not be grounds for extension of the Contract Times, provided Engineer completes his reviews within the times specified.
7. Where a Submittal is required by the Contract Documents or the accepted schedule of Submittals, any related Work performed prior to Engineer's review and approval of the pertaining Submittal will be at the sole expense and responsibility of Contractor.

C. Transmittal of Submittals:
1. All Submittals (Shop Drawings, product data, and Samples) for Equipment and Materials furnished by Contractor, Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor.
2. After checking and verifying all field measurements, transmit all Submittals to Engineer for approval as follows:
   a. Submittal Information Block:
      (1) Affix to all paper copies whether Submittal is prepared by Contractor, Subcontractor, or Supplier. Use transparent decal type Submittal Information Blocks for Shop Drawings and use gummed paper type for product data and Sample Submittals. All Submittal Information Blocks needed for this Contract will be furnished to Contractor at no charge at the initial coordination conference.
   b. Submittals shall be numbered sequentially. Resubmission shall include original submittal number with sequential alphabetic suffix.
   c. Limit information in each submittal to grouping by specification section.
   d. Mark each Submittal by Project name and number, Contract title and number, and applicable Specification Section and Article number. Include in the letter of transmittal the Drawing number and title, sheet number (if applicable), revision number, and electronic filename (if applicable). Unidentifiable Submittals will be returned for proper identification.
   e. Check and approve Submittals of Subcontractors, Suppliers, and manufacturers prior to transmitting them to Engineer. Contractor's submission shall constitute a representation to Owner and Engineer that Contractor approves Submittals and has determined and verified all design criteria, quantities, dimensions, field construction and installation criteria, materials, catalog numbers, compliance with Laws and Regulations, and similar data, and Contractor assumes full responsibility for doing so; and Contractor has coordinated each Submittal with the requirements of the Work and the Contract Documents.
   f. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from requirements of the Contract Documents.
   g. Make all modifications noted or indicated by Engineer and return the required number of revised Submittals until approved. Direct specific attention in writing, or on revised Submittals, to changes other than the modifications called for by

Engineer on previous Submittals. After paper copy Submittals have been approved, submit copies thereof for final distribution. Previously approved Submittals transmitted for final distribution will not be further reviewed and are not to be revised. If errors are discovered during manufacture or fabrication, correct the Submittal and resubmit for review.

h. Following completion of the Work and prior to final payment, furnish record documents and approved Samples and Shop Drawings necessary to indicate "as constructed" conditions, including field modifications, in the number of copies specified. Furnish additional copies for insertion in Equipment instruction books and operating manuals as required. All such copies shall be clearly marked "PROJECT RECORD."
   (1) Submit a final record copy of the Master Field Drawing list which shall indicate the final revision status of each drawing on the list.

i. Keep a copy or sample of each Submittal in good order at the Site.

3. Quantity Requirements:
   a. Except as otherwise specified, transmit all Shop Drawings in the following quantities:
      (1) Initial Submittal:
         (a) Electronic - One copy to Engineer.
      (2) Resubmittals:
         (a) Electronic - One copy to Engineer.
      (3) Submittal for final distribution:
         (a) Electronic - One copy to Engineer.
      (4) As-constructed documents:
         (a) Electronic - One copy to Engineer. One copy to Owner.
   b. Transmit Submittals of product data as follows:
      (1) Initial Submittal:
         (a) Electronic - One copy to Engineer.
      (2) Resubmittals:
         (a) Electronic - One copy to Engineer.
      (3) Submittal for final distribution:
         (a) Electronic - One copy to Engineer.
   c. Transmit Submittals of Equipment instruction books and operating manuals as follows:
      (1) Initial Submittal:
         (a) Electronic - One copy to Engineer. One copy to Owner.
      (2) Resubmittals:
         (a) Electronic - One copy to Engineer. One copy to Owner.
      (3) Submittal for Final Distribution – one electronic copy to Engineer.
   d. When all Submittals have been updated to "as-constructed" conditions, transmit to Engineer and to Owner in electronic format.
   e. Owner may copy and use for internal operations and staff training purposes any and all document Submittals required by this Contract and approved for final distribution, whether or not such documents are copyrighted, at no additional cost to Owner. If permission to copy any such Submittal for the purposes stated is unreasonably withheld from Owner by Contractor or any Subcontractor, manufacturer, or Supplier, Contractor shall provide to Engineer 50 copies plus the number of copies required by Contractor at each final distribution issue.

D. Engineer's Review:

1. Engineer will review and take appropriate action on Submittals in accordance with the accepted schedule of Submittals. Engineer's review and approval will be only to determine if the items of Equipment and Materials covered by the Submittals will, after installation or incorporation in the Work, conform to information given in the Contract Documents and be compatible with the design concept of the completed Project as a functioning whole as indicated by the Contract Documents.
2. Engineer's review and approval will not extend to design data reflected in Submittals which is peculiarly within the special expertise of Contractor or Contractor's Subcontractors or Suppliers. Review and approval of a component item as such will not indicate approval of the assembly in which the item functions.
3. Engineer's review and approval of Shop Drawings, product data, or Samples will not relieve Contractor of responsibility for any deviation from requirements of the Contract Documents unless Contractor has in writing called Engineer's attention to such deviation at the time of submission, and Engineer has given written concurrence in and approval of the specific deviation. Approval by Engineer shall not relieve Contractor from responsibility for errors or omissions in Submittals.

E. Submittal Action Stamp:

1. Engineer's review action stamp, appropriately completed, will appear on all Submittals of Contractor when returned by Engineer. Review status designations listed on Engineer's action stamp are defined as follows:

   A - SUBMITTAL APPROVED: Signifies Equipment or Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work. Contractor is to proceed with fabrication or procurement of the items and with related Work. Copies of the Submittal are to be transmitted to Engineer for final distribution.

   B - SUBMITTAL APPROVED AS NOTED (RESUBMIT): Signifies Equipment and Material represented by the Submittal conforms with the design concept and complies with the intent of the Contract Documents and is approved for incorporation in the Work in accordance with Engineer's notations. Contractor is to proceed with fabrication or procurement of the items and with related Work in accordance with Engineer's notations and is to submit a revised Submittal responsive to notations marked on the returned Submittal or written in the letter of transmittal.

   C - SUBMITTAL RETURNED FOR REVISION (RESUBMIT): Signifies Equipment and Material represented by the Submittal appears to conform with the design concept and comply with the intent of the Contract Documents but information is either insufficient in detail or contains discrepancies which prevent Engineer from completing his review. Contractor is to resubmit revised information responsive to Engineer's annotations on the returned Submittal or written in the letter of transmittal. Fabrication or procurement of items represented by the Submittal and related Work is not to proceed until the Submittal is approved.

   D - SUBMITTAL NOT APPROVED (SUBMIT ANEW): Signifies Equipment and Material represented by the Submittal does not conform with the design concept or comply with the intent of the Contract Documents and is disapproved for use in the Work. Contractor is to provide Submittals responsive to the Contract Documents.

E - PRELIMINARY SUBMITTAL: Signifies Submittals of such preliminary nature that a determination of conformance with the design concept or compliance with the intent of the Contract Documents must be deferred until additional information is furnished. Contractor is to submit such additional information to permit layout and related activities to proceed.

F - FOR REFERENCE, NO APPROVAL REQUIRED: Signifies Submittals which are for supplementary information only; pamphlets, general information sheets, catalog cuts, standard sheets, bulletins and similar data, all of which are useful to Engineer or Owner in design, operation, or maintenance, but which by their nature do not constitute a basis for determining that items represented thereby conform with the design concept or comply with the intent of the Contract Documents. Engineer reviews such Submittals for general content but not for basic details.

G - DISTRIBUTION COPY (PREVIOUSLY APPROVED): Signifies Submittals which have been previously approved and are being distributed to Contractor, Owner, Resident Project Representative, and others for coordination and construction purposes.

F. Instruction Books and Operating Manuals:
   1. In addition to electronic Submittals specified above, equipment instruction books and operating manuals prepared by the manufacturer shall include the following:
      a. Index and tabs.
      b. Instructions for installation, start-up, operation, inspection, maintenance, parts lists and recommended spare parts, and data sheets showing model numbers.
      c. Applicable drawings.
      d. Warranties and guarantees.
      e. Address of nearest manufacturer-authorized service facility.
      f. All additional data specified.
   2. Information listed above shall be bound into hard-back binders of three-ring type. Sheet size shall be 8-1/2 x 11. Binder color shall be black. Capacity shall be a minimum of 1-1/2 inches, but sufficient to contain and use sheets with ease.
      a. Provide the following accessories:
         (1) Label holder.
         (2) Business card holder.
         (3) Sheetlifters.
         (4) Horizontal pockets.
      b. The following information shall be imprinted, inserted, or affixed by label on the binder front cover:
         (1) Owner's name.
         (2) Owner's facility or plant name.
         (3) Equipment item name.
         (4) Volume number (if applicable).
         (5) Contract number.
         (6) Manufacturer's name and address.
      c. The following information shall be imprinted, inserted, or affixed by label on the binder spine:
         (1) Equipment item name.
         (2) Owner's name and Owner's facility or plant name.
         (3) Manufacturer's name.

(4) Contract number.
(5) Volume number (if applicable).

d. Submit mockup of cover and spine for Engineer's review.

G. Samples:
1. Office Samples shall be of sufficient size and quantity to clearly illustrate the following:
a. Functional characteristics of the product, with integrally related parts and attachment devices.
b. Full range of color, texture, and pattern.
c. Material, manufacturer, pertinent catalog number, and intended use.

1.05 INFORMATIONAL SUBMITTALS:

A. Informational Submittals are comprised of technical reports, administrative Submittals, and guarantees which relate to the Work, but do not require Engineer approval prior to proceeding with the Work. Informational Submittals include:
1. Welder qualification tests.
2. Welding procedure qualification tests.
3. Hydrostatic testing of pipes.
4. Field test reports.
5. Concrete cylinder test reports.
6. Certification on Materials:
a. Steel mill tests.
b. Paint laboratory tests.
c. Metal paneling laboratory tests.
d. Cement tests.
7. Piping stress analysis.
8. Shipping or packing lists.
9. Job progress schedules.
10. Equipment and Material delivery schedules.
11. Progress photographs.
12. Warranties and guarantees.

B. Transmittal of Informational Submittals:
1. All informational Submittals furnished by Subcontractors, manufacturers, and Suppliers shall be submitted to Engineer by Contractor unless otherwise specified.
a. Identify each informational Submittal by Project name and number, Contract title and number, and Specification Section and Article number marked thereon or in letter of transmittal. Unidentifiable Submittals will be returned for proper identification.
b. At the time of each submission, call to the attention of Engineer in the letter of transmittal any deviations from requirements of the Contract Documents.
2. Quantity Requirements:
a. Technical reports and administrative Submittals except as otherwise specified:
(1) Electronic: One to Engineer.
b. Written Certificates and Guarantees:
(1) Engineer: One copy.
3. Test Reports:
a. Responsibilities of Contractor, Owner, and Engineer regarding tests and inspections of Equipment and Materials and completed Work are set forth elsewhere in these Contract Documents.

b. The party specified responsible for testing or inspection shall in each case, unless otherwise specified, arrange for the testing laboratory or reporting agency to distribute test reports as follows:
   (1) Owner: Electronic copy.
   (2) Engineer: Electronic copy.
   (3) Resident Project Representative: Electronic copy.
   (4) Contractor: Electronic copy.
   (5) Manufacturer or Supplier: Electronic copy.

C. Engineer's Review:
   1. Engineer will review informational Submittals for indications of Work or Material deficiencies.
   2. Engineer will respond to Contractor on those informational Submittals which indicate Work or Material deficiency.

PART 2 - EXECUTION - NOT APPLICABLE.

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 01 33 00

SECTION 01 35 00 – SPECIAL PROCEDURES

PART 1 - GENERAL

1.01 SUMMARY:

A. The Contractor shall obtain approval from the Project Manager one week in advance of any construction which will result in the interruption of service to an existing City customer. For major shutdowns, Contractor shall have an approved sequence of work. For all shutdowns, Contractor shall have all materials onsite, inspected by Engineer, and ready for installation.

B. Only City and County of Broomfield personnel shall operate the valves in the existing water system.

1.02 CONNECTION TO EXISTING FACILITIES:

A. The Contractor shall plan connections to existing facilities thoroughly in advance. Unless otherwise specified or indicated, the Contractor shall make all necessary connections to existing facilities. The Contractor shall sequence and schedule the work to minimize water service interruptions to the customers. All connections shall be completed, water service restored, and lanes reopened on the same day. All required equipment, materials and labor shall be on hand prior to undertaking the connections.

B. A normal outage shall be a maximum of four (4) hours. If the outage will be greater than four (4) hours, then work shall be done in a manner so as to minimize the inconvenience to the customer as directed by the Project Manager.

C. In commercial areas, any disruption of service shall be undertaken only after said disruption has been coordinated with the City and the private property owner. Coordination shall be required for both the service change over and any connections made to the existing system.

D. If an industry or building that cannot be out of water or sanitary sewer, the Contractor or as indicated otherwise shall be required to provide an appropriate means as approved by the City of providing water and sanitary sewer to the affected customer during the installation of the connection.

E. The Contractor shall notify the Project Manager at least one week prior to making connections to the existing facilities or needing any valve operated, except in the case of emergencies. All disruptions of service must be approved by the Project Manager prior to the work. The Contractor shall not schedule disruptions of service on a Monday or Friday without approval by the project manager. The Project Manager shall notify the Contractor of the timing of the connection.

F. Planned disruptions may be canceled by the Project Manager, if in the opinion of the Project Manager, the Contractor has not completed work necessary for the proposed connection by the beginning of the day of the connection, is not ready to being the connection at the start of scheduled outage, or does not have the required equipment, materials and labor on hand to make the connection within the scheduled outage time. Cancelled disruptions will be non-excusable delays.

1.03 SEQUENCE OF CONSTRUCTION AND OPERATION:

A. The Contractor shall not store equipment or materials on arterial or collector streets. The Contractor shall stage equipment and materials to minimize crossing arterial or collector streets. The Contractor shall not store equipment and materials on the street in front of residences or businesses for more than one week.

B. Trench Backfill and Maintenance

1. All pavement in arterial streets, collector street intersections; and concrete pavement and concrete pavement with an asphalt pavement overlay shall be saw cut and shall not be milled. Other locations shall be milled. The Contractor shall submit a milling and saw cutting schedule for approval by the Project Manager. The schedule shall include task/activity lines with the stationing for each phase of milling and saw cutting. The start date for milling shall not be more than two weeks before the start date for the water main installation in that phase.
2. All trenches in commercial/industrial collector streets shall be backfilled with native material or imported backfill as approved by the Engineer. If the permanent patch is not placed on the same day, all trenches in commercial/industrial collector streets shall be temporarily patched with a minimum of a 4-inch inch course of recycled asphalt millings and the permanent bottom lift patch shall be placed within two (2) calendar days. All streets must be re-opened to traffic in both directions at the end of each day.
3. All trenches in residential collector and residential streets and alleys shall be backfilled with native material or imported backfill as approved by the Engineer. Unless a permanent patch is placed on the same day, all trenches in residential collector and residential streets and alleys shall be temporarily patched with a minimum of a 4-inch inch course of recycled asphalt millings. See Section 32 11 23. All streets must be re-opened to traffic in both directions at the end of each day.
4. See Section 31 32 11 or Temporary Erosion and Sediment Control.
5. Failure by the Contractor to perform any of the above within 24 hours of written notice by the Project Manager shall cause the City to issue a STOP WORK ORDER.

C. Utility Locating Service through Vacuum Excavation (Potholing)
1. Before the asphalt pavement is cut, the Contractor shall pothole utilities to identify the alignment and depth of utility crossings. At the discretion of the Engineer, the alignment of the new water main may be changed to reduce conflicts.

1.04 WORK AREA LIMITS:

A. The Contractor shall be limited to working in the City right-of-way and utility easements.
B. The Contractor may make arrangements with the adjacent private land owners for the storage of equipment and materials. Any such arrangements must be confirmed with a written statement from the landowner and a copy must be presented to the City, for review.
C. The Contractor shall maintain access to all roadways at all times. No extra payment will be allowed for maintenance of access.
D. The Contractor shall protect all vegetation outside of the project limits and shall be liable for replacement of any vegetation damaged by his construction activities.

END OF SECTION 01 35 00

SECTION 01 40 00 – CONTRACTOR QA/QC

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality assurance and quality control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and quality control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality assurance and quality control services required by Engineer, Owner, or authorities having jurisdiction are not limited by provisions of this Section.

1.02 RELATED REQUIREMENTS:

A. For developing a schedule of required tests and inspections: Section 01 32 00 – "Construction Progress Schedules and Reports."

B. For repair and restoration of construction disturbed by testing and inspecting activities: Section 01 73 29 – "Cutting and Patching."

C. For specific test and inspection requirements: DIVISIONS 02 through 46 sections.

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International (ASTM):

1. E548 - Guide for General Criteria Used for Evaluating Laboratory Competence.

C. Code of Federal Regulations (CFR):

1. 29 CFR 1910, Subpart A, Section 1910.7 - Definition and Requirements for a Nationally Recognized Testing Laboratory (NRTL).

1.04 DEFINITIONS:

A. Quality Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

B. Quality Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate that actual Equipment and Materials incorporated into the Work and completed construction comply with requirements. Services do not include Contract enforcement activities performed by Engineer.

C. Mockups: Full-size, physical assemblies that are constructed on Site. Mockups are used to verify selections made under Sample Submittals, to demonstrate aesthetic effects and, where indicated, qualities of materials and execution, and to review construction, coordination, testing, or operation; they are not Samples. Approved mockups establish the standard by which the Work will be judged.

D. Laboratory Mockups: Full-size, physical assemblies that are constructed at testing facility to verify performance characteristics.

E. Preconstruction Testing: Tests and inspections that are performed specifically for the Project before Equipment and Materials are incorporated into the Work to verify performance or compliance with specified criteria.
F. Product Testing: Tests and inspections that are performed by an NRTL, an NVLAP, or a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with industry standards.
G. Source Quality Control Testing: Tests and inspections that are performed at the source, i.e., plant, mill, factory, or shop.
H. Field Quality Control Testing: Tests and inspections that are performed on Site for installation of the Work and for completed Work, i.e., soil compaction, concrete strength, and weld radiographs.
I. Testing Agency: An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
J. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.
K. Experienced: When used with an entity, "experienced" means having successfully completed a minimum of five previous projects similar in size and scope to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

1.05 SUBMITTALS:

A. Qualification Data: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority.
B. Schedule of Tests and Inspections: Prepare in tabular form and include the following:
    1. Specification Section number and title.
    2. Description of test and inspection.
    3. Identification of applicable standards.
    4. Identification of test and inspection methods.
    5. Number or frequency of tests and inspections required.
    6. Time schedule or time span for tests and inspections.
    7. Entity responsible for performing tests and inspections.
    8. Requirements for obtaining samples.
    9. Unique characteristics of each quality control service.
C. Reports: Arrange for testing agency/laboratory to prepare and submit certified written reports that include the following:
    1. Date of issue.
    2. Project title and number.
    3. Name, address, and telephone number of testing agency.
    4. Dates and locations of samples and tests or inspections.
    5. Names of individuals making tests and inspections.
    6. Description of the Work and test and inspection method.
    7. Identification of product and Specification Section.
    8. Complete test or inspection data.
    9. Test and inspection results and an interpretation of test results.
    10. Record of temperature and weather conditions at time of sample taking and testing and inspecting.

11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

D. Permits, Licenses, and Certificates: For Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of the Work.

1.06 QUALITY ASSURANCE:

A. General: Qualifications paragraphs in this Article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Installer Qualifications: A firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

C. Manufacturer Qualifications: A firm experienced in manufacturing Equipment or systems or Material similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Fabricator Qualifications: A firm experienced in producing Equipment and Material similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, Equipment, or Material that are similar to those indicated for this Project in material, design, and extent.

F. Testing Agency Qualifications: An NRTL, an NVLAP, or an independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E548; and with additional qualifications specified in individual Sections; and where required by authorities having jurisdiction, that is acceptable to authorities.
1. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7.
2. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program (NVLAP).

G. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's Equipment, Material, or systems that are similar in material, design, and extent to those indicated for this Project.

H. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:
1. Contractor responsibilities include the following:
a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build Site-assembled test assemblies and mockups using installers who will perform same tasks for Project.

e. Build laboratory mockups at testing facility using personnel, products, and methods of construction indicated for the completed Work.
f. When testing is complete, remove test specimens, assemblies, mockups, and laboratory mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to Engineer, with copy to Contractor. Interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from the Contract Documents.

I. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:
1. Build mockups in location and of size indicated or, if not indicated, as directed by Engineer or Owner.
2. Notify Engineer seven days in advance of dates and times when mockups will be constructed.
3. Demonstrate the proposed range of aesthetic effects and workmanship.
4. Obtain Engineer's and Owner's approval of mockups before starting work, fabrication, or construction.
a. Allow seven days for initial review and each re-review of each mockup.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed, unless otherwise indicated.

J. Laboratory Mockups: Comply with requirements of preconstruction testing and those specified in individual Sections in DIVISIONS 02 through 46.

1.07 QUALITY CONTROL:

A. Owner Responsibilities: Where quality control services are indicated as Owner's responsibility, Owner will engage a qualified testing agency to perform these services.
1. Owner will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspecting they are engaged to perform.
2. Costs for retesting and reinspecting construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to Contractor.

B. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality control services specified and those required by authorities having jurisdiction. Perform quality control services required of Contractor by authorities having jurisdiction, whether specified or not.
1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality control services. Testing agency shall be acceptable to Engineer.
a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
2. Notify testing agencies at least 24 hours in advance of time when Work that requires testing or inspecting will be performed.
3. Where quality control services are indicated as Contractor's responsibility, submit a certified written report, in Adobe PDF format, of each quality control service.
4. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.

5. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Manufacturer's Field Services:
   1. Where indicated or specified in respective Equipment specifications, provide services of an experienced, competent, factory-authorized representative of the manufacturer of each item of Equipment.
   2. Arrange for Field Services representative to visit the Site of the Work and inspect, check, adjust as necessary, and approve the Equipment installation, including service connections. Field Services representative shall be represent when Equipment is started up and placed into operation, and shall revisit the Site as often as necessary until problems are corrected, and Equipment installation and operation are acceptable to Engineer (and Owner).
   3. Submit to Engineer the Field Services representative's completed record forms as required and written report certifying that the Equipment has been properly installed and lubricated; is in accurate alignment; is free from undue stress imposed by connecting piping or anchor bolts; and has been successfully operated under expected full load conditions.

D. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.

E. Testing Agency Responsibilities: Cooperate with Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
   1. Notify Engineer and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
   2. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
   3. Conduct and interpret tests and inspections and state in each report whether tested and inspected work complies with or deviates from requirements.
   4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
   5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
   6. Do not perform any duties of Contractor.

F. Associated Services: Cooperate with agencies performing required tests, inspections, and similar quality control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
   1. Access to the Work.
   2. Incidental labor and facilities necessary to facilitate tests and inspections.
   3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
   4. Facilities for storage and field curing of test samples.
   5. Delivery of samples to testing agencies.
   6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
   7. Security and protection for samples and for testing and inspecting equipment at Project Site.

G. Coordination: Contractor shall coordinate sequence of activities to accommodate required quality assurance and quality control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities.

H. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality control services required by the Contract Documents. Submit schedule within 30 days of date established in the Notice to Proceed.
   1. Distribution: Distribute schedule to Owner, Engineer, testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.08 SPECIAL TESTS AND INSPECTIONS:

A. Special Tests and Inspections: The Engineer, acting as a consultant, agent, or employee of the engineer, shall act as Special Inspector for post-installed anchor and rebar inspections. All other special tests and inspections required shall be the responsibility of the Contractor, including:
   1. Verifying that manufacturer maintains detailed fabrication and quality control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
   2. Notifying Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
   3. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
   4. Interpreting tests and inspections and stating in each report whether tested and inspected work complies with or deviates from the Contract Documents.
   5. Retesting and reinspecting corrected work.
   6. Submit draft start-up plan for the work prior to commissioning of the site for further coordination amongst the project team. Contractor shall lead effort to finalize the start-up plan and shall submit the final copy to the Owner and Engineer prior to site commissioning.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION

3.01 TEST AND INSPECTION LOG:

A. Prepare a record of tests and inspections. Include the following:
   1. Date test or inspection was conducted.
   2. Description of the Work tested or inspected.
   3. Date test or inspection results were transmitted to Engineer.
   4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project Site. Post changes and modifications as they occur. Provide access to test and inspection log for Engineer's reference during normal working hours.

3.02 REPAIR AND PROTECTION:

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.
   1. Comply with the Contract Document requirements for Section 01 73 29 – "Cutting and Patching."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

END OF SECTION 01 40 00

SECTION 01 42 00 – DEFINITIONS AND STANDARDS

PART 1 - GENERAL

1.01 SUMMARY:

A. Definitions:

1. Basic contract definitions used in the Contract Documents are defined in the General Conditions and Special Conditions. Definitions and explanations are not necessarily either complete or exclusive, but are general for the Work.
2. General Requirements are the provisions or requirements of DIVISION 01 Sections, and which apply to the entire Work of the Contract.

1.02 RELATED REQUIREMENTS:

A. Specification standards and associations applicable to the Work are specified in each Section.

1.03 SPECIFICATION FORMAT AND CONTENT EXPLANATIONS:

A. Specification Format: The Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's (CSI) Section Format and MasterFormat numbering system. Some portions may not fully comply and no particular significance will be attached to such compliance or noncompliance.

1. Divisions and Sections: For convenience, a basic unit of Specification text is a "Section," each unit of which is numbered and named. These are organized with related Sections, into "Divisions," which are recognized as the present industry consensus on uniform organization and sequencing of Specifications. The Section title is not intended to limit meaning or content of Section, nor to be fully descriptive of requirements specified therein, nor to be an integral part of text.
2. Section Numbering: Used for identification and to facilitate cross-references in Contract Documents. Sections are placed in numeric sequence; however, numbering sequence is not complete, and listing of Sections in Table of Contents at beginning of the Project Manual must be consulted to determine numbers and names of Specification Sections in these Contract Documents.
3. Page Numbering: Numbered independently for each Section. Section number is shown with page number at bottom of each page, to facilitate location of text.
4. Parts: Each Section of Specifications generally has been subdivided into three basic "parts" for uniformity and convenience (PART 1 - GENERAL, PART 2 - PRODUCTS, and PART 3 - EXECUTION). These "Parts" do not limit the meaning of text within. Some Sections may not contain all three "Parts" when some are not applicable, or may contain more than three "Parts" to add clarity to organization of Section.
5. Underscoring of Titles: Used strictly to assist reader of Specification in scanning text for key words in content. No emphasis on or relative importance is intended except where underscoring may be used in body of text to emphasize a duty, critical requirement, or similar situation.
6. Project Identification: Project file number and identification are recorded at bottom of each page of Specifications to minimize possible misuse of Specifications, or confusion with other Project Specifications.

B. Specification Content:

1. These Specifications apply certain conventions in the use of language and the intended meaning of certain terms, words, and phrases when used in particular situations or circumstances. These conventions are explained as follows:
    a. Imperative and Streamlined Language: These Specifications are written in imperative and abbreviated form. This imperative language of the technical

Sections is directed at the Contractor, unless specifically noted otherwise. Incomplete sentences shall be completed by inserting "shall," "the Contractor shall," and "shall be," and similar mandatory phrases by inference in the same manner as they are applied to notes on the Drawings. The words "shall be" shall be supplied by inference where a colon (:) is used within sentences or phrases. Except as worded to the contrary, fulfill (perform) all indicated requirements whether stated imperatively or otherwise.

b. Specifying Methods: The techniques or methods of specifying requirements varies throughout text, and may include "prescriptive," "compliance with standards," "performance," "proprietary," or a combination of these. The method used for specifying one unit of Work has no bearing on requirements for another unit of Work.

c. Overlapping and Conflicting Requirements: Where compliance with two or more industry standards or sets of requirements is specified, and overlapping of those different standards or requirements establishes different or conflicting minimums or levels of quality, notify Engineer in writing for a decision, which Engineer will render in writing within a reasonable time.

d. Abbreviations: Throughout the Contract Documents are abbreviations implying words and meanings which shall be appropriately interpreted. Specific abbreviations have been established, principally for lengthy technical terminology and in conjunction with coordination of Specification requirements with notations on Drawings and in schedules. These are normally defined at first instance of use. Organizational and association names and titles of general standards are also abbreviated.

C. Assignment of Specialists: In certain instances, Specification text requires that specific Work be assigned to specialists in the operations to be performed. These specialists shall be engaged for performance of those units of Work, and assignments are requirements over which Contractor has no choice or option. These assignments shall not be confused with, and are not intended to interfere with, enforcement of building codes and similar regulations governing the Work, local trade and union jurisdictions, and similar conventions. Nevertheless, final responsibility for fulfillment of Contract requirements remains with Contractor.

D. Trades: Except as otherwise specified or indicated, the use of titles such as "carpentry" in Specification text, implies neither that the Work must be performed by an accredited or unionized tradesperson of corresponding generic name (such as "carpenter"), nor that specified requirements apply exclusively to work by tradespersons of that corresponding generic name.

1.04 DRAWING SYMBOLS:

A. Except as otherwise indicated, graphic symbols used on Drawings are those symbols recognized in the construction industry for purposes indicated. Refer instances of uncertainty to Engineer for clarification.

1.05 INDUSTRY STANDARDS:

A. Applicability of Standards: Except where the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents. Such standards are made a part of the Contract Documents by reference and are stated in each Section.

1. Referenced standards, referenced directly in Contract Documents or by governing regulations, have precedence over non-referenced standards which are recognized in industry for applicability to the Work.

2. Where compliance with an industry standard is required, the latest standard in effect at time of opening Bids shall govern.
3. Where an applicable code or standard has been revised and reissued after the effective date of the Contract and before performance of Work affected by the revision, Engineer will decide whether to issue a Change Order to proceed with the revised standard.
4. In every instance the quantity or quality level shown or specified shall be the minimum to be provided or performed. The actual installation may comply exactly, within specified tolerances, with the minimum quantity or quality specified, or it may exceed that minimum within reasonable limits. In complying with these requirements, indicated numeric values are minimum or maximum values, as noted, or appropriate for the context of the requirements. Refer instances of uncertainty to Engineer for a decision before proceeding.
5. Each entity engaged in construction on the Project is required to be familiar with industry standards applicable to that entity's construction activity. Copies of applicable standards are not bound with the Contract Documents.
    a. Where copies of standards are needed for performance of a required construction activity, Contractor shall obtain copies directly from the publication source.

B. Abbreviations and Names: Trade association names and titles of general standards are frequently abbreviated. Where such acronyms or abbreviations are used in the Specifications or other Contract Documents, they mean the recognized name of the trade association, standards generating organization, authority having jurisdiction, or other entity applicable to the context of the text provision.

PART 2 - PRODUCTS - NOT APPLICABLE.

PART 3 - EXECUTION - NOT APPLICABLE.

END OF SECTION 01 42 00

SECTION 01 51 00 – TEMPORARY UTILITIES AND FACILITIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes requirements of a temporary nature not normally incorporated into final Work. It includes the following:
   1. Utility services.
   2. Construction and support facilities.
   3. Construction aids.
   4. Safety and health.
   5. Fire protection.

1.02 RELATED REQUIREMENTS:

A. Temporary Barriers and Controls: Section 01 57 00.
B. Field Offices and Sheds: Section 01 52 00.

1.03 REFERENCE STANDARDS:

A. American National Standards Association (ANSI):
   1. A10 Series - Safety Requirements for Construction and Demolition.
B. National Electrical Contractors Association (NECA):
   1. Electrical Design Library - Temporary Electrical Facilities.
C. National Fire Protection Association (NFPA):
   1. 10 - Portable Fire Extinguishers.
   2. 70 - National Electrical Code.
   3. 241 - Safeguarding Construction, Alterations, and Demolition Operations.
D. National Electrical Manufacturers Association (NEMA).
E. Underwriters Laboratories (UL).

1.04 SUBMITTALS:

A. Temporary Utilities: Submit reports of tests, inspections, meter readings, and similar procedures performed on temporary utilities.

1.05 QUALITY ASSURANCE:

A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but not limited to:
   1. Building Code requirements.
   2. Health and safety regulations.
   3. Utility company regulations.
   4. Police, Fire Department, and rescue squad rules.
   5. Environmental protection regulations.
B. Standards:
   1. Comply with NFPA 10 and 241, and ANSI A10 Series standards "Temporary Electrical Facilities."
   2. Comply with NEMA, NECA, and UL standards and regulations for temporary electric service. Install service in compliance with NFPA 70.
C. Inspections: Arrange for authorities having jurisdiction to inspect and test each temporary utility before use. Obtain required certifications and permits.

1.06 PROJECT CONDITIONS:

A. Temporary Utilities: Prepare a schedule indicating dates for implementation and termination of each temporary utility. At the earliest feasible time, when acceptable to Owner, change over from use of temporary service to use of the permanent service.

B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous, dangerous, unsanitary conditions, or public nuisances to develop or persist on the Site.

PART 2 - PRODUCTS

2.01 MATERIALS AND EQUIPMENT:

A. Provide new materials and equipment. If acceptable to Engineer, undamaged previously used materials and equipment in serviceable condition may be used. Provide materials and equipment suitable for the use intended, of capacity for required usage, and meeting applicable codes and standards. Comply with requirements of DIVISIONS 02 through 46.

B. Water: Provide potable water approved by local health authorities.

1. Water connections require reduced pressure backflow prevention devices, tested annually throughout the duration of construction.
2. Temporary water use requires hydrant meter checkout and permitting through the City of Broomfield.

C. Water Hoses: Provide 3/4-inch, heavy-duty, abrasion-resistant, flexible rubber hoses 100 feet long, with pressure rating greater than the maximum pressure of the water distribution system. Provide adjustable shutoff nozzles at hose discharge.

D. Electrical Outlets: Provide properly configured, NEMA-polarized outlets to prevent insertion of 110- to 120V plugs into higher voltage outlets. Provide receptacle outlets equipped with ground-fault circuit interrupters, reset button, and pilot light for connection of power tools and equipment.

E. Electrical Power Cords: Provide grounded extension cords. Use hard-service cords where exposed to abrasion and traffic. Provide waterproof connectors to connect separate lengths of electric cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

F. Lamps and Light Fixtures: Provide general service incandescent lamps of wattage required for adequate illumination. Provide guard cages or tempered-glass enclosures where exposed to breakage. Provide exterior fixtures where exposed to moisture.

G. Heating Units: Provide temporary heating units that have been tested and labeled by UL, FM, or another recognized trade association related to the type of fuel being consumed.

H. Fire Extinguishers: Provide hand-carried, portable, UL-rated, Class A fire extinguishers for temporary offices and similar spaces. In other locations, provide hand-carried, portable, UL-rated, Class ABC, dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for the exposures. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

PART 3 - EXECUTION

3.01 TEMPORARY UTILITIES:

A. General:

1. Engage the appropriate local utility company to install temporary service or connect to existing service. Where utility company provides only part of the service, provide the

remainder with matching, compatible materials and equipment. Comply with utility company recommendations.

2. Provide adequate utility capacity at each stage of construction. Prior to availability of temporary utilities at the Site, provide trucked-in services as required for start-up of construction operations.
3. Obtain and pay for temporary easements required to bring temporary utilities to the Project Site, where Owner's permanent easement cannot be used for that purpose.
4. Furnish, install, and maintain temporary utilities required for adequate construction, safety, and security. Modify, relocate, and extend systems as Work progresses. Repair damage caused by installation or use of temporary facilities. Grade the areas of Site affected by temporary installations to required elevations and grades, and clean the area. Remove on completion of Work or until service or facilities are no longer needed or are replaced by authorized use of completed permanent facilities.
5. The types of temporary construction utilities and facilities required include, but not by way of limitation, water distribution, drainage, dewatering equipment, enclosure of Work, heat, ventilation, electrical power distribution, lighting, hoisting facilities, stairs, ladders, and roads.
6. Inspect and test each service before placing temporary utilities in use. Arrange for required inspections and tests by governing authorities, and obtain required certifications and permits for use.
7. Materials used for temporary service shall not be used in the permanent system unless so specified or acceptable to Engineer.

B. Because of operational requirements, Owner may restrict or curtail Contractor's use of electric power and water. If these utilities are critical to Contractor's operations and completion of the Contract on the agreed schedule, Contractor shall consider furnishing alternate sources for its own use. Restriction or curtailment of these utilities shall not be a basis for a claim against Owner or an extension of the agreed schedule.

3.02 TEMPORARY ELECTRICITY AND LIGHTING:

A. New Service:
1. Arrange with utility company and provide service required for power and lighting.
2. Connect temporary service in a manner directed by utility company officials. Provide separate meter for metering of power used by all entities authorized to be at or perform Work at the Project Site.
3. The electric service shall be of sufficient capacity and characteristics for the various construction tools, machinery, lights, heating and air conditioning, pumps, and other tools required by Contractor and its Subcontractors.
4. Provide weatherproof, grounded, power distribution system sufficient to accommodate construction operations requiring power, use of power tools, electrical heating, and lighting. Provide overload protection. Locate multiple outlets spaced so that entire area of construction can be reached by power tools on a single extension cord of 100-foot maximum length. Supply power for electric welding, if any, from either temporary power distribution system or by engine-driven, power-generator sets at Contractor's option.
5. Provide all necessary temporary wiring, panelboards, switches, outlets, and other devices so that power and lighting is available throughout the construction area. Include meters, transformers, overload protection disconnects, automatic ground fault interrupters, and main distribution switch gear. Include overcurrent protection on all conductors of the temporary system.

6. Provide adequate artificial lighting for all areas of Work when natural light is not adequate for Work.
    a. Sufficient light shall be provided for general construction areas and floor areas, with additional sufficient lighting for specific tasks and to meet safety requirements.

B. Use of Existing System:
1. Owner's existing system may be used for temporary electricity, as approved by Owner.
2. Provide connections to existing facilities, size to provide service required for power and lighting.
3. Power Source: Make connections to Owner's service, located at point indicated or instructed by Owner.
4. Modify, supplement, and extend service as necessary to meet needed requirements and prevent overloading of existing system.
5. Protect system to prevent interference with Owner's normal usage.

C. Costs of Installation and Operation:
1. Pay fees and charges for permits and applications.
2. Pay costs of installation, maintenance, removal of temporary services, and restoration of any permanent facilities used.
3. Cost of power used for either temporary services or permanent services will be paid by Contractor. Costs of power used for permanent services will be paid by Owner after Construction Acceptance.

3.03 TEMPORARY HEAT AND VENTILATION:

A. General:
1. Provide temporary heat, ventilation, and cooling as required to maintain adequate environmental conditions to facilitate progress of the Work, to meet specified minimum conditions for the installation of materials, and to protect materials and finishes from damage. Protect from adverse affects of low temperatures or high humidity, and to prevent hazardous accumulations of dust, fumes, vapors, or gases.
2. Methods of heating and fuel shall be suitable for particular purposes. Portable heaters shall be standard approved units with controls.

B. Use of Permanent System:
1. Prior to use of permanent system, obtain written permission of Owner, which will define:
    a. Conditions of use.
    b. Provisions relating to guarantees on equipment.
2. Prior to operation, verify that inspection has been made by proper authorities and installation has been approved for operation.
3. Install temporary filters for air-handling units and for permanent ducts. Install new filters upon Substantial Completion.
4. Provide operation and maintenance of systems.
5. Place operational zones of permanent HVAC system in use sequentially as respective areas of Project become adequately enclosed for efficient operation.

C. Costs of Installation and Operation:
1. Pay fees and charges for applications, permits, and inspections.
2. Pay costs of installation, operation, maintenance, removal of equipment, and restoration of existing or permanent facilities if used.
3. Pay cost of power and fuel used.

3.04 TEMPORARY WATER:

A. Contractor shall use only existing services on-site, new services will not be allowed.

B. Use of Existing System:

1. Owner's existing system may be used for temporary water.
2. Make connections to existing facilities to provide water for construction purposes and not for the use of temporary field offices and sheds.
    a. Water Source: Make connections to Owner's service located at point indicated or where instructed by Owner.
3. Modify, supplement, and extend system as necessary to meet temporary water requirements and prevent overloading of existing system.
4. Regulate system to prevent interference with Owner's usage.

C. Use of Permanent System:

1. Prior to use of permanent system for construction purposes, obtain written permission of Owner.
2. Prior to Use of System for Drinking Water:
    a. Disinfect piping.
    b. Obtain inspection and approval of governing authority.

D. Costs of Installation and Operation:

1. Pay all costs for installation, maintenance, and removal.
2. Cost of water used will be paid by Owner.

3.05 TEMPORARY TELEPHONE SERVICE:

A. General:

1. Arrange with local cellular/mobile telephone service company and provide mobile telephone service for use by Contractor and so Contractor can be reached at construction Site during normal working hours.

B. Costs of Installation and Operation:

1. Pay all costs for installation, maintenance and removal, and service charges for local calls. Toll charges shall be paid by the party who places the call.

3.06 TEMPORARY SANITARY FACILITIES:

A. Contractor-Furnished Facilities:

1. Furnish, install, and maintain temporary sanitary facilities for use through construction period. Remove on completion of Work.
2. Provide for all construction workers under this Contract and representatives at the Site.
3. Toilet facilities shall be of the chemical, aerated recirculation, or combustion type, properly vented, and fully enclosed with a glass- fiber-reinforced polyester shell or similar nonabsorbent material.
    a. Provide lavatories, mirrors, urinals (where applicable), and water closets in independent units. Provide individual compartments for water closets where the unit is intended for occupancy by more than one person. Provide suitable enclosure with nonabsorbent sanitary finish materials and adequate heat, ventilation, and lighting.
    b. Provide separate toilet facilities for male and female construction personnel as required.
4. Wash Facilities: Install potable water-supplied wash facilities at locations convenient to construction personnel involved in the handling of compounds and materials where wash-up is necessary to maintain a safe, healthy and sanitary condition. Where recommended or required by governing authorities and regulations or recognized

standards provide emergency safety showers, emergency eye-wash fountains, showers, and similar facilities. Dispose of drainage properly. Supply soap and other cleaning compounds appropriate for each condition.

5. Drinking Water Fixtures: Provide containerized tap-dispenser type drinking water units.
6. Supply and maintain toilet tissue, paper towels, paper cups and similar disposable materials as appropriate for each facility. Provide appropriate covered waste containers for used material.

B. Use of Existing Facilities:
   1. Existing restrooms facilities shall not be used.

3.07 TEMPORARY INTERNET SERVICE:

A. General:
   1. Arrange with local internet service providers to provide high speed internet service to the site for the duration of construction.
   2. Provide all broadband modems, routers, and ISP, equipped with hardware firewall, capable of providing one megabyte per second upload and 15 megabyte per second download speeds at all computers connected to the internet.
   3. Pay for costs of internet services.

3.08 SEWERS AND DRAINAGE:

A. General: Where drainage facilities are not available for discharge of effluent, provide containers to remove and dispose of effluent off the Site in a lawful manner. Provide drainage ditches, dry wells, waste stabilization ponds, and similar discharge facilities to remove effluent that can be lawfully discharged in that manner.

B. Maintain temporary drainage facilities in a clean, sanitary condition. Following heavy usage, restore to normal conditions promptly. Provide and maintain temporary earthen embankments and similar barriers in and around construction excavations and subgrade construction, sufficient to prevent flooding by runoff of storm water from heavy rain storms.

3.09 TEMPORARY CONSTRUCTION AIDS:

A. General:
   1. Provide construction aids and equipment required by personnel and to facilitate the execution of the Work; scaffolds, staging, ladders, stairs, ramps, runways, platforms, railings, hoists, cranes, chutes, and other such facilities and equipment.
   2. Materials may be new or used, must be suitable for the intended purpose, and meet the requirements of applicable codes, regulations, and standards.
   3. When permanent stair framing is in place, provide temporary treads, platforms, and railings for use by construction personnel.

3.10 TEMPORARY ENCLOSURES:

A. New Construction:
   1. Provide temporary enclosure of exterior walls as Work progresses, to provide acceptable working conditions, weather protection for interior materials, allow for effective temporary heating, and to prevent entry of unauthorized persons.
      a. Provide temporary exterior doors with hardware, including being lockable.
      b. Other enclosures shall be removable as necessary for Work and for handling of materials.
   2. Restore permanent facilities used for temporary purposes to specified condition.

B. Existing Construction:

1. Provide temporary enclosures to separate Work areas from the areas of existing building occupied by Owner to prevent penetration of dust or moisture into occupied areas, to prevent damage to existing equipment, and to protect Owner's employees and operations from construction Work.
    a. Temporary Partition and Ceiling Enclosures: Framing and sheet materials which comply with structural and fire rating requirements of applicable codes and standards.
    b. Close joints between sheet materials and seal edges and intersections with existing surfaces. Prevent penetration of dust or moisture.
    c. In locations where fire protection is required, provide the fire protection as required by local fire regulations.
2. Restore existing facilities used for temporary purposes to original or better condition.

3.11 TEMPORARY SAFETY AND HEALTH:

A. General: Contractor shall be solely responsible for initiating, maintaining, and supervising all safety and health precautions and programs in connection with the Work. Contractor shall take all necessary precautions for the safety of, and shall provide necessary protections to prevent injury or loss to, all employees on the Work and other persons and organizations who may be affected thereby.

3.12 TEMPORARY FIRE PROTECTION:

A. General:
    1. Contractor shall be responsible for development of a fire prevention and protection program for all Work under this Contract.
    2. The program shall comply with the applicable provisions for safety and protection specified in the Contract Documents and with applicable parts of the NFPA 10 and 241.
    3. Locate fire extinguishers where convenient and effective for their intended purpose, but not less than one extinguisher on each floor at or near such usable stairwell.
    4. Store combustible materials in containers in fire-safe locations.
    5. Maintain unobstructed access to fire extinguishers, fire hydrants, temporary fire protection facilities, stairways, and other access routes for fighting fires. Prohibit smoking in hazardous fire exposure areas.
    6. Provide supervision of welding operations and similar sources of fire ignition.
    7. Post warning and instructions at each extinguisher location, and instruct construction personnel on proper use of extinguishers and other available facilities at Project Site. Post local fire department telephone number on or near each telephone instrument at Project Site.
B. Permanent Fire Protection:
    1. Complete each fire protection facility at earliest reasonable date, place into operation, and make ready for emergency use.
    2. Instruct personnel at Site on availability and proper use.

3.13 INSTALLATION AND REMOVAL:

A. Relocation: Relocate construction aids as required by progress of construction, storage limitations, or Work requirements and to accommodate requirements of Owner and other contractors at the Site.
B. Removal: Remove temporary materials, equipment, and services when construction needs can be met and allowed by use of permanent construction, or at completion of the Project.
C. Repair: Clean and repair damage caused by installation or by use of temporary facilities.

1. Remove foundations and underground installations for construction aids.
2. Grade the areas of the Site affected by temporary installations to required elevations and clean the area.

END OF SECTION 01 51 00

SECTION 01 52 00 – FIELD OFFICES AND SHEDS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes requirements for temporary field offices and other structures required for office and storage space required by Contractor and Engineer.

B. Field Offices for Contractor and Resident Project Representative shall be provided at the Broomfield project site.

1.02 RELATED REQUIREMENTS:

A. Equipment and Materials: Section 01 60 00.

B. Temporary Utilities and Facilities: Section 01 51 00.

C. Use of Existing Facilities:

1. Existing facilities at the Site shall not be used for field offices.

D. Use of Permanent Facilities:

1. Permanent facilities when substantially completed shall not be used for field offices or for storage.

PART 2 - PRODUCTS

2.01 FIELD OFFICES:

A. General:

1. Provide trailers, mobile buildings, or buildings constructed with floors raised aboveground, with steps, landings, and railings at entrance doors.
2. Buildings shall be structurally sound, secure, and weathertight.
3. Provide appropriate type fire extinguishers at each office and storage area.
4. Maintain offices during progress of the Work.
5. Install office spaces ready for occupancy 15 days after date stated in Notice to Proceed.
6. Provide adequate space, tables and chairs for progress meetings in one of the field offices.

B. Contractor's Office:

1. Provide a field office for Contractor's superintendent on the Site.
2. It shall be of size required for general use, with lights, heat, furnishings, internet service, and other necessary facilities and utilities required by Contractor's operations.

C. Resident Project Representative's Office:

1. Provide a field office for Engineer's Resident Project Representative on the Site. Engineer’s Resident Project Representative’s office may be located within Contractor’s trailer (but suitably separated by wall and doorway), mobile building, or building constructed with floors raised aboveground with steps and landings at entrance doors as long as requirements as stated in Paragraph 2.01 C. 2, this Section, are met.
2. Provide the following minimum requirements:
   a. The office shall be suitable height and of ample size to accommodate the furniture and equipment listed below, without crowding (at least 200 sq. ft. of floor area). The office shall be subdivided and contain one private office of approximately 200 sq. ft. for use by Resident Project Representative. The office shall be weather-tight; the walls and roof shall be insulated with at least 1 1/2-inch insulating board and suitably ventilated; and the floor shall be tight and of double-thick construction. The office door shall have a cylinder lock with two keys. If trailer is furnished, provide weather skirt around trailer base. Storm doors are required at all entrances.

b. The Contractor shall furnish the following furniture, equipment, supplies, and services:
   (1) One plan table or sloping plan shelf, about 3 feet by 5 feet, with a reasonably smooth top, and one suitable swivel stool.
   (2) One conference table, approximately 30 inches by 72 inches and two additional folding chairs.
   (3) Shelves, counters, and tack board as directed.
   (4) Electric lights and outlets as directed. Contractor shall pay all charges for the energy used.
   (5) Two desks for general office use, each about 3 feet by 5 feet, each with a desk chair of the armchair swivel type.
   (6) Two four-drawer, legal size, metal filing cabinets, each with lock and two keys.
   (7) Two portable ABC type fire extinguishers of at least 4-lb capacity.
   (8) Supply of drinking water with a suitable electric water cooler.
   (9) Janitor service weekly.
   (10) Thermostatically controlled heating units or system of adequate capacity to maintain a minimum temperature of not less than 70°F under all cold weather conditions. Contractor shall provide all fuel or power used and service necessary.
   (11) Thermostatically controlled, refrigerant type, air conditioners of adequate capacity to maintain a maximum temperature of not more than 72°F under all hot weather conditions. Contractor shall provide all service necessary and provide all power used.
   (12) Printer that can copy, print and scan up to and including 11 inch by 17 inch sized paper. Copy capability shall be at the approximate rate of 40 copies per minute with the first copy produced in approximately 10 seconds. The machine shall accommodate ordinary, un-sensitized stock paper in variable weight, colors, and sizes. The machine shall use standard 115-volt, 60-hertz electrical power. Contractor shall maintain, at all times, an adequate supply of white paper in both letter and legal sizes. Contractor shall also provide maintenance for the machine.

c. Services:
   (1) Lighting: 50 foot candles at desktop height. Exterior lighting at entrance door.
   (2) Heating and air conditioning.
   (3) Electrical Service: Minimum of two circuits, 110V, 60-hertz. Minimum of four 110V duplex convenience outlets.
   (4) Toilet facilities - portable toilet.
   (5) Hi speed internet connection capable of uploading and downloading large files such as pictures.

2.02 STORAGE SHEDS AND TRAILERS:

A. On Site:
   1. Provide temporary buildings or trailers needed for storage of Equipment and Materials installed under this Contract.
   2. Provide ventilation and heating as required by Equipment and Material stored.

B. Off Site:

1. Advise Engineer of any arrangements made for storage of Equipment and Materials in a place other than Owner's Site. Furnish evidence of insurance coverage with Application for Payment as specified by the Contract Documents.

PART 3 - EXECUTION

3.01 LOCATION, INSTALLATION AND MAINTENANCE:

A. General:
   1. Place temporary buildings, trailers, and stored materials in locations acceptable to Owner or Engineer.
   2. Install field offices and sheds to resist winds and elements of the locality where installed.
   3. Remove when no longer needed at the Site or when Work is completed.
   4. Keep approach walks free of leaves, mud, water, ice, or snow.
   5. At completion of Work, remove temporary buildings and trailers, foundations (if any), utility services, and debris.
   6. Prepare ground or paved areas as specified in applicable Sections.

END OF SECTION 01 52 00

SECTION 01 57 00 – TEMPORARY BARRIERS AND CONTROLS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes General Requirements for:
   1. Safety and Protection of Work and Property.
   2. Barriers.
   3. Security and Protection Facilities Installation.
   4. Environmental Controls.
   5. Access Roads and Parking Areas.
   6. Traffic Control and Use of Roadways.
   7. Railroad Service.

1.02 RELATED REQUIREMENTS:

A. Section 01 11 00 - "Summary of Work" for work restrictions and limitations.
B. Section 01 52 00 - "Field Offices and Sheds."

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Chain-Link Fencing: Minimum 2-inch thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch OD line posts and 2-7/8-inch OD corner and pull posts, with 1-5/8-inch OD top rails.
B. Portable Chain-Link Fencing: Minimum 2-inch, 0.148-inch thick, galvanized-steel, chain-link fabric fencing; minimum 6 feet high with galvanized-steel pipe posts; minimum 2-3/8-inch-OD line posts and 2-7/8-inch OD corner and pull posts, with 1-5/8-inch OD top and bottom rails. Provide concrete bases for supporting posts.

PART 3 - EXECUTION

3.01 SAFETY AND PROTECTION OF WORK AND PROPERTY:

A. General:
   1. Provide for the safety and protection of the Work and of Materials and Equipment to be incorporated therein, whether in storage on or off the Site. Provide protection at all times against rain, wind, storms, frost, freezing, condensation, or heat so as to maintain all Work and Equipment and Materials free from injury or damage. At the end of each day, all new Work likely to be damaged shall be appropriately protected.
   2. Notify Engineer immediately at any time operations are stopped due to conditions which make it impossible to continue operations safely or to obtain proper results.
   3. Construct and maintain all necessary temporary drainage and do all pumping necessary to keep excavations, floors, pits, trenches, manholes, and ducts free of water.
   4. Protect floors from damage by proper covering and care when handling heavy equipment, painting, or handling mortar or other such materials. Use proper cribbing and shoring to prevent overloading of floors while moving heavy equipment. Provide metal pans under pipe-threading machines and clean such pans daily, keeping oil off floors. Restore floors to former condition where damaged or stained.
   5. Concrete floors less than 28 days old shall not be loaded without written permission from Engineer.
   6. Restrict access to roofs except as required by the Work. Where access is required, provide protection with plywood, boards, or other suitable materials.

B. Property Other than Owner's:
   1. Provide for the safety and protection of property at the Site or adjacent thereto, including trees, shrubs, lawns, walks, pavements, roadways, structures, utilities, and Underground Facilities not designated for removal, relocation, or replacement in the course of construction. Report immediately to the owners thereof and promptly repair damage to existing facilities resulting from construction operations.
   2. Names and telephone numbers of representatives of agencies and utilities having jurisdiction over streets and utilities in the Work area shall be obtained by the Contractor. Concerned agencies or utilities shall be contacted a minimum of 24 hours prior to performing Work, closing streets and other traffic areas, or excavating near underground utilities or pole lines.
   3. Operation of valves or other appurtenances on existing utilities, when required, shall be by or under the direct supervision of the owning utility.
   4. Where fences are to be breached on private property, the owners thereof shall be contacted and arrangements made to ensure proper protection of any livestock or other property thus exposed.
   5. The applicable requirements specified for protection of the Work shall also apply to the protection of existing property of others.
   6. Before acceptance of the Work by Owner, restore all property affected by Contractor's operations to the original or better condition.

3.02 BARRIERS:

A. General:
   1. Furnish, install, and maintain suitable barriers as required to prevent public entry, to protect the public, and to protect the Work, existing facilities, trees, and plants from construction operations. Remove when no longer needed or at completion of Work.
   2. Materials may be new or used, suitable for the intended purpose, but shall not violate requirements of applicable codes and standards or regulatory agencies.
   3. Barriers shall be of a neat and reasonable uniform appearance, structurally adequate for the required purposes.
   4. Maintain barriers in good repair and clean condition for adequate visibility. Relocate barriers as required by progress of Work.
   5. Repair damage caused by installation and restore area to original or better condition. Clean the area.

B. Fences:
   1. Prior to the start of Work at the Project Site, install enclosure fence with suitably locked entrance gates.
   2. Locate fence to enclose the entire Project Site, or that portion the Contractor establishes as required to encompass the construction operation.
   3. Locate vehicular entrance gates in a suitable relation to construction facilities and to avoid interference with traffic on public thoroughfares.
   4. Locate pedestrian entrance gates as required to provide controlled personnel entry, in a suitable relation to construction parking facilities.
   5. Fence construction shall be as specified on Construction Drawings.

C. Tree and Plant Protection:
   1. Preserve and protect existing trees and plants at the Site which are designated to remain and those adjacent to the Site.

2. Provide temporary barriers around each, or around each group of trees and plants. Construct to a height of six feet around trees, and to a diameter at the drip line or five feet from trunk, whichever is greater, to adequately protect plants.
3. Consult with Engineer and remove agreed-on roots and branches which will interfere with construction. Employ qualified tree surgeon to remove and to treat cuts.
4. Protect root zones of trees and plants as follows:
   a. Do not allow vehicular traffic or parking.
   b. Do not store materials or products.
   c. Prevent dumping of refuse or chemically injurious materials or liquids.
   d. Prevent puddling or continuous running water.
5. Carefully supervise excavating, grading and filling, and subsequent construction operations to prevent damage.
6. Remove and replace, or suitably repair, trees and plants which are damaged or destroyed due to construction operations, and which were designated to remain.

3.03 SECURITY AND PROTECTION FACILITIES INSTALLATION:

A. Site Enclosure Fence: Before construction operations begin, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.
   1. Extent of Fence: As required for Contractor's own security.
   2. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Owner or coordinate with City locks.

B. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

C. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

D. Temporary Egress: Maintain temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction.

3.04 ENVIRONMENTAL CONTROLS:

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.
   1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property owner to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.
   1. Comply with work restrictions specified in Section 01 11 00 - "Summary."

C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings.
   1. Plan and execute construction and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation.
   2. Hold the areas of bare soil exposed at one time to a minimum.

3. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
4. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
5. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
6. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

E. Stormwater Control:
1. Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.
2. Provide methods to control surface water to prevent damage to the Project, the Site, or adjoining properties.
3. Provide temporary control measures such as berms, dikes, and drains.
4. Control fill, grading, and ditching to direct surface drainage away from excavations, pits, tunnels, and other construction areas; and to direct drainage to proper runoff.
5. Provide, operate, and maintain hydraulic equipment of adequate capacity to control surface and groundwater.
6. Provide temporary drainage where the roofing or similar waterproof deck construction is completed prior to the connection and operation of the permanent drainage piping system.

F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion.

G. Noise Control: Contractor shall comply with noise and vibration requirements as described in City and County of Broomfield Municipal Code, Chapter 9-36.

H. Dust Control:
1. Provide positive methods and apply dust control materials to minimize raising dust from construction operations; and to prevent airborne dust from dispersing into the atmosphere.
2. Clean interior spaces prior to the start of finish painting and continue cleaning on an as-needed basis until painting is finished.
3. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

I. Pest Control:
1. Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

J. Rodent Control:
1. Provide rodent control as necessary to prevent infestation of construction or storage areas.
    a. Employ methods and use materials which will not adversely affect conditions at the Site or adjoining properties.
    b. Should the use of rodenticides be considered necessary, submit an informational copy of the proposed program to Owner with a copy to Engineer. Clearly indicate:
        (1) The area or areas to be treated.

(2) The rodenticides to be used, with a copy of the manufacturer's printed instructions.
(3) The pollution preventive measures to be employed.

2. The use of any rodenticide shall be in accordance with the manufacturer's printed instructions and regulatory agencies.

K. Debris Control and Clean-Up:
1. Keep the premises free at all times from accumulations of debris, waste materials, and rubbish caused by construction operations and employees. Responsibilities shall include:
a. Adequate trash receptacles about the Site, emptied promptly when filled.
b. Periodic cleanup to avoid hazards or interference with operations at the Site and to maintain the Site in a reasonably neat condition.
c. The keeping of construction materials such as forms and scaffolding neatly stacked.
d. Immediate cleanup to protect the Work by removing splattered concrete, asphalt, oil, paint, corrosive liquids, and cleaning solutions from walls, floors, and metal surfaces before surfaces are marred.
2. Prohibit overloading of trucks to prevent spillages on access and haul routes. Provide periodic inspection of traffic areas to enforce requirements.
3. Final cleanup is specified in Section 01 78 00 - Contract Closeout.

L. Pollution Control:
1. Provide methods, means, and facilities required to prevent contamination of soil, water, or atmosphere by the discharge of hazardous or toxic substances from construction operations.
2. Provide equipment and personnel, perform emergency measures required to contain any spillages, and remove contaminated soils or liquids. Excavate and dispose of any contaminated earth off-Site in approved locations, and replace with suitable compacted fill and topsoil.
3. Take special measures to prevent harmful substances from entering public waters, sanitary, or storm sewers.

3.05 ACCESS ROADS AND PARKING AREAS:

A. New Temporary On-Site Roads and Parking Areas:
1. Locate roads, drives, walks, and parking facilities to provide access to construction offices, mobilization, Work, storage areas, and other areas required for execution of the Contract.
a. Consult with Engineer regarding any desired deviation therefrom.
b. Size of parking facilities shall be adequate to provide for needs of Contractor's personnel, Resident Project Representatives, and visits to Site by Engineer and Owner.
2. Provide access for emergency vehicles. Maintain driveways a minimum of 15 feet wide between and around combustible materials in storage and mobilization areas.
3. Maintain traffic areas free of excavated materials, construction equipment, snow, ice, and debris.
4. Construct temporary bridges and culverts to span low areas and allow unimpeded drainage.
5. Keep fire hydrants and water control valves free from obstruction and accessible for use.
6. Construction:
a. Clear areas required.

b. Fill, compact, and grade areas as necessary to provide suitable support for vehicular traffic under anticipated loadings. Materials and construction shall be as specified in Divisions 31 and 32.
c. Provide for surface drainage of facilities and surrounding areas.
d. Maintain roads, walks, and parking areas in a sound, clean condition. Repair or replace portions damaged during progress of Work.

7. Removal:
a. Completely remove temporary materials and construction when construction needs can be met by use of permanent installation, unless construction is to be integrated into permanent construction. Remove and dispose of compacted materials to depths required by various conditions to be met in completed Work.
b. Restore areas to original, better, or specified condition at completion of Work.

B. Existing On-Site Roads and Parking Areas:
1. Designated existing on-Site streets and parking facilities may be used for construction traffic.
a. Provide temporary additional roads as needed for required construction access.
b. Maintain existing construction, and restore to original, better, or specified condition at completion of Work.
c. Do not allow heavy vehicles or construction equipment in parking areas.
2. Do not allow existing on-Site streets, parking facilities, or walks to be used for construction traffic, equipment, or personnel.

3.06 TRAFFIC CONTROL AND USE OF ROADWAYS:

A. Traffic Controls:
1. Comply with requirements of authorities having jurisdiction.
2. Protect existing site improvements to remain including curbs, pavement, and utilities.
3. Maintain access for fire-fighting equipment and access to fire hydrants.
4. Provide, operate, and maintain equipment, services, and personnel, with traffic control and protective devices, as required to expedite vehicular traffic flow on haul routes, at Site entrances, on-Site access roads, and parking areas. This includes traffic signals and signs, flagmen, flares, lights, barricades, and other devices or personnel as necessary to adequately protect the public.
5. Remove temporary equipment and facilities when no longer required. Restore grounds to original, better, or specified condition when no longer required.
6. Provide and maintain suitable detours or other temporary expedients if necessary.
7. Bridge over open trenches where necessary to maintain traffic.
8. Consult with governing authorities to establish public thoroughfares which will be used as haul routes and Site access. All operations shall meet the approval of owners or agencies having jurisdiction.

B. Parking: Provide temporary parking areas for construction personnel.

C. Maintenance of Roadways:
1. Repair roads, walkways, and other traffic areas damaged by operations. Keep traffic areas as free as possible of excavated materials and maintain in a manner to eliminate dust, mud, and hazardous conditions.
2. All operations and repairs shall meet the approval of owners or agencies having jurisdiction.

A. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas as indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and nontracking. Reapply treatment as required to minimize dust.

B. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.
   1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
   2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 20 00 - "Site Preparation and Earthwork."
      Recondition base after temporary use, including removing contaminated material, regrading, proofrolling, compacting, and testing.

END OF SECTION 01 57 00

SECTION 01 58 00 – PROJECT IDENTIFICATION AND SIGNS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes basic requirements for temporary Project identification and informational signs required during construction.

1.02 RELATED REQUIREMENTS:

A. Submittals: Section 01 33 00.
B. Protective Coatings: Section 09 90 00.

1.03 QUALITY ASSURANCE:

A. Design sign and structure to withstand wind and environmental conditions of locality. Provide with finish adequate to withstand weathering, fading, chipping, and peeling for duration of construction.

1.04 SUBMITTALS:

A. Submit as specified in Section 01 33 00.
B. Includes, but not limited to, the following:
   1. Shop Drawings and product data as applicable.
   2. Show content, layout, lettering, colors, structure, and foundation.

PART 2 - PRODUCTS

2.01 IDENTIFICATION SIGNS:

A. Project Identification:
   1. Contractor to provide a minimum of two (2) project identification signs. Location shall be discussed at the Preconstruction Conference.
   2. Construct structure and framing of wood or metal, structurally adequate to resist design requirements of locality.
   3. Construct sign surface of minimum 3/4inch thickness exterior grade plywood with medium density overlay. Panels shall be of size to minimize joints.
   4. Rough hardware shall be galvanized or aluminum.
   5. Coating: Paint as specified in Section 09 90 00 of colors selected by Engineer/Architect.
   6. Information Content:
      a. Project title, logo, and name of Owner as shown on Contract Documents.
      b. Contractor’s logo.
      c. Engineer’s logo.

2.02 INFORMATIONAL SIGNS:

A. Construction:
   1. This includes signs for traffic, construction workers, and general public in regards to directions, warnings, hazards, locations of areas, facilities, equipment, and others of a similar nature.
   2. Provide signs of design, size, color, and lettering as required by regulatory agencies. Signs shall be painted metal, wood, plastic, or fiberglass and of materials suitable for the conditions in which they are placed, such as weathering and fading.
   3. Construct structure and framing of wood or metal, structurally adequate to resist design requirements of area of Project.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Project and Contractor Identification Sign:
   1. Install in appropriate location so as not to obstruct traffic, pedestrians, or construction operations.
   2. Erect on framing or foundation, and rigidly brace.
   3. Maintain sign in good repair, in a clean and neat condition.
   4. Remove upon completion of Project.

B. Informational Signs:
   1. Install at appropriate locations and in sufficient quantities to assure visibility. Relocate as required by progress of Work.
   2. Maintain signs in good repair, in a neat, clean, readable condition.
   3. Remove all signs, framing, supports, and foundations upon completion of Project.

END OF SECTION 01 58 00

SECTION 01 60 00 – EQUIPMENT AND MATERIALS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements governing Contractor's selection of products for use in the Project.

1.02 RELATED REQUIREMENTS:

A. The following Sections contain requirements that relate to this Section:
B. For the applicability of industry standards to products specified: DIVISIONS 02 through 46.
C. For submittal of Contractor's construction progress schedule and the Submittal schedule: Sections 01 32 00 and 01 33 00.

1.03 DEFINITIONS:

A. Definitions used in this Article are not intended to change the meaning of other terms used in these Contract Documents, such as "specialties," "systems," "structures," "finishes," "accessories," and similar terms. Such terms are self-explanatory and have well-recognized meanings in the construction industry.
   1. "Products" are items purchased for incorporation in the Work, whether purchased for the Project or taken from previously purchased stock. The term "product" includes the terms "Material," "Equipment," "system," and terms of similar intent.
      a. "Named Products" are items identified by the manufacturer's product name, including make or model number or other designation, shown or listed in the manufacturer's published product literature, that is current as of the date of the Contract Documents.
   2. "Materials" are products substantially shaped, cut, worked, mixed, finished, refined or otherwise fabricated, processed, or installed to form a part of the Work.
   3. "Equipment" is a product with operational or nonoperational parts, whether motorized, or manually operated, that may require service connections, such as wiring or piping.

1.04 SUBMITTALS:

A. Submittal of preliminary procurement schedule is specified in Section 01 32 00 - Construction Progress Schedules and Reports.
B. Submittals for products are specified in Section 01 33 00 and in applicable Sections of DIVISIONS 02 through 46.

1.05 QUALITY ASSURANCE:

A. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.
B. Compatibility of Options: When the Contractor is given the option of selecting between two or more products for use on the Project, the product selected shall be compatible with products previously selected, even if previously selected products were also options.
C. Nameplates: Along with required labels and operating data, manufacturer or producer's nameplates, imprints, or trademarks may be placed on surfaces exposed to view.
   1. Labels: Locate required product labels and stamps on concealed surfaces or, where required for observation after installation, on accessible surfaces that are not conspicuous.
   2. Equipment Nameplates: Provide a permanent nameplate on each item of service-connected or power-operated Equipment. Locate on an easily accessible surface that is inconspicuous in occupied spaces. The nameplate shall contain the following information and other essential operating data:

a. Name of product and manufacturer including address (and telephone number).
b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

D. Electronic Equipment Compliance:
1. Contractor warrants that all equipment, devices, items, systems, software, hardware, or firmware provided shall properly, appropriately, and consistently function and accurately process date and time data (including without limitation: calculating, comparing, and sequencing). This warranty supersedes anything in the Specifications or other Contract Documents which might be construed inconsistently. This warranty is applicable whether the equipment, device, item, system, software, hardware, or firmware is specified with or without reference to a manufacturer's name, make, or model number.

1.06 TRANSPORTATION AND SHIPMENT:

A. Shipment Preparation:
1. Contractor shall require manufacturers and Suppliers to prepare products for shipment in a manner to facilitate unloading and handling, and to protect against damage, deterioration, or unnecessary exposure to the elements in transit and storage. Provisions for protection shall include the following:
a. Crates or other suitable packaging materials.
b. Covers and other means to prevent corrosion, moisture damage, mechanical injury, and accumulation of dirt in motors, electrical equipment, and machinery.
c. Suitable rust-preventive compound on exposed machined surfaces and unpainted iron and steel.
d. Grease packing or oil lubrication in all bearings and similar items.

B. Marking: Each product item shall be tagged or marked as identified in the delivery schedule or on Submittals. Complete packing lists and bills of material shall be included with each shipment. Each piece of every item need not be marked separately, provided that all pieces of each item are packed or bundled together and the packages or bundles are properly tagged or marked.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING:

A. Deliver, store, and handle products according to the manufacturer's recommendations, using means and methods that will prevent damage, deterioration, and loss, including theft.
1. Schedule delivery to minimize long-term storage at the Site and to prevent overcrowding of construction spaces. Allow ample time to avoid delay of the Work.
2. Coordinate delivery with installation time to assure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to the Site in an undamaged condition in the manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products upon delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected. Inspect shipment to assure:
a. Product complies with requirements of Contract Documents and reviewed Submittals.
b. Quantities are correct.
c. Containers and packages are intact and labels are legible.

d. Products are properly protected and undamaged.

5. Store products at the Site in a manner that will facilitate inspection and measurement of quantity or counting of units. Mark deliveries of component parts of Equipment to identify the Equipment, to permit easy accumulation of parts, and to facilitate inspection and measurement of quantity or counting of units.
6. Store heavy Materials away from the Project structure in a manner that will not endanger the supporting construction.
7. Store products subject to damage by the elements above ground, under cover in a weathertight enclosure, and with ventilation adequate to prevent condensation. Maintain temperature and humidity within range required by manufacturer's instructions.
8. Protect motors, electrical Equipment, plumbing fixtures, and machinery of all kinds against corrosion, moisture deteriorations, mechanical injury, and accumulation of dirt or other foreign matter.
9. Protect exposed machined surfaces and unpainted iron and steel as necessary with suitable rust-preventive compounds.
10. Protect bearings and similar items with grease packing or oil lubrication.
11. Handle and store steel plate, sheet metal, and similar items in a manner to prevent deformation.
12. Resident Project Representative shall have authority to reject equipment and material storage methods if they do not comply with requirements listed above and per Manufacturer storage recommendations.

B. Handling:
1. Provide equipment and personnel necessary to unload and handle products, by methods to prevent damage or soiling to products, or packaging.
2. Handle by methods to prevent bending or overstressing. Where lifting points are designated, lift components only at those points.
3. Provide additional protection to surrounding surfaces as necessary to prevent damage.

C. Maintenance of Storage:
1. Inspect stored products on a scheduled basis.
2. Verify that storage facilities comply with manufacturer's product storage requirements, including environmental conditions continually maintained.
3. Verify that surfaces of products exposed to elements are not adversely affected; that any weathering of finishes is acceptable under requirements of Contract Documents.
4. For mechanical and electrical Equipment in long-term storage, provide manufacturer's service instructions to accompany each item, with notice of enclosed instructions on exterior of package. Service Equipment on a regularly scheduled basis.

D. Protection After Installation: Provide substantial coverings as necessary to protect installed products from damage from subsequent construction operations. Remove coverings when no longer needed or as specified.

PART 2 - PRODUCTS

2.01 PRODUCT SELECTION:

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise specified or indicated, new at the time of installation.
1. Provide products complete with accessories, trim, finish, safety guards, and other devices and details needed for a complete installation and the intended use and effect.
2. Where available, provide standard products of types that have been produced and used successfully in similar situations on other projects.

3. Continued Availability: Where, because of the nature of its application, Owner is likely to need replacement parts or additional amounts of a product at a later date, either for maintenance and repair or replacement, provide standard products for which the manufacturer has published assurances that the products and its parts are likely to be available to Owner at a later date.
4. Conform to applicable Specifications, codes, standards, and regulatory agencies.
5. Comply with size, make, type, and quality specified, or as specifically approved in writing by Engineer.
6. Manufactured and Fabricated Products:
    a. Design, fabricate, and assemble in accordance with the best engineering and shop practices.
    b. Manufacture like parts of duplicate units to standard sizes and gages, to be interchangeable.
    c. Equipment and Materials shall be suitable for service conditions intended.
    d. Equipment capacities, sizes, and dimensions indicated or specified shall be adhered to unless variations are specifically approved in writing by Engineer.
    e. Provide labels and nameplates where required by regulatory agencies or to state identification and essential operating data.
7. Do not use products for any purpose other than that for which designed.
8. To the fullest extent possible, provide products of the same kind from a single source.

PART 3 - EXECUTION

3.01 INSTALLATION OF PRODUCTS:

A. Comply with manufacturer's instructions and recommendations for installation of products in the applications indicated. Anchor each product securely in place except as required for proper movement and performance, and accurately located and aligned with other Work.
    1. Obtain and distribute copies of manufacturer's printed instructions and recommendations if not a part of Submittals, containers, or packaging to parties involved in the installation, including a copy to Engineer and Resident Project Representative.
    2. Maintain one complete set of instructions at the Site during installation and until completion.
    3. Handle, install, connect, clean, condition, and adjust products in accordance with such instructions and in conformance with specified requirements. Should job conditions or specified requirements conflict with manufacturer's instructions, consult with Engineer for further instructions.

B. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

END OF SECTION 01 60 00

SECTION 01 73 29 – CUTTING AND PATCHING

PART 1 - GENERAL

1.01 SUMMARY:

A. Definition: Cutting and patching includes cutting into existing construction to provide for the installation of Work, and the repair required to restore materials to their original or better condition.
   1. Cutting and patching is performed for coordination of the Work, to uncover Work for access or inspection, to obtain samples for testing, to permit alterations to be performed, or for other similar purposes.
   2. Cutting and patching performed during the manufacture of products or during the initial fabrication, erection, or installation process is not considered to be cutting and patching under this definition. Drilling of holes to install fasteners and similar operations is also not considered to be cutting and patching.

1.02 RELATED REQUIREMENTS:

A. Refer to Division 02 for demolition of selected portions of the building for alterations.
B. Refer to other Sections of these Specifications for specific cutting and patching requirements and limitations applicable to individual units of Work.

1.03 SUBMITTALS:

A. Cutting and Patching Proposal: Submit a proposal describing procedures well in advance of the time cutting and patching will be performed if Owner requires approval of these procedures before proceeding. Request approval to proceed. Include the following information, as applicable, in the proposal:
   1. Describe the extent of cutting and patching required. Show how it will be performed and indicate why it cannot be avoided.
   2. Describe anticipated results in terms of changes to existing construction. Include changes to structural elements and operating components as well as changes in the building's appearance and other significant visual elements.
   3. List products to be used and firms or entities that will perform Work.
   4. Indicate dates when cutting and patching will be performed.
   5. List utilities that cutting and patching procedures will disturb or affect. List utilities that will be relocated and those that will be temporarily out-of-service. Indicate how long service will be disrupted.
   6. Where cutting and patching involves adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with the original structure.
   7. Approval by Engineer to proceed with cutting and patching does not waive Engineer's right to later require complete removal and replacement of defective Work.

1.04 QUALITY ASSURANCE:

A. Requirements for Structural Work: Do not cut and patch structural elements in a manner that would change their load-carrying capacity or load-deflection ratio.
B. Operational Limitations: Do not cut and patch operating elements or related components in a manner that would result in reducing their capacity to perform as intended. Do not cut and patch operating elements or related components in a manner that would result in increased maintenance or decreased operational life or safety.
C. Visual Requirements: Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in the Engineer's opinion, reduce the building's

aesthetic qualities. Do not cut and patch construction in a manner that would result in visual evidence of cutting and patching. Remove and replace construction cut and patched in a visually satisfactory manner.

1.05 WARRANTY:

A. Existing Warranties: Replace, patch, and repair material and surfaces cut or damaged by methods and with materials in such a manner as not to void any warranties required or existing.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. GENERAL: Except as otherwise indicated, specified, or as directed by Engineer, use materials for cutting and patching that are identical to existing materials. If identical materials are not available or cannot be used, use materials that match existing adjacent surfaces to the fullest extent possible with regard to visual effect. Use materials whose installed performance will equal or surpass that of existing materials.

PART 3 - EXECUTION

3.01 ÍNSPECTION:

A. Before cutting, examine the surfaces to be cut and patched and the conditions under which the Work is to be performed. If unsafe or otherwise unsatisfactory conditions are encountered, take corrective action before proceeding with the Work.

3.02 PREPARATION:

A. Temporary Support: Provide adequate temporary support of Work to be cut to prevent failure.
B. Protection: Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project that may be exposed during cutting and patching operations. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
C. Precautions: Take precautions not to cut existing pipe, conduit, or ductwork serving the building, but scheduled to be removed or relocated, until provisions have been made to bypass them.

3.03 PERFORMANCE:

A. General: Employ skilled workmen to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time and complete Work without delay.
   1. Cut existing construction to provide for installation of other components or performance of other construction activities and the subsequent fitting and patching required to restore surfaces to their original condition.
B. Cutting:
   1. Cut existing construction using methods that are least likely to damage elements to be retained, or adjoining construction. Where possible, review proposed procedures with the original installer.
   2. In general, where cutting, use hand or small power tools designed for sawing or grinding, not hammering and chopping. Cut through concrete and masonry using a cutting machine such as a carborundum saw or diamond core drill. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces.

To avoid marring existing finished surfaces, cut or drill from the exposed or finished side into concealed surfaces. Temporarily cover openings when not in use.

3. Comply with requirements of applicable Sections of DIVISION 31 where cutting and patching requires excavating and backfilling.
4. Bypass utility services such as pipe and conduit before cutting, where such utility services are shown or required to be removed, relocated, or abandoned. Cut off conduit and pipe in walls or partitions to be removed. After bypass and cutting, cap, valve, or plug and seal tight remaining portion of pipe and conduit to prevent entrance of moisture or other foreign matter.

C. Patching:
1. Patch with seams which are durable and as invisible as possible. Comply with specified tolerances for the Work.
2. Where feasible, inspect and test patched areas to demonstrate integrity of the installation.
3. Restore exposed finishes of patched areas and where necessary extend finish restoration into retained adjoining Work in a manner which will eliminate evidence of patching and refinishing.
4. Patch, repair, or rehang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.04 CLEANING:

A. Thoroughly clean areas and spaces where Work is performed. Remove dirt, dust, grease, paint splatter, mortar, oils, sealants, and items of similar nature. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

END OF SECTION 01 73 29

SECTION 01 75 00 – MANUFACTURER'S FIELD SERVICES

PART 1 - GENERAL

1.01 SUMMARY:

A. This section includes requirements of manufacturers for services to be performed at the Project Site in regards to erection, start-up, and testing of Equipment.

1.02 SERVICES REQUIRED:

A. Services with Equipment and Materials Furnished Under this Contract:
   1. Furnish the services of qualified field personnel from the Suppliers or manufacturers of Equipment furnished and installed under this Contract, as required to perform all manufacturer's Field Services called for in the Specifications. Field personnel shall be certified by the Supplier or manufacturer of the specific product or system as having the necessary knowledge and experience to perform the required functions.
   2. Where such service is specified, Contractor shall not perform any Work related to the installation or operation of Equipment furnished and installed under this Contract without direct observation and guidance of the Supplier's or manufacturer's field personnel unless Engineer concurs otherwise.
   3. Contractor shall arrange for the Supplier's or manufacturer's field personnel to perform the following:
      a. Observe the erection, installation, start-up, and testing of Equipment.
      b. Instruct and guide Contractor in proper procedures.
      c. Provide two-week notice to Engineer and Owner of field personnel visit to perform start-up, testing, and training activities.
      d. Supervise the initial start-up, operational check, and any required adjustments of Equipment.
      e. Instruct Owner's designated personnel in proper operation and maintenance of all Equipment.
      f. Furnish a written report to Engineer covering all Work done at least once each week and when Work on each item of Equipment or system is completed.
   4. Advise Engineer of arrival at the Site of all Supplier's and manufacturer's field personnel.
   5. All other manufacturer's Field Services by such field representatives in connection with start-up, testing, and instruction of Owner's personnel will be furnished at no charge to Owner.

PART 2 - PRODUCTS: SPECIFIED IN APPLICABLE SECTIONS.

PART 3 - EXECUTION

3.01 OPERATION AND TESTING:

A. Placing Equipment in Operation:
   1. Place all Equipment installed under this Contract (and those furnished by Owner or others under separate contract) into successful operation according to instructions of the Supplier, manufacturer, or field representative, including making all required adjustments, tests, operation checks, and the following:
      a. Cleaning, sounding, blowing-out, and flushing of lubricating oil and water systems, and other pipelines.
      b. Lubrication (lubricants supplied by Contractor unless specified to be furnished by Owner or others).
      c. Tests of lubrication system safety interlocks and system performance.

d. Final alignment checks and measurements made under observation of Engineer and Owner. Alignment checks shall include opening connections, if required, to ensure there are no abnormal stresses on Equipment from pipes, ducts, or other attachments. Alignment shall be within tolerances specified by the manufacturer, and measurements shall be recorded and furnished to Engineer.
e. Motor rotation checks before connecting couplings.
f. Inspection of sleeve bearings for adequate contact.
g. Checking of anchor-bolt tensions, grout, and shims. Tighten anchor bolts with calibrated torque wrenches using care not to over stress bolts.

2. After "run-in" and acceptance of alignment, affix major Equipment in place using standard tapered dowels with jack-out nuts at head end to facilitate removal.
3. Contractor shall record all above operations and submit to Owner and Engineer.
4. Furnish all necessary attendants and personnel as part of the Work to accomplish the above operations until such time as individual items, systems, Equipment, or sections of the plant are acceptable for operation by Owner.
5. Provide attendants on a continuous basis as required to complete events without interruption once they have been started.
6. Owner will provide water for placing Equipment in operation. Owner's operating personnel will assist.

B. Performance Tests:
1. Equipment Furnished Under this Contract:
a. Owner will operate equipment under normal operating conditions for a period of two (2) weeks after installation to determine if the Equipment installed as part of the Work performs in accordance with Contract Documents and as guaranteed. Final acceptance of Equipment or Substantial Completion will be based on acceptable results of such tests.
b. No tests will be conducted on Equipment for which Supplier’s or manufacturer's Field Service is specified unless Supplier’s or manufacturer's field representative is present and declares in writing that the Equipment is ready for such test.
c. Contractor will be notified by Owner so that Contractor can have a representative or manufacturer's representative present during any tests of Equipment for which Supplier’s or manufacturer's Field Service is not specified.
d. The tests will be made as set forth in the Contract Documents unless the interested parties mutually agree upon some other manner of testing.

END OF SECTION 01 75 00

SECTION 01 78 00 – CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements for Contract closeout including, but not limited to, the following:
   1. Inspection procedures.
   2. Project record document submittal.
   3. Instruction book and operating manual submittal.
   4. Submittal of warranties.
   5. Final cleaning.

B. Closeout requirements for specific construction activities are included in the appropriate Sections of the Specifications.

1.02 RELATED REQUIREMENTS:

A. Prerequisites to Substantial Completion, Construction Acceptance, and Final Acceptance: CITY AND COUNTY OF BROOMFIELD CONSTRUCTION CONTRACT GENERAL CONDITIONS, and SPECIAL CONDITIONS.

B. Submittals: Section 01 33 00.

C. Manufacturer's Field Service: Section 01 75 00.

D. Warranties: Section 01 78 36.

1.03 SUBSTANTIAL COMPLETION:

A. Preliminary Procedures: Before requesting inspection for Notice of Substantial Completion, complete the following. List exceptions in the request.
   1. In the Application for Payment that coincides with, or first follows, the date Substantial Completion is claimed, show 100% completion for the portion of the Work claimed as Substantially Complete.
      a. Include supporting documentation for completion as indicated in these Contract Documents and a statement showing an accounting of changes to the Contract Price.
      b. If 100% completion cannot be shown, include a list of incomplete items, the value of incomplete Work, and reasons the Work is not complete.
   2. Advise Owner of pending insurance changeover requirements.
      a. Contractor shall maintain insurance policies for the full period of the Contract, including any warranty period.
   3. Submit specific warranties, workmanship Bonds, maintenance agreements, final certifications, and similar documents.
   4. Obtain and submit releases enabling Owner unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
   5. Submit record drawings, instruction books and operating manuals, final project photographs, damage or settlement surveys, property surveys, and similar final record information.
   6. Deliver tools, spare parts, extra stock, and similar items.
   7. Make final changeover of permanent locks and transmit keys to Owner. Advise Owner's personnel of changeover in security provisions.
   8. Complete start-up testing of systems and instruction of Owner's operation and maintenance personnel. Discontinue and remove temporary facilities from the Site, along with mockups, construction tools, and similar elements.

B. Inspection Procedures: On receipt of a request for inspection, Engineer will proceed with inspection in accordance with the General Conditions.

1.04 CONSTRUCTION ACCEPTANCE:

A. Preliminary Procedures: Before requesting reinspection for Notice of Construction Acceptance and retainage payment, complete the following. List exceptions in the request.
   1. Submit an updated final statement, accounting for final additional changes to the Contract Price. Submit the final payment request with releases and supporting documentation not previously submitted and accepted. Include insurance certificates for products and completed operations where required.
   2. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the Date of Substantial Completion or when Owner took possession of and assumed responsibility for corresponding elements of the Work.
   3. Submit consent of surety to final payment.
   4. Submit evidence of continuing insurance coverage complying with insurance requirements.

B. Reinspection Procedure: Owner and Engineer will reinspect the Work upon receipt of notice that the punch list items have been completed.
   1. Submit a certified copy of Engineer's final inspection list of items to be completed or corrected, endorsed and dated by Engineer. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance and shall be endorsed and dated by Engineer.
   2. If the Work is accepted, Owner will prepare a Notice of Construction Acceptance. If the Work is incomplete, Owner will advise Contractor of Work that is incomplete or of obligation that have not been fulfilled but are required from Construction Acceptance.
   3. If necessary, reinspection will be repeated.

1.05 RECORD DOCUMENT SUBMITTALS:

A. General: Do not use record documents for construction purposes. Protect record documents from deterioration and loss in a secure, fire-resistant location. Provide access to record documents for Engineer's reference during normal working hours.

B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark which drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
   1. Record information concurrently with construction progress.
   2. Mark record sets with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work. Mark each document "PROJECT RECORD" in neat, large, printed letters.
   3. Mark new information that is important to Owner but was not shown on Contract Drawings or Shop Drawings.
   4. Note related Change Order numbers where applicable.
   5. Organize record drawing sheets into manageable sets. Bind sets with durable-paper cover sheets; print suitable titles, dates, and other identification on the cover of each set.
   6. Upon completion of the Work, submit record drawings to Engineer for Owner's records.
   7. Include the following:

a. Depths of various elements of foundation in relation to finish first floor datum.
b. Horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
c. Location of internal utilities and appurtenances concealed in the construction, referenced to visible and accessible features of construction.
d. Where Submittals are used for mark-up, record a cross-reference at corresponding location on Drawings.
e. Field changes of dimension and detail.
f. Changes made by Change Order or other Modifications.
g. Details not on original Contract Drawings.

C. Record Specifications: Maintain one complete copy of the Project Manual including Addenda. Include with the Project Manual one copy of other written construction documents, such as Change Orders and Modifications issued in printed form during construction.
1. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications.
2. Give particular attention to substitutions and selection of options and information on concealed construction that cannot otherwise be readily discerned later by direct observation.
3. Note related record drawing information and product data.
4. Upon completion of the Work, submit record Specifications to Engineer for Owner's records.
5. Include the following:
a. Manufacturer, trade name, catalog number, and Supplier of each product and item of Equipment actually installed, particularly optional and substitute items.
b. Changes made by Addendum, Change Order, or other Modifications.
c. Related Submittals.

D. Record Product Data: Maintain one copy of each product data Submittal. Note related Change Orders and markup of record drawings and specifications.
1. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the Site and from the manufacturer's installation instructions and recommendations.
2. Give particular attention to concealed products and portions of the Work that cannot otherwise be readily discerned later by direct observation.
3. Upon completion of markup, submit complete set of record product data to Engineer for Owner's records.

E. Instruction Books and Operating Manuals: Organize operation and maintenance data into suitable sets of manageable size as specified in Section 01 33 00.

F. Electronic Documentation:
1. In addition to paper copies, provide electronic versions of record documents showing "as-constructed" conditions, as a marked-up version of the Issued for Construction documents.

G. Warranties and Bonds: Specified in CITY AND COUNTY OF BROOMFIELD CONSTRUCTION CONTRACT GENERAL CONDITIONS, and SPECIAL CONDITIONS, Section 01 33 00, and Section 01 78 36.

1.06 SPARE PARTS:

A. Products Required:

1. Provide to Owner the quantities of products, spare parts, maintenance tools, and maintenance materials specified in individual Sections, in addition to that required for completion of Work.
2. Products shall be identical to those installed in the Work. Include quantities required from Supplier or manufacturer of original purchase to avoid variations in manufacture.

B. Storage, Maintenance:
1. Coordinate with Owner. Deliver and unload spare products to Owner at Project Site and obtain receipt prior to final payment.
2. For portions of the Work accepted and occupied by Owner prior to Substantial Completion, deliver the applicable spare products to Owner at time of acceptance. Obtain receipt.
3. Maintain spare products in original containers with labels intact and legible, until delivery to Owner.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 CLOSEOUT PROCEDURES:

A. Operation and Maintenance Instructions: Arrange for each installer of Equipment that requires regular maintenance to meet with Owner's personnel at Project Site to provide instruction in proper operation and maintenance. Provide instruction by manufacturer's representatives if installers are not experienced in operation and maintenance procedures. Include a detailed review of the following items:
1. Instruction books and operating manuals.
2. Record documents.
3. Spare parts and materials.
4. Tools.
5. Lubricants.
6. Fuels.
7. Identification systems.
8. Control sequences.
9. Cleaning.
10. Warranties and bonds.
11. Maintenance agreements and similar continuing commitments.

B. As part of instruction for operating Equipment, demonstrate the following procedures:
1. Start-up.
2. Shutdown.
3. Emergency operations.
4. Noise and vibration adjustments.
5. Safety procedures.
6. Economy and efficiency adjustments.
7. Effective energy utilization.

C. Manufacturer's Field Services: Specified in Section 01 75 00.

3.02 FINAL CLEANING:

A. General: Contractor shall keep the Site premises free from accumulations of waste materials, rubbish, and other debris resulting from the Work. Regular Site cleaning is included in Section 01 57 00.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to the condition expected in a normal, commercial building cleaning and maintenance program. Comply with manufacturer's instructions.
   1. Complete the following cleaning operations before requesting inspection for Notice of Substantial Completion.
      a. Remove labels that are not permanent labels.
      b. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other substances that are noticeable, vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
      c. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films, and similar foreign substances. Restore reflective surfaces to their original condition. Clean concrete floors to a "broom clean" condition. Vacuum carpeted surfaces.
      d. Wipe surfaces of mechanical and electrical Equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
      e. Remove debris and surface dirt from limited-access spaces including roofs, plenums, shafts, trenches, equipment vaults, manholes, and similar spaces.
      f. Clean the Site, including landscape development areas, of rubbish, litter, and other foreign substances. Sweep paved areas broom clean; remove stains, spills, and other foreign deposits. Rake grounds that are neither paved nor planted to a smooth, even-textured surface.
      g. Clean light fixtures and lamps so as to function with full efficiency.
   2. Remove temporary structures, tools, equipment, supplies, and surplus materials.
   3. Remove temporary protection devices and facilities which were installed to protect previously completed Work.
   4. Special Cleaning: Cleaning for specific units of Work is specified in applicable Sections of Specifications.

C. Removal of Protection: Remove temporary protection and facilities installed for protection of the Work during construction.

D. Compliance: Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from the Site and dispose of lawfully.
   1. Extra materials of value remaining after completion of associated Work become Owner's property. Dispose of these materials as directed by Owner.

E. Repairs:
   1. Repair damaged protective coated surfaces.
   2. Repair roads, walks, fences, and other items damaged or deteriorated because of construction operations.
   3. Restore all ground areas affected by construction operations.

END OF SECTION 01 78 00

SECTION 01 78 36 – WARRANTIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes administrative and procedural requirements for warranties required by the Contract Documents, including manufacturers standard warranties on products and special warranties.

A. Refer to the CITY AND COUNTY OF BROOMFIELD CONSTRUCTION CONTRACT GENERAL CONDITIONS, and SPECIAL CONDITIONS for terms of the Contractor's period for correction of the Work.

1.02 RELATED SECTIONS:

A. The following Sections contain requirements that relate to this Section:
   1. Procedures for submitting warranties: Section 01 33 00.
   2. Contract closeout procedures: Section 01 78 00.
   3. Specific requirements for warranties on products and installations specified to be warranted: DIVISIONS 02 through 46
   4. Certifications and other commitments and agreements for continuing services to Owner: Specified throughout the Contract Documents.

B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of the warranty on the Work that incorporates the products. Manufacturer's disclaimers and limitations on product warranties do not relieve Suppliers, manufacturers, and Subcontractors required to countersign special warranties with Contractor.

1.03 WARRANTY REQUIREMENTS:

A. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted construction.

B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.

C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether Owner has benefited from use of the Work through a portion of its anticipated useful service life.

D. Owner's Recourse: Expressed warranties made to Owner are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the Law. Expressed warranty periods shall not be interpreted as limitations on the time in which Owner can enforce such other duties, obligations, rights, or remedies.
   1. Rejection of Warranties: Owner reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

E. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, Owner reserves the right to refuse to accept the Work, until Contractor presents evidence that entities required to countersign such commitments are willing to do so.

F. The equipment Manufacturer shall warrant that all equipment shall be free from defects cause by faulty material or workmanship for a minimum period of one (1) year from the date of Construction Acceptance, unless otherwise specified in the respective equipment specification sections. Multiple warranties for individual components shall not be acceptable.

1.04 SUBMITTALS:

A. Submit written warranties to Engineer prior to the date requesting inspection for Substantial Completion. Commencement date of Warranties shall be the date of Construction Acceptance. If the Notice of Substantial Completion designates a commencement date for warranties other than the Date of Notice of Construction Acceptance for the Work, or a designated portion of the Work, submit written warranties upon request of Engineer.

B. When the Contract Documents require Contractor, or Contractor and a Subcontractor, Supplier, or manufacturer to execute a special warranty, prepare a written document that contains appropriate terms and identification, ready for execution by required parties. Submit a draft to Owner, through Engineer, for approval prior to final execution.

1. Refer to DIVISIONS 02 through 46 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Bind warranties and bonds in heavy-duty, commercial-quality, durable three-ring, vinyl-covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.

1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address, and telephone number of the installer.
2. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," and as required by Section 01 33 00.
3. When warranted construction requires operation and maintenance manuals, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 01 78 36

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 41 19 – SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Demolition and removal of selected portions of building or structure.
   2. Demolition and removal of selected site elements.
   3. Salvage of existing items to be reused or recycled.

1.03 RELATED REQUIREMENTS:

A. Section 01 11 00 - Summary for restrictions on use of the premises, Owner-occupancy requirements, and phasing requirements.
B. Section 31 20 00 – Site Preparation and Earthwork for site clearing and removal of above- and below-grade improvements not part of selective demolition.

1.04 REFERENCE STANDARDS:

A. The American Society of Safety Engineers
   1. ASSE A10.6-2006: Safety Requirements for Demolition Operations (ANSI)
B. Code of Federal Regulations
   1. 40 CFR 82-2012: Protection of Stratospheric Ozone
C. NFPA
   1. NFPA 241-2013: Safeguarding Construction, Alteration, and Demolition Operations
D. Resilient Floor Covering Institute
   1. Recommended Work Practices for the Removal of Resilient Floor Coverings. 2011.

1.05 DEFINITIONS:

A. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.
B. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.
C. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.06 MATERIALS OWNERSHIP:

A. Unless otherwise indicated, demolition waste becomes property of Contractor.
B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Owner that may be uncovered during demolition remain the property of Owner.
   1. Carefully salvage in a manner to prevent damage and promptly return to Owner.

1.07 SUBMITTALS:

A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

B. Schedule of Selective Demolition Activities: Indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's on-site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.

C. Pre-demolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33 – Construction Photographs. Submit before Work begins.

D. Warranties: Documentation indicating that existing warranties are still in effect after completion of selective demolition.

E. Inventory: Submit a list of items that have been removed and salvaged.

1.08 FIELD CONDITIONS:

A. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Before selective demolition, Owner will remove the following items:
   a. Trail signage
   b. Trail head rocks

B. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Historic Areas: Demolition and hauling equipment and other materials shall be of sizes that clear surfaces within historic spaces, areas, rooms, and openings, including temporary protection, by 12 inches or more.

D. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1.09 COORDINATION:

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS:

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Standards: Comply with ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Survey of Existing Conditions: Record existing conditions by use of preconstruction photographs or video.

1. Comply with requirements specified in Section 01 32 33 – Construction Photographs.
2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3.02 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS:

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.

3.03 PROTECTION:

A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.
2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.
4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling specified in Section 01 51 00 - Temporary Utilities and Facilities.

B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

C. Remove temporary barricades and protections where hazards no longer exist.

3.04 SELECTIVE DEMOLITION, GENERAL:

A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least 8 hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested, or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly.

B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Removed and Salvaged Items:
1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Owner.
4. Transport items to Owner's storage area indicated on Drawings.
5. Protect items from damage during transport and storage.

D. Removed and Reinstalled Items:
1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

3.05 DISPOSAL OF DEMOLISHED MATERIALS:

A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. Burning: Do not burn demolished materials.

3.06 CLEANING:

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

DIVISION 03 – CONCRETE

SECTION 03 10 00 – CONCRETE FORMWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes formwork for cast-in-place concrete.

1.03 RELATED REQUIREMENTS:

A. Section 03 20 00 – Concrete Reinforcement.
B. Section 03 30 00 – Concrete.

1.04 REFERENCE STANDARDS:

A. Applicable Standards:
   1. American Concrete Institute (ACI):
      a. ACI 117 - Specifications for Tolerances for Concrete Construction and Materials.
      b. ACI 301- Specifications for Structural Concrete.
      c. ACI 318 - Building Code Requirements for Reinforced Concrete.
      d. ACI 347R - Guide to Formwork for Concrete.
      e. ACI 350 - Code Requirements for Environmental Engineering Concrete Structures.
      f. ACI 350.5 - Specifications for Environmental Concrete Structures.
   2. ASTM International (ASTM):
      a. ASTM C31/C31M REV A– Standard Practice for Making and Curing Concrete Test Specimens in the Field.
      b. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
      c. ASTM C1077 - Standard Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.

PART 2 - PRODUCTS

2.01 MATERIALS FOR FACING:

A. Where concrete will be exposed to view after construction:
   1. Use exterior grade plywood at least 5/8 inch thick or steel forms capable of producing a smooth, uniform appearance.
   2. Do not use form-facing materials with raised grain, torn surfaces, worn edges, dents, or other defects that will impair the texture of concrete surfaces.
B. Where concrete will not be exposed to view after construction:
   1. Exterior grade plywood at least 5/8 inch thick.
   2. Steel.
   3. Wood fiberboard.
   4. Dressed lumber free of loose knots.
C. Treat forms with commercially available form releasing agents that will not bond with, stain, or adversely affect concrete surfaces. Agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion, nor shall it impede the wetting of surfaces to be cured with water or curing compounds. Form releasing agents shall be VOC compliant with a

maximum VOC content of 3.8 lbs./gal. (450 g/L), or less where area restrictions are more stringent.

D. Clean forms of sawdust, dust, dirt, and other foreign materials.

2.02 FORM TIES:

A. Break back, coil, or screw type, except where otherwise specified.
B. Use water-seal coil type in walls below grade and in walls of water bearing structures. Removable through-wall tapered ties shall not be used.
C. Coil type shall leave conical depression in concrete.
D. Space as required against pressure of fresh concrete.
E. The portion of the form tie remaining in place shall provide for a clearance of two times the minimum dimension of the tie, but not less than 3/4 inch, from the formed surface.

2.03 CHAMFER STRIPS:

A. Chamfer: 3/4 inch except where otherwise indicated.
B. Place in all forms to provide chamfer where concrete will have exposed projecting corners.

PART 3 - EXECUTION

3.01 FORM CONSTRUCTION:

A. Conform to ACI 301, 318, and 347R. Shop Drawings for formwork, shoring, and reshoring are not required to be submitted for approval.
B. Adequately brace, stiffen, and support forms to prevent perceptible deflection or settlement, and to hold plumb, level, and true to line.
C. Construct and maintain forms to the tolerances given in ACI 117.
D. Construct sufficiently tight to prevent mortar leakage.
E. Avoid offsets between adjacent forms and construct so that shores, braces, and stiffening members are in line with those below.
F. Space studs and stringers as required to support facing against concrete pressure, but not more than 12 inches for 5/8-inch plywood or 16 inches for 3/4-inch plywood. Maximum deflection of facing materials reflected on concrete surfaces exposed to view shall be 1/240 of the span between structural members of the formwork.
G. Use walers, strongbacks, shores, and bracing as required.
H. Form all necessary openings or chases for piping, ductwork, and similar items where indicated or as required for the Work.
I. Construct forms to be removable in sections without marring concrete surface.
J. Surface of forms shall provide a smooth, dense, plane surface to finished concrete where exposed to view.
K. Contractor shall be responsible for structural adequacy, design, engineering, and construction of the formwork.
L. Stay-in-place metal forms shall not be used.

3.02 TIME-IN-PLACE FOR FORMS:

A. It is the responsibility of Contractor to consider all applicable factors and leave the formwork in place until it is safe to remove them.
B. All removal shall be performed in a manner which will prevent damage to the concrete and ensure the complete safety of the structure.
C. Where forms support more than one element, the forms shall not be removed until the form removal criteria are met by all supported elements.

D. Evidence that concrete has gained sufficient strength to permit removal of forms shall be determined by tests on control cylinders. All control cylinders shall be stored in the structure or as near the structure as possible, so they receive the same curing conditions and protection methods as given those portions of the structure they represent. Control cylinders shall be removed from the molds at an age of no more than 24 hours. All control cylinders shall be prepared and tested in accordance with ASTM C31/C31M REV A and ASTM C39/C39M at the expense of Contractor by an independent laboratory that complies with ASTM C1077. Control cylinders shall be tested within 4 hours after removal from the Site.

E. Forms shall not be removed unless the minimum time or minimum compressive strength requirements below are met.
   1. Formwork Not Supporting Weight of Concrete:
      a. Formwork for walls, columns, sides of beams, gravity structures, slabs-on-ground and other vertical type formwork not supporting the weight of concrete shall remain in place 24-hours minimum after concrete placement is completed.
   2. Formwork Supporting Weight of Concrete:
      a. Formwork supporting weight of concrete and shoring shall not be removed until structural members have acquired sufficient strength to safely support their own weight and any construction or other superimposed loads to which the supported concrete may be subjected. As a minimum, no forms or shoring shall be loosened or removed until control concrete test cylinders indicate the concrete has attained the following compressive strengths for the respective structural members:

Structural Member	Percent of Design Compressive Strength
Unshored slab and beam forms or forms which can be removed without disturbing shores	70
Slab or beam shoring	85

END OF SECTION 03 10 00

SECTION 03 20 00 – CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes steel reinforcement bars, ties, welded wire fabric, bolsters, chair supports, and accessories.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 03 10 00 - Concrete Formwork.
B. Section 03 30 00 - Concrete.

1.04 REFERENCE STANDARDS:

A. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A615/A615M- Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
      b. A706/A706M- Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   2. American Concrete Institute (ACI):
      a. 301- Specifications for Structural Concrete.
      b. SP 66 - Detailing Manual.
      c. 318- Building Code Requirements for Structural Concrete.
      d. 117 - Specifications for Tolerances for Concrete Construction and Materials.
   3. American Welding Society (AWS):
      a. A5.5 - Low Alloy Steel Electrodes for Shielded Metal Arc Welding.
      b. B2.1 - Welding Procedure and Performance Qualification.
      c. D1.4- Structural Welding Code Reinforcing Steel.
   4. Concrete Reinforcing Steel Institute (CRSI):
      a. Manual of Standard Practice.

1.05 SUBMITTALS:

A. Submit as specified in Division 01.
B. Include, but not limited to, the following:
   1. Complete bar schedule, bar details, and erection drawings to conform to ACI SP 66.
   2. Drawing with each type of bent bar marked with identification mark. Straight bars shall have mark number or be identified by size and length.
   3. Erection drawings shall be clear, easily legible, and to a minimum scale of:
      a. 1/4 inch = 1 foot (1:50).
      b. 1/8 inch = 1 foot (1:100) if bars in each face are shown in separate views.
   4. Size and location of all openings.
   5. Concrete protective cover.
   6. Grade of steel.
   7. Lap splice lengths.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Store steel reinforcement blocked up off the ground and in orderly stacks.

B. Store only bars with the same identifying label in the same stack.

1.07 TESTING:

A. Perform at the mill for each heat.
B. Submit certified test results upon request.

PART 2 - PRODUCTS

2.01 REINFORCEMENT BARS, TIES, AND STIRRUPS:

A. Materials:
   1. Conform to ASTM A615, Grade 60, except as otherwise specified.
   2. Cold-drawn wire for spiral column ties shall conform to ASTM A1064.
   3. Reinforcement indicated or specified to be welded shall conform to ASTM A706.
B. Fabrication of Bars:
   1. Fabricate with cold bends conforming to the recommended dimensions shown in ACI 318.
   2. Fabricate bars according to the tolerances given in ACI 117.
   3. Field fabrication will be allowed only if Contractor has equipment to properly fabricate steel.
   4. Attach metal or plastic tags with identifying mark or length corresponding to mark number or length on Drawing. Straight bars shall have mark number or size and length. Bent bars shall have mark number.
   5. Contractor may, at his option, continue steel reinforcement through openings in walls and slabs, then field-cut the opening so that there will be the required concrete cover between ends of bars and edge of opening.

2.02 BOLSTERS, CHAIRS, AND ACCESSORIES:

A. Conform to ACI SP 66 and the CRSI Manual of Standard Practice.
B. Provide all spacers, bolsters, chairs, ties, and other devices necessary to properly space, place, support, and fasten steel reinforcement in place during the concrete placement.
C. Metal accessories shall be galvanized or plastic-coated where legs will be exposed in finished concrete surfaces.
D. Do not use rocks, broken bricks, wood blocks, or concrete fragments for support of steel reinforcement.

2.03 PRECAST CONCRETE BLOCK BAR SUPPORTS:

A. May be used only for bar supports in slabs on ground.
B. Conform to ACI SP-66 and the CRSI Manual of Standard Practice.
C. Each block shall have a minimum of 9 square inches (5800 square millimeters) of bearing area. Space as required by the particular condition of weight, bearing surface, and rigidity of the steel reinforcement.

PART 3 - EXECUTION

3.01 PLACEMENT OF STEEL REINFORCEMENT:

A. Place all steel reinforcement before concrete is cast in accordance with approved erection drawings, ACI 117, ACI 318, and the CRSI Manual of Standard Practice.
B. Remove oil, mill scale, pitting, mud, loose rust, ice, and other materials that would reduce bond from bars before placing.

C. Tie securely with 16 gage (1.6 mm) or larger annealed iron wire.
D. Place to maintain concrete cover to conform to ACI 117 and ACI 318, unless otherwise indicated.
E. Splice steel where indicated. Splices shall be in full contact and shall conform to ACI 318.
    1. Unless otherwise indicated, lap splices shall be Class B as defined by ACI 318.
    2. Splice steel using Cadweld Series T-splices where indicated or approved.
        a. Provide a manufacturer's representative to give on-site instructions to all welders who will perform the splices in the field.
        b. Contractor shall have the manufacturer's representative instruct, observe, and approve in writing those persons doing the welding.
        c. Contractor shall arrange for the manufacturer's representative to return at the request of the Engineer.
    3. Lenton Mechanical Splices:
        a. Lenton mechanical splices shall be used where indicated.
        b. The Lenton mechanical splices shall develop in tension and compression at least 125% of the yield strength (Fy) of the bar spliced.
        c. Lenton mechanical splices shall be positive locking, taper threaded type coupler.
    4. Splices in members indicated as "tension tie members" shall be made with Cadweld Series T-splices or Lenton mechanical splices in accordance with ACI 318.
    5. Any additional Contractor-proposed splice shall be submitted for acceptance of location and splice length.
F. Connection of reinforcement bars to steel shapes or plate shall be with a Cadweld Series B-splice.
G. Do not bend bars embedded in hardened or partially hardened concrete without approval from Engineer. If bending is permitted, conform to procedures of ACI 301 unless otherwise prescribed by the governing building code.
H. Do not weld reinforcing bars unless specifically indicated. Where welding is indicated, provide bars conforming to ASTM A706/A706M and comply with AWS D1.4.

END OF SECTION 03 20 00

SECTION 03 30 00 – CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes concrete and related items.

1.03 RELATED REQUIREMENTS:

A. Section 03 10 00 - Concrete Formwork.
B. Section 03 20 00 - Concrete Reinforcement.
C. Section 03 30 05 - Void Form
D. Section 05 05 19 - Post-Installed Anchors
E. Section 05 45 00 - Aluminum.
F. Section 07 16 00 - Bituminous Dampproofing.
G. Section 09 90 00 - Protective Coatings.
H. Section 26 05 43 - Underground Duct Banks and Manholes.
I. Section 31 63 29 - Drilled Shaft Foundations.

1.04 REFERENCE STANDARDS:

A. Comply with the provisions of the following codes, specifications, and standards, except as otherwise indicated.
B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
    1. American Concrete Institute (ACI):
        a. 211.1 - Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
        b. 301 - Specifications for Structural Concrete.
        c. 302.1R - Guide for Concrete Floor and Slab Construction.
        d. 304R - Guide for Measuring, Mixing, Transporting, and Placing Concrete.
        e. 305.1 – Specification for Hot Weather Concreting
        f. 306R - Committee Report on Cold Weather Concreting.
        g. 306.1 – Standard Specification for Cold Weather Concreting
        h. 308.1 - Standard Specification for Curing Concrete.
        i. 309R - Guide for Consolidation of Concrete.
        j. 318 - Building Code Requirements for Structural Concrete.
        k. 350 - Environmental Engineering Structures.
        l. 350.1 – Tightness Testing of Environmental Concrete Structures.
        m. 350.5 – Specifications for Environmental Concrete Structures
    2. ASTM International (ASTM):
        a. B370 - Copper Sheet and Strip for Building Construction.
        b. C31/C31M - Practice for Making and Curing Concrete Test Specimens in the Field.
        c. C33 - Concrete Aggregates.
        d. C39 - Test Method for Compressive Strength of Cylindrical Concrete Specimens.
        e. C40 - Test Method for Organic Impurities in Fine Aggregates for Concrete.
        f. C42 - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.

g. C88 - Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
h. C114 - Test Methods for Chemical Analysis of Hydraulic Cement.
i. C117 - Test Method for Material Finer than 75µ (No. 200) Sieve in Mineral Aggregates by Washing.
j. C136 - Test Method for Sieve Analysis of Fine and Coarse Aggregates.
k. C142 - Test Method for Clay Lumps and Friable Particles in Aggregates.
l. C143 - Test Method for Slump of Hydraulic Cement Concrete.
m. C150 - Portland Cement.
n. C172 - Practice for Sampling Freshly Mixed Concrete.
o. C192/C192M - Practice for Making and Curing Concrete Test Specimens in the Laboratory.
p. C231 - Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
q. C233 - Test Methods for Air-Entraining Admixtures for Concrete.
r. C260 - Air-Entraining Admixtures for Concrete.
s. C289 - Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method).
t. C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
u. C430 - Test Method for Fineness of Hydraulic Cement by the 45µ (No. 325) Sieve.
v. C494 - Chemical Admixtures for Concrete.
w. C566 - Test Method for Total Evaporable Moisture Content of Aggregate by Drying.
x. C595/C595M - Blended Hydraulic Cements.
y. C618 - Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
z. C881 - Epoxy-Resin-Base Bonding Systems for Concrete.
aa. C1012 - Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution
bb. C1107 - Packaged Dry, Hydraulic Cement Grout (Nonshrink).
cc. C1193 - Guide for Use of Joint Sealants.
dd. C1218 - Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
ee. C1260 - Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ff. C1293 - Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction
gg. C1315 - Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
hh. C1567 - Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ii. C1602 – Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
jj. C1778 - Standard Guide for Reducing the Risk of Deleterious Alkali-Aggregate Reaction in Concrete
kk. D1751 - Preformed Expansion Joint Filler for Concrete Paving and Structural Construction. (Nonextruding and Resilient Bituminous Types).

ll. D1752 - Preformed Sponge Rubber, Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.

3. Concrete Plant Manufacturers Bureau (CPMB):
   a. 100 - Concrete Plant Standards.
   b. 102 - Recommended Guide Specifications for Batching Equipment and Control Systems in Concrete Batch Plants.
4. Plant Mixer Manufacturers Division (PMMD):
   a. 100 - Concrete Plant Mixer Standards.
5. Federal Specification (FS):
   a. SS-S-200 - Sealants, Joint: Two-Component, Jet-Blast-Resistant, Cold-Applied, for Portland Cement Concrete Pavement.
   b. TT-S-227 - Sealing Compound: Elastomeric Type, Multi-Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
6. National Bureau of Standards (NBS) Specifications for Scales.
7. Truck Mixer Manufacturers Bureau (TMMB):
   a. Truck Mixer, Agitator and Front Discharge Concrete Carrier Standards.

1.05 SUBMITTALS:

A. Submit as specified in Division 01.

B. Include, but not limited to, product data and Shop Drawings of the following:
   1. Nonshrink grouts.
   2. Admixtures.
   3. Bonding agents.
   4. Curing agents.
   5. Floor hardeners, sealers, and coloring compounds
   6. Expansion joint materials.
   7. Formwork spray agents.
   8. Joint sealants.
   9. Waterstops.
   10. Construction joint layout plan.
   11. Concrete pour sequence plan.

C. Mill Certificates:
   1. Submit to Engineer a minimum of one copy for each cement shipment.

D. Concrete Mix Design:
   1. Submit the following test data for each mix design for approval prior to placing concrete. Resubmit for any change in each mix design
      a. Concrete:
         (1) Fine and coarse aggregate, water and cement sources.
         (2) Mix proportions, slump and air content.
         (3) Data on 30 consecutive satisfactory compressive strength tests and standard deviation calculations, laboratory trail batch strength curves.
            (a) Strength tests shall include any Type D admixtures used in final mix design.
         (4) Dry shrinkage test results
      b. Cement:
         (1) Mill certificate.
         (2) ASTM C430.

c. Fine Aggregate:
(1) ASTM C33.
(2) ASTM C40.
(3) ASTM C88.
(4) ASTM C117.
(5) ASTM C136.
(6) ASTM C142.
(7) Fineness modulus.
(8) ASTM C1260 or approved service records.

d. Coarse Aggregate:
(1) ASTM C33.
(2) ASTM C88.
(3) ASTM C136.
(4) ASTM C142.
(5) ASTM C1260 or approved service records.

E. Construction Joint layout
1. Dimensioned drawings showing location of all wall and slab construction joints.

1.06 QUALITY ASSURANCE:

A. Field Testing: Shall be performed by an ACI Concrete Field-Testing Technician Grade 1.
1. Reference Section 3.09 for concrete testing requirements.

B. Finishing: Finishing of concrete slabs and floors shall be supervised by an ACI Concrete Flatwork Technician/Finisher.

C. Submit qualification records of field testing and finishing technicians prior to placing concrete.

1.07 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project Site or remotely at Contractor's option.

PART 2 - PRODUCTS

2.01 CONCRETE:

A. Materials:
1. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
a. Portland cement Type I/II shall conform to ASTM C150. Portland cement Type 1P or 1L shall conform to ASTM C595. Supplement with the following:
(1) 15 to 25% Fly ash may be used as the pozzolan. Fly ash shall conform to ASTM C618, Class F.
b. The maximum amount retained on the No. 325 sieve shall be 10% as determined in accordance with ASTM C430.
c. The maximum amount of alkalis (NA_2O + 0.658 K_2O) shall be 0.80% determined in accordance with ASTM C114.
d. Use one brand of cement throughout the Project unless otherwise approved by Engineer.
2. Fine Aggregate:
a. Conform to ASTM C33.
b. Fineness modulus shall be between 2.3 and 3.1.

c. Approved service record of 3 years with a history indicating that the fine aggregate is not chemically reactive.
d. Fine aggregate considered deleterious or potentially deleterious shall not be used without approval.
e. Maintain fine aggregate free of ice and frozen lumps.

3. Coarse Aggregate:
   a. Conform to ASTM C33.
      (1) Limits for deleterious substances and physical property requirements shall conform to Table 4 and applicable class designation 5S, 5M, or 1N.
   b. Approved service record of 3 years with a history indicating that the coarse aggregate is not chemically reactive.
   c. For a new coarse-aggregate source, when 3 years' approved service records are not available, or when the service records are unacceptable; the aggregate shall be evaluated for potential reactivity. Aggregate must be considered innocuous in accordance with petrographic examination by ASTM C295 or when tested in accordance with ASTM C1260. Alternatively, aggregate may be considered non-reactive when tested in accordance with ASTM C1293.
   d. Coarse aggregate considered deleterious or potentially deleterious shall not be used without approval.
   e. Maintain coarse aggregate free of ice and frozen lumps.
   f. Grading Requirements:
      (1) Size No. 67, from 3/4-inch to No. 4 sieve for all concrete unless otherwise specified.
      (2) Size No. 57, from 1-inch to No. 4 sieve for all concrete unless otherwise specified.
      (3) From 3/8-inch to No. 4 sieve for topping course.
4. Mixing Water:
   a. Only potable water will be acceptable.
5. Admixtures:
   a. Water-Reducing Type:
      (1) Conform to ASTM C494, Type A, D, F, and G.
      (2) Conform to manufacturer's recommendations for use.
      (3) Technical assistance of the manufacturer's field representative shall be furnished upon request.
   b. Air-Entraining Type:
      (1) Conform to ASTM C260.
      (2) Conform to manufacturer's recommendations for use.
      (3) Technical assistance of the manufacturer's field representative shall be furnished upon request.
   c. Color: For electrical duct banks only, use a red dye additive mixed into the concrete.
   d. Admixtures shall not contain any chloride ions.
   e. Storage: Admixtures shall be stored in such a manner as to avoid contamination, evaporation, freezing, temperature changes, settling, or any damage which would adversely affect their characteristics.

B. Laboratory Testing of Materials for Use in Concrete:

1. An approved independent testing laboratory shall be selected and paid by Contractor to perform all required laboratory tests of materials proposed for use in the production of concrete and to determine mix proportions when laboratory trial batches are required.

C. Concrete Qualities Required:
   1. Minimum 28-day compressive strength:
      a. Structural concrete and all concrete unless otherwise indicated: 4,500 psi.
      b. Roof Topping: 4,000 psi
      c. Drilled Shafts: Refer to Section 31 63 29.
      d. Electrical Duct Banks: 4,000 psi
      e. Pavements, Curbs, Gutters, Sidewalks, and drainage pavements: 4,000 psi.
      f. Compressive-strength determinations shall be made from 4-inch (150-mm) diameter by 8-inch long concrete cylinders tested in accordance with ASTM C39.
   2. Concrete Slump:
      a. All concrete unless otherwise indicated: 2 to 4 inches prior to the addition of water reducing admixtures.
      b. Roof Topping: 4 to 6 inches.
      c. Drilled Shafts: Refer to Section 31 63 29.
      d. Electrical Duct Banks: 4 to 6 inches.
      e. Slump of concrete shall not exceed 8 inches including the effects of all water reducing admixtures.
      f. Slump of concrete shall be tested in accordance with ASTM C143. If the contractor wishes to use a mix with a slump outside the range listed above, the written approval from the engineer of record is required prior to mix design submittal.
   3. Air Content:
      a. Structural concrete and all concrete unless otherwise indicated: 6% ±1.5%.
      b. Interior concrete slabs receiving vehicular or pedestrian traffic: 3% maximum.
      c. Roof Topping: 6% ±1.5%.
      d. Drilled Shafts: 6% ±1.5%.
      e. Pavements, Curbs, Gutters, Sidewalks, and drainage pavements: 6% ±1.5%.
      f. Testing shall be in accordance with ASTM C231.
   4. Water-Cement Ratio:
      a. In addition to the aforementioned requirements, water-cement ratios shall be limited as follows:
         (1) Water and Chemical Containing Elements: 0.42
         (2) Precast Concrete roof topping: 0.40
         (3) All other elements: 0.45
   5. Dry shrinkage shall not exceed 0.040 percent when tested in accordance to ASTM C157 for concrete used in liquid and chemical retaining structures.
   6. Chloride Ion Content:
      a. Maximum water-soluble chloride ion content, in percent by weight of cement:
         (1) 0.15 for all concrete unless otherwise specified.
      b. Testing shall be in accordance with ASTM C1218.

D. Mix Proportions:
   1. Concrete shall be homogeneous, readily placeable, uniformly workable, and finishable; proportioned to conform to ACI 211.1.
      a. Mix proportions for all concrete, unless otherwise specified, shall be selected preferably on the basis of field experience; but in the case where sufficient or

suitable strength test data is not available, concrete shall be proportioned on the basis of laboratory trial mix design.

b. Field experience using test results within the preceding year, with the materials and plant to be employed may be the basis of mix proportioning, provided that not less than 30 consecutive satisfactory compressive strength tests on concrete using the proposed materials with a similar mix are available. A compressive strength test is defined as the average 28-day compressive strength of two 6-inch by 12-inch or three 4-inch by 8-inch companion cylinders made conforming to ASTM C172 and ASTM C31 and tested conforming to ASTM C39
   (1) The standard deviation of compressive strength tests shall be computed as a basis for design of the mix. The design average compressive strength shall exceed the specified strength by at least:
      (a) 400 psi if standard deviation is less than 300 psi
      (b) 550 psi if standard deviation is 300 to 400 psi.
      (c) 700 psi if standard deviation is 400 to 500 psi .
      (d) 900 psi if standard deviation is 500 to 600 psi .
      (e) 1,200 psi if standard deviation is greater than 600 psi.

c. Laboratory Trial Batch: When laboratory trial batches are used as a basis for determining mix proportions, all such Work shall be performed by the laboratory as specified in PART 2, Paragraph 2.01.B. - Laboratory Testing of Materials for Use in Concrete, this Section.
   (1) Laboratory trial batches shall be used to establish a water-cement ratio, compression-strength curve with at least three points, each representing the strength of a separate trial batch. At least one point shall be above and one below the strength required. Each point on the curve shall represent the average of at least three cylinders tested at 28 days or an earlier age when approved by Engineer. The slump and air content shall be at the maximum limits specified in PART 2, Paragraph 2.01.C. - Concrete Qualities Required, this Section.
   (2) A point on the water-cement ratio, compressive-strength curve shall be selected that will provide an average compressive strength at least 1,200 psi greater than the specified minimum strength.
   (3) Laboratory trial batches shall be used to determine the drying shrinkage of concrete trial mixes. A drying shrinkage test shall be conducted for every mix design proposed for the project. Drying shrinkage tests shall be conducted including all admixtures required in proposed mix designs. Three test specimens shall be prepared for each drying shrinkage test. Test specimens (4 inch by 4 inch by 11 inch prisms) shall be molded, cured, dried, and measured in accordance with ASTM C157 except with modifications listed below.
      (a) After 7 days in the lime saturated water the specimen shall be removed and measured to determine the base length for drying shrinkage calculations. This point shall be considered day zero for time measurement. Specimens shall be immediately placed in a humidity-controlled room maintained at 73^{o} F, ±3^{o}F and 50 percent, ±4 percent relative humidity for the remainder of the test (21 days after day zero measurement). Final length measurement shall be conducted at 28 days after the addition of water to the cement during the mixing operations.

2. Mix proportions for roof or floor topping course:
    a. Max Aggregate size 3/8-inch.
    b. Minimum 28-day Compressive Strength: 4000 psi.
    c. Maximum water cement ratio: .40
    d. Maximum concrete slump of 4 inches.

E. Mixing and Delivery:
1. Conform to ACI 304R.
    a. Ready-mixed concrete shall be produced and delivered conforming to ASTM C94 as applicable.
2. Cement temperature, when added to mix, shall not exceed 170ºF (77ºC).
3. Adjust the amount of mix water to compensate for the moisture content of the aggregates.
4. Concrete Plant:
    a. Conform to "Concrete Plant Mixer Standards" of the Plant Mixer Manufacturers Division, Concrete Plant Manufacturers Bureau, and "Concrete Plant Standards" of the Concrete Plant Manufacturers Bureau.
    b. Before test sampling and placing concrete, water may be added at Project Site, subject to limitations of ACI 301. Water added to concrete having a slump below the specified minimum shall be at Contractor's risk. If the water added produces a slump greater than the specified maximum, the concrete will be rejected. If water is added, the concrete shall be remixed for a minimum of 25 revolutions. Water shall not be added after the truck mixer has begun to discharge concrete.
    c. Contractor shall furnish Owner with a concrete delivery ticket for each load of concrete. The ticket shall have the following information recorded:
        (1) Serial number of tickets.
        (2) Time batched.
        (3) Time arrived on jobsite.
        (4) Specified compressive strength of concrete at 28 days.
        (5) Amount of concrete (by volume).
        (6) Batch weights of all cementitious materials, aggregates, admixtures and water.
        (7) Mix number.
        (8) Amount of water with-held (by volume).
        (9) Amount of all water added at jobsite by Contractor.
        (10) Name of ready-mix batch plant.
        (11) Date.
        (12) Truck number.
        (13) Name of purchaser.
5. Plant and truck mixer uniformity shall be tested according to ASTM C94. Frequency of tests shall be as specified in PART 3, this Section.

2.02 GROUT:

A. Grout for Dry Packing:
1. Volume: 1 part Portland cement to 2 parts sand.
2. Keep water to a minimum as required for placing by the dry packing method.
3. Place after the mixed grout has been allowed to stand for 2 hours.
4. The sand and cement shall be as specified for concrete.

B. Flowable Nonshrinking Grout:

1. Required for setting handrail posts, for setting equipment recommended by the manufacturer to be set with nonshrinking grout, and in other places indicated.
2. Grout shall be nonmetallic and conform to ASTM C1107.
3. Prepare and place conforming to manufacturer's printed instructions.
4. For equipment bases, the concrete surfaces shall be grit blasted or roughened with a chipping hammer prior to grouting. The foundation plates shall be cleaned of any grease, oil, paint, primers, or epoxy coatings.

C. Grout for tie-hole patching:
1. Where tie hole is in contact with finished drinking water, product shall be ANSI/NSF 61/ NSF 600 certified.
a. Master Builder Solutions, MasterSeal 590.
b. Engineer approved equal.
2. For all other locations:
a. Dayton Superior 1107 Advantage Grout.
b. Euclid Chemical, Speed Plug.
c. W.R Meadows, Meadow-Plug.
d. Engineer approved equal.

D. Grout for Bonding:
1. Proportion (by weight): 1 part cement to 1-1/2 parts sand.
2. Keep water to a minimum.

2.03 BONDING AGENT:

A. Provide moisture-insensitive, epoxy-resin bonding agent conforming to ASTM C881, Type V.

2.04 CONCRETE ACCESSORIES:

A. PVC Waterstops:
1. Serrated virgin polyvinyl chloride equal to one of the following:
a. CJ-3 or CJ-5: 9” Base Seal Waterstop
(1) Sika Greenstreak Style 771
(2) Vinylex Style BS9532
(3) Engineer approved equal.
b. CJ-1 or CJ-8: 4” ribbed with center bulb
(1) Sika Greenstreak Style 702
(2) Vinylex Style RB4316
(3) Engineer approved equal.
c. CJ-10: 6” ribbed with center bulb
(1) Sika Greenstreak Style 705
(2) Vinylex Style RB6316A
(3) Engineer approved equal.
d. CJ-12: 6” Ribbed Split-Flange Waterstop
(1) Sika Greenstreak Style 724
(2) Vinylex Style RSB638
(3) Engineer approved equal.
e. All other locations unless otherwise indicated or specified
(1) Sika Greenstreak Style 703
(2) Vinylex Style RB6316
(3) Engineer approved equal for

2. Provide factory fabricated waterstop corner transitions and intersections leaving only straight butt joint splices for the field.
3. Use for all locations unless otherwise specified.

B. Plastic Waterstops:
1. Swellable, Chloroprene Rubber Waterstop:
   a. Greenstreak, Inc. - Hydrotite Product N. CJ-1020-2K-ADH.
   b. Adeka - Ultra Seal MC-2010MN.
2. Swellable, Bentonite Waterstop:
   a. Greenstreak, Inc. - Swellstop Profile 594 (3/4 inch by 1 inch).
   b. CETCO Building Materials - Volclay RX 101 (3/4 inch by 1 inch).
3. Non-swelling, Mastic/Asphaltic Waterstop:
   a. Greenstreak, Inc. - Lockstop.
   b. Henry Company - Synko-Flex (SF302).
4. Provide all accessories as recommended by the manufacturer including, but not limited to, primers, adhesives, and sealants to ensure watertight construction. Install per manufacturer's written instructions and recommendations.

C. Expansion Joints:
1. Expansion Joint Filler: Premolded cork of thickness indicated and conforming to ASTM D1752, Type III, self-expanding cork. Unless indicated to be asphalt-impregnated fiber.
2. Expansion Joint Filler: Preformed asphalt-impregnated fiber of thickness indicated and conforming to ASTM D1751. Use where indicated.
3. Bond Breaker: Polyethylene tape or other plastic tape as recommended by sealant manufacturer.
4. Sealant Backer Rod: Provide closed cell backer rod or other backing material as recommended by sealant manufacturer.
5. Joint Sealants:
   a. Multi-component sealant as follows:
      (1) Joint Sealant - General Use:
         (a) BASF Building Systems: Sonneborn Sonolastic NP 2 (vertical use) and Sonolastic SL 2 (horizontal use).
         (b) Epoxy Systems Products Company: Product #11.
         (c) Euclid Chemical Company: Eucolastic II.
         (d) Pecora Corporation: NR-200, Dynatred.
      (2) Joint Sealant - Potable Water Treatment and Storage Facilities:
         (a) Sika Corporation: Sikaflex-2c NS.

D. Preformed Contraction Joints: Zip Joint T-shaped plastic strip as manufactured by BoMetals, Inc., Powder Springs, Georgia. Depth of preformed construction joint shall exceed 1/4 of the slab thickness.

2.05 CURING AGENT:

A. Apply to all concrete surfaces unless otherwise indicated or specified.
B. Curing agent shall conform as follows:
1. ASTM C309, Type 1: Use where concrete surface is not exposed to direct sunlight after placement and for conditions where hot concreting does not apply.
2. ASTM C309, Type 1-D: Use where slabs are exposed to direct sunlight for a period of seven days minimum after placement. Curing and sealing agent with fugitive dye shall

be readily distinguishable upon the concrete surface for at least four hours after application but shall be inconspicuous within seven days after application.

3. ASTM C309, Type 2: Use as specified in PART 3, Article 3.05 - Hot Weather Concreting, this Section.

C. Curing compound used on floors to be sealed, painted, tiled, topped, dampproofed, waterproofed, or covered with resilient floor covering shall be guaranteed not to interfere with application of sealer, paint, tile mortar, or tile adhesive after a 28-day curing period.

D. Curing compound shall be VOC compliant with a maximum VOC content of 2.9 lbs./gal (350 g/L), or less where Project location regulations are more stringent.

E. Provide NSF 61 and 600 certified products for any curing agent used on a surface that will contact water at any stage of treatment, distribution, or storage.

2.06 CONCRETE FLOOR CURING AND SEALING AGENT:

A. Apply to all interior concrete floor surfaces subject to vehicle or pedestrian traffic (not for liquid retaining basin slabs).

B. Curing and sealing agent shall conform as follows:

1. ASTM C1315, Type I, Class A: Use where slabs are not exposed to direct sunlight after placement and for conditions where hot concreting does not apply.
2. ASTM C1315, Type II, Class A: Use as specified in PART 3, Article 3.05 - Hot Weather Concreting, this Section.

C. Apply as soon as possible and in conformance with manufacturer's written instructions.

2.07 CONCRETE FLOOR HARDENER:

A. Liquid floor hardener shall be one of the following:

1. Tamms Industries - Clearseal WB300.
2. L&M Construction Chemicals, Inc. - Chem Hard.
3. ChemRex, Inc. - Sonneborn Sonosil.
4. Euclid Chemical Company - Euco Diamond Hard.

B. Apply as soon as possible and in conformance to manufacturer's recommendations.

PART 3 - EXECUTION

3.01 PREPARATION FOR CONCRETE PLACEMENT:

A. Openings Through Concrete: Provide openings through concrete as indicated and for the proper installation of all equipment, piping, wiring, ductwork and similar items, installed under this Contract. Form all openings prior to placement of concrete unless noted otherwise.

B. Installation of Embedded Items:

1. Provide for accurate installation of embedded items installed under this Contract.
2. Securely fix floor drains in place to prevent flotation while placing concrete. Uniformly and accurately slope finish floor slab toward the drains.
3. Embedded items shall be as indicated or specified, or as selected by Contractor and approved by Engineer.
4. During cold weather, protect pipe sleeves, shear pockets, and blockouts from moisture which may freeze, expand, and crack the sleeve, pocket or blockout and concrete structure.
5. Grease or tape anchor bolt threads to protect from concrete splatter.

C. Installation of Joints:

1. Construction Joints:

a. Location:
(1) Locate joints, which are not indicated or specified, in conformance with ACI 318.
(2) Unless noted otherwise, construction joints shall be spaced no more than 25'-0" apart in vertical walls only. Flatwork or slabs may be placed in sections with a maximum area of 3000 square ft and a maximum aspect ratio of 1:1.5 (width:length).
(3) Obtain Engineer's approval of joints located by Contractor prior to preparation of reinforcing steel drawings.

b. Preparation and Installation:
(1) Clean and break laitance or other foreign material from bonding surface.
(2) Tighten forms remaining in place (where applicable) to prevent seepage between forms and hardened concrete.
(3) Provide waterstops as indicated or specified and as required in any new construction joint requested by Contractor.

c. Waterstops:
(1) Install in all construction joints where indicated.
(2) Install conforming to manufacturer's printed instructions. All joints and splices of PVC waterstop shall be 100% fused. Use thermostatically controlled splicing iron as recommended by manufacturer.

2. Expansion Joints:
a. Install filler, backer rod and sealant in strict conformance with manufacturer's written instructions.
b. Reinforcing steel shall not extend through expansion joints unless indicated otherwise.
c. Attach rigid joint filler to the face of the joint prior to placing adjacent concrete. The filler shall occupy the entire width of the joint.
d. Install sealant backer rod for sealant except where indicated to be omitted. Install bond breaker where indicated.
e. Clean joints surfaces immediately before application of sealant.
f. Install joint sealants to conform to ASTM C1193. Tool sealants to provide smooth, uniform bead with a slightly concave surface, eliminate air pockets, and verify the sealant has contact and adhesion with sides of joint.
g. Protect joints from moisture and ice during freezing.

3. Contraction Joints: As specified in this PART 3, Article 3.03 - Finishing, this Section.

D. Cutting and Bonding to Existing Concrete:
1. Cutting Existing Concrete:
a. Use methods and equipment that will avoid damage to adjacent parts of the structure from heavy blows or vibration.
b. Cut existing concrete with power concrete saw where possible to prevent spalling and chipping and to form neat, straight edge.
c. Remove all loose or cracked concrete resulting from cutting existing concrete, leaving only sound, undamaged concrete adjacent to new Work.
d. Leave access opening edges with a neat, true grout surface to the opening size indicated.
e. Cut reinforcing steel with sufficient length remaining (approximately 38 bar diameters) for bending and lapping into new construction.

2. Bonding to Existing Concrete:
    a. Roughen concrete to 1/4-inch (6-mm) amplitude by use of a pneumatic chipping hammer or other approved means.
    b. Thoroughly clean the concrete surface and apply the bonding agent in accordance with manufacturer's written instructions.

3.02 PLACING OF CONCRETE:

A. Conventional Placing:
1. General Requirements:
    a. Conform to ACI 304R.
    b. Bonding surfaces, including reinforcement, shall be clean, free of laitance and foreign materials.
    c. Place concrete on properly prepared and unfrozen subgrade and only in dewatered excavation and forms.
    d. Use forms for all concrete except where otherwise indicated or specified.
    e. Do not place concrete that has partially hardened or has been contaminated by foreign materials.
    f. Prevent mud or foreign materials from entering the concrete or forms during placement operations.
2. Conveying:
    a. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.
    b. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end.
    c. Aluminum conveying equipment shall not be used.
3. Depositing:
    a. Place concrete in continuous horizontal lifts not to exceed 2 feet, and place concrete against bulkheads and keyways at vertical joints.
    b. Maximum free drop of concrete and grout for bonding shall be 5 feet, in walls 10 inches or less in thickness, with 1-foot additional drop allowed for each inch of wall thickness over 10 inches, with a maximum drop of 10 feet.
    c. When vapor barrier is used, keep lapped joints closed and take precautions to avoid puncturing the barrier.
4. Consolidation of Concrete:
    a. Consolidate concrete in conformance with ACI 309R. Characteristics and application of concrete vibrators shall be as set forth in Table 5.1.5.
    b. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.
    c. Vibrate concrete only until the concrete is thoroughly consolidated and the voids filled, as evidenced by the leveled appearance of the concrete at the exposed surface and the embedment of the surface aggregate.
    d. Insert internal vibrators vertically to the full depth of the layer being placed and into the previous layer. Do not drag vibrators through the concrete. Insert and withdraw vibrator slowly with the vibrator running continuously so that no hole

will be left in the concrete. Do not flow concrete from one location to another by use of a vibrator.

e. Consolidate concrete layer to full depth when using a surface vibrator. Use thinner layers or a more powerful vibrator if necessary to achieve complete consolidation.

f. Use form vibrators only where sections are too thin or where sections are inaccessible for internal vibrators.

5. Time Requirements:

a. Place concrete at a sufficient rate to assure that lifts below have not taken initial set before fresh concrete is deposited.

b. Place concrete within 45 minutes after mixing. This period may be extended to 1 hour and 30 minutes provided that the combined air temperature, relative humidity, and wind velocity are such that the plasticity of the fresh concrete is satisfactory for placement and consolidation, and that the specified mixing water is not exceeded. Concrete which has partially set shall not be retempered but shall be discarded.

B. Placing Concrete at Joints:

1. Take precautions to ensure tight, well-bonded construction joints with no air pockets or voids.

2. Take special precautions to avoid bending or displacing waterstop while placing concrete around it.

3. Delay construction at a joint a minimum of 16 hours where placement is continued past joint, except where otherwise indicated.

3.03 FINISHING:

A. Unformed Surfaces:

1. Screed Finish:

a. Use as first stage for all concrete finishes.

b. Use as final finish on surfaces that will be covered by additional concrete, grout placement, or mortar setting bed except as otherwise specified.

c. Immediately after screeding, use a wood float, darby, or bullfloat to eliminate high and low spots and to embed large aggregate. This shall be done in a manner to produce even, uniform surfaces so that surface irregularities do not exceed 3/8 inch in 10 feet when used as final finish.

2. Floated Finish:

a. Use as second stage of broomed, troweled, or magnesium-troweled finish.

b. Float with mechanical float. Hand floating will be permitted only in areas inaccessible to mechanical float.

c. On surfaces not to receive troweled finish, finish with wood or cork float after mechanical floating to a true uniform surface so that surface irregularities do not exceed 1/4 inch in 10 feet, except at floor drains.

3. Broomed Finish:

a. Use as final finish on all outdoor slabs including pavements, and sidewalks.

b. After floated finish, draw a stiff bristle broom across the surface making uniform corrugations, perpendicular to the direction of traffic, not more than 1/16 inch deep.

4. Troweled Finish (Steel Trowel Finish):

a. Use as final finish on inside floors and on all other unformed surfaces not otherwise indicated or specified.

b. Trowel with mechanical steel trowel to obtain a smooth, dense finish. Hand steel trowel shall be used in areas not accessible by mechanical trowel. The final troweling shall be done after the concrete has become hard enough so that no mortar adheres to the edge of trowel and a ringing sound is produced as the trowel passes over the surface.
c. Do not trowel before surface water has evaporated or has been removed with a squeegee.
d. Finish to a true uniform surface so that surface irregularities do not exceed 1/4 inch in 10 feet, except at floor drains.
e. Do not add sand or cement to the floor surface.

5. Contraction Joints:
   a. Locate as indicated.
   b. Maintain true alignment with straightedge.
   c. Joints shall be grooved except where sawed joints are indicated.
      (1) Slab on grade joints shall be sawed.
   d. Grooved (Tooled) Joints:
      (1) Perform during the finishing process.
      (2) Width of groove shall not exceed 1/4 inch (6 mm).
      (3) Depth of groove shall be at least 1 inch (25 mm).
   e. Sawed Joints:
      (1) Cut joints with power blade as soon as concrete surface is firm enough to resist tearing or damage by the blade and before random shrinkage cracks can occur. (Usually required 4 to 12 hours after finishing.)
      (2) Make joints approximately 1/8 inch (3 mm) wide with depth equal to 1/4 the slab thickness unless otherwise indicated.
      (3) Seal where indicated with the same type sealant specified for expansion joint sealant.
6. Floor Flatness and Levelness:
   a. Applicable for steel troweled finish floors, and other floors as indicated or specified.
   b. Finish to a true uniform surface so that surface irregularities do not exceed 1/4 inch in 10 feet, except at floor drains.

B. Formed Surfaces:
1. Repair surface defects as specified in PART 3, Paragraph 3.03.C. - Repair of Defective Surfaces, this Section.
2. Burlap (Rubbed) Finish:
   a. Apply burlap surface treatment to the following formed surfaces:
      (1) Concrete exposed to public view.
      (2) Concrete that is to be painted.
   b. Remove forms as soon as permitted in accordance with Section 03 10 00.
   c. Wet and fill all voids using mortar with the same sand-cement ratio as original concrete. Blend with white cement to match concrete color.
   d. Strike off all excess mortar flush with the surface using a burlap or canvas cloth with a circular motion.
   e. Remove all rough spots and rub with cloth to leave a surface of uniform texture and appearance.

f. Finish shall result in a coating of mortar that will fill all small voids and air holes, leaving a smooth surface.
g. Cure as specified in this PART 3, Article 3.04 - Curing, this Section.

C. Repair of Defective Surfaces:
1. Defined as any concrete surface showing misalignment, rock pockets, poor joints, holes from ties, voids, honeycomb, or any other defective area at time of form removal.
2. Repairing:
a. Repair as soon as forms have been removed.
b. Chip surface back to minimum depth of 1/2 inch, chip edges perpendicular to surface, prewet depression and brush with neat cement immediately before patching.
c. Patch surfaces using stiff mortar with same sand-cement ratio as original concrete and with minimum water for placing. Blend with white cement to match concrete color.
d. Compact mortar into depressions so that after curing, hole is filled and mortar is flush with surface. Use hammer and ramming rod for compacting the holes.
e. Moist-cure for 3 days or use curing compound.
f. Engineer shall be notified of areas containing defects or where reinforcing steel is exposed, prior to determination of repair method.

3.04 CURING:

A. Cure concrete by one of the following methods in accordance with ACI 308.1:
1. Leaving in forms for a minimum of 7 days when the temperature is at least 50°F. When temperatures are below, follow requirements of cold weather concreting.
2. When absorbent wood forms are used, keep formwork wet until removed.
3. Use of saturated bats, soaker hoses, or sprinkler for a minimum of 7 days. Keep concrete continuously wet.
4. Using polyethylene sheets applied in full contact with surfaces.
5. Using one coat of a liquid membrane forming compound as specified. Apply immediately after removal of forms (which have been continuously wet); or in case of a slab, after the concrete has been finished and has hardened sufficiently to walk on.
6. Curing of concrete during hot or cold weather shall conform to PART 3 - Hot Weather Concreting and Cold Weather Concreting, this Section.

3.05 HOT WEATHER CONCRETING:

A. Work shall conform to all requirements of ACI Specification 305.1, Specification for Hot Weather Concreting, except as modified by these contract documents.
B. Follow the requirements of ACI 305.1 if any of the following conditions occur:
1. When the temperature is 90ºF or above.
2. When the temperature is likely to rise above 90ºF within the 24-hour period after concrete placement.
3. When there is any combination of high air temperature, low relative humidity, and wind velocity which would impair either concrete strength or quality.
C. Fresh concrete shall have a maximum temperature of 95ºF at time of discharge.
D. Dampen subgrade and forms with cool water immediately prior to placement of concrete.
E. Protect freshly placed concrete immediately after placement so that the rate of evaporation as determined by ACI 305.1 Equations 3.1.3 does not exceed 0.2 pound per square foot per hour.

F. Protect concrete with suitable insulation if rapidly decreasing nighttime temperatures occur, which would cause thermal shock to concrete placed during warm daytime temperatures.
G. Protect the concrete with temporary wet covering during any appreciable delay between placement and finishing.
H. Begin curing unformed surfaces immediately after finishing and continue for 24 hours. Curing shall consist of application and maintenance of water-saturated material to all exposed surfaces; horizontal, vertical, and otherwise. After the 24-hour interval, continue curing using one of the following methods:
    1. Moist curing for 6 days.
    2. Application of one coat of curing compound as specified.
    3. Application and maintenance of curing paper or heat-reflecting plastic sheets for 6 more days.
I. Strip forms and apply curing compound as specified. Do not allow concrete surfaces to dry prior to application of curing compound.

3.06 COLD WEATHER CONCRETING:

A. Work shall conform to all requirements of ACI 306.1, Standard Specification for Cold Weather Concreting, except as modified by the requirements of these Contract Documents.
    1. Modification to Section 3.2.2: Temperature shall be measured twice per day until protection may be terminated
    2. Modification to Section 3.4.5: Refer to Section 03 10 00 to determine when forms may be removed.
B. Follow the requirements of ACI 306.1 if any of the following conditions apply:
    1. When the temperature is 40ºF or is likely to fall below 40ºF during the 24-hour period after concrete placement.
C. Minimum temperature for concrete as mixed shall be as indicated in Table 3.2.1 of ACI 306.1. Maximum temperature for concrete as mixed shall be 20ºF greater than the corresponding minimum temperature, unless a higher temperature is required by an accepted curing method.
D. Place and maintain concrete so that its temperature is never less than the temperature indicated in Table 3.2.1 of ACI 306.1. Maintain the required temperature for the time duration indicated on Tables 5.1 and 7.1 of ACI 306R.
E. Monitor temperature of concrete in place at corners or edges of formwork as applicable.
F. Air Heaters:
    1. Do not expose concrete to carbon monoxide or carbon dioxide fumes from heaters or engines.
    2. Salamanders will not be permitted.
    3. Heaters shall be indirect fired heaters which use a heat exchanger to avoid direct contact with combustion air or portable hydronic heaters.
    4. Personnel shall be present at all times to maintain safe, continuous operation of heating system.
G. Control temperature and humidity of protected concrete so that excessive drying of concrete surfaces does not occur.
H. Calcium chloride will not be permitted as a concrete accelerator or to thaw frozen subgrade prior to concrete placement.
I. The maximum allowable temperature drop during the first 24-hour period after protection is discontinued shall be as indicated on line 1 of Table 5.1 of ACI 306R.
J. Cure the concrete in accordance with Chapter 10 of ACI 306R.

3.07 LOW-STRENGTH CONCRETE:

A. Low-Strength Concrete:
   1. Defined as either:
      a. Concrete whose average, of any sets of three consecutive 28-day compressive strength tests, is below the required 28-day strength.
      b. Concrete whose individual 28-day strength test (average of two 6-inch by 12-inch cylinders or three 4-inch by 8-inch cylinders) is more than 500 psi below the required 28-day strength.
   2. Should concrete meet either definition of low-strength concrete as a minimum, the Contractor shall take the following steps:
      a. Increase the cement content. The increase shall be based on a statistical evaluation of the strength data, the design water-cement ratio, compressive-strength curve, and acceptable mix-design literature as follows:
         (1) If sufficient concrete has been furnished to accumulate 30 tests, these should be used to establish a new target average strength in accordance with ACI 318, Section 5.3.
         (2) If less than 30 tests have been made, the new target average strength should be at least as great as the average strength used in the initial selection of the mix proportions. Increase the target average strength based on a statistical evaluation of the available strength data, the design water-cement ratio, compressive-strength curve, and acceptable mix-design literature. If the statistical average equals or exceeds the initial mix-design level, a further increase in the average level is required.
      b. Remove and replace with acceptable concrete when the quality and location of the low-strength concrete is such that Engineer considers the strength or durability of the structure is impaired and so orders.
   3. Low-strength concrete shall be considered defective Work as defined in General Conditions.

B. Potentially Low-Strength Concrete: Defined as concrete whose 7-day test (average of two 6-inch by 12-inch cylinders or three 4-inch by 8-inch cylinders) is less than 70% of the specified minimum 28-day compressive strength.

C. Construction delays caused by low-strength or potentially low-strength concrete shall not relieve Contractor from responsibility for late completion even though extensions of time may be granted.

3.08 MISCELLANEOUS CONCRETE ITEMS:

A. Concrete Seal Slab (Mud Slab):
   1. Apply to the ground surface immediately beneath all "on-grade" slabs and footings where indicated or specified.
   2. Seal slab shall consist of a concrete slab of the thickness indicated but not less than 2 inches.
   3. Accurately screed so that the top of the seal slab will not be higher than the bottom elevation of structural slabs or footings to be placed thereon.
   4. Do not place seal slab until after all excavating, (piling,) (and caissons) in the area have been completed and all drain lines, conduits, and other items under the area are completed and properly backfilled and compacted.

B. Equipment Bases:

1. Construct equipment bases, pads, and foundations as indicated or, when not indicated, conforming to equipment manufacturer's requirements.
2. Reinforce conforming to typical detail unless otherwise indicated.
3. Equipment bases shall include concrete, reinforcing steel, form work as required, and anchor bolts. Place grout for equipment installed under this Contract.
4. Finish top area of bases between anchor bolts and forms with a troweled finish.

3.09 TESTING:

A. Field Testing of Concrete Plant and Mixing Trucks:
   1. The concrete plant shall be inspected and tested to ensure conformance with ACI 304R and the "Concrete Plant Standards of the Concrete Plant Manufacturers Bureau." The scales shall be calibrated at the initial setup and at 3-month intervals thereafter.
   2. Mixing trucks shall be inspected and tested to ensure conformance with ACI 304R and "Truck Mixer and Agitator Standards of the Truck Mixer Manufacturers Bureau" of the National Ready-Mix Concrete Association. Tests shall be done at initial setup and every 3 months thereafter.
   3. Submit test reports when requested.

B. Construction Testing Service
   1. An independent material testing service for field testing shall be selected as required in the General Conditions. The material testing service shall furnish test equipment, test cylinder molds, and certified personnel to perform all required field tests, make the required concrete test cylinders, and deliver test cylinders to the testing laboratory. The prescribed tests shall be made in the presence of or with the concurrence of the Owner.
   2. Contractor shall schedule and coordinate with the independent testing service.
   3. If additional compressive strength tests are desired by the contractor to obtain additional data points for scheduling purposes the contractor shall pay for the additional tests.

C. Field Testing of Concrete and Making of Concrete Test Cylinders:
   1. Field testing personnel shall be on-site throughout placement of concrete.
   2. Concrete sampling for tests and cylinder making shall be done conforming to ASTM C172. Samples shall be taken at random and at the point of truck discharge.
   3. Perform the following tests:
      a. Prepare test cylinders conforming to ASTM C31, with not less than two sets of cylinders from each day's placement for each 100 cubic yards or fraction thereof.
         (1) A set of cylinders is defined as the following for different cylinder sizes:
            (a) 6-inch by 12-inch: 4 cylinders
            (b) 4-inch by 8-inch: 5 cylinders
      b. Slump test conforming to ASTM C143. Perform tests on the first batch produced each day, for every 50 cubic yards or fraction thereafter, and with every set of test cylinders. Additional tests shall be run when directed by Engineer.
      c. Air content test conforming to ASTM C231. Perform for first batch of day and with each set of test cylinders.
      d. The batch of concrete being tested for slump or air content shall not be placed until acceptable results are obtained.
      e. Discard concrete used for slump and air tests.
      f. Perform concrete and air temperature tests for first batch of day and with each set of test cylinders. Additional readings shall be taken when directed by Engineer.

g. Any batch of concrete with slump or air content not in conformance with Specifications shall be rejected.
h. Furnish slump, air content, and temperature test results to the testing laboratory for inclusion in the cylinder test reports.

D. Laboratory Testing Concrete During Construction:
1. Laboratory will cure and test concrete cylinders conforming to ASTM C192 and C39, testing 1 cylinders at 7 days of age, three 4-inch cylinders at 28 days of age and one hold.
2. Contractor shall have the right to observe all phases of concrete cylinder curing and testing. Should Contractor observe any deviations from the prescribed testing procedures that he considers detrimental to concrete strength test results, he shall immediately notify Owner in writing.
3. Contractor shall make arrangements with the testing laboratory to receive copies of test reports. The cost of providing a maximum of two copies of each report to the Contractor will be paid by Owner.
4. Should the test results indicate low strength concrete as defined in PART 3, Article 3.07 - Low-Strength Concrete, this Section, Contractor shall take immediate corrective action.
5. Should the statistical data indicate an excessive margin of safety, the concrete mix may be modified subject to Engineer's approval.
6. Should the material tests taken during construction indicate nonconformance with the Specifications, Contractor shall take immediate corrective action.

E. Water Leakage Tests:
1. Purpose: Determine water tightness of finished concrete liquid-containment structures.
2. Testing Procedure:
a. Test Shall be performed in accordance with the latest edition of ACI 350.1with the following modifications.
b. Testing shall meet the qualitative criteria requirements of the latest edition of ACI 350.1 Section 2.3.2. Areas where moisture can be picked up on a dry hand shall be repaired.
c. Testing shall meet the quantitative criteria requirements of 0.050% of volume per day loss per ACI 350.1 Section 2.3.3. Chemical containment basins shall meet the requirements of “No measurable loss”.
d. Test shall be performed on all concrete liquid-containment structures, including basins, containment areas, and overflow troughs. Test adjacent basins independently to verify there is no leakage between shared walls. Perform leakage tests after concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength.
e. Perform leakage test before backfill, brick facing, or other work that will cover concrete wall surfaces.
f. Install all temporary bulkheads, cofferdams, and pipe blind flanges, and close all valves. Inspect each to see that it provides a complete seal.
g. Measure the water surface at two points 180 degrees apart, when possible where attachments such as ladders exist, at 24-hour intervals.
h. Clean all soil and debris from top of exposed base slab edge and power wash for inspection of visual leak test. Heaters or burners may be used to remove standing water on the footing 24 hours prior to visual inspection.
3. Contractor shall dispose of test water in an acceptable manner.
4. Repairs When Test Fails:

a. Repair cracks and joints visually leaking using a hydrophobic polyurethane grout injected from the outside.
b. Hydrophobic polyurethane shall be NSF 61 and 600 approved.
c. Follow manufactures installation instructions.
d. Drill holes for injection ports at 45º angle to surface intersecting crack at center of wall. Start injection at lowest port. Inject polyurethane until grout appears at adjacent port before continuing on to next port.
e. Cracks shall remain dry for 24 hours prior to continuing the visual leak test.
f. If structure continues to leak after application of polyurethane grout; dewater the structure, repair leaks and wet areas by Engineer approved means and repeat water leakage test in its entirety until the structure successfully passes the test.

3.10 REPAIR, REPLACEMENT, AND FIELD MODIFICATIONS:

A. Embedded items and concrete that are misplaced or damaged during construction shall not be repaired, replaced, or field-modified without approval of Engineer.

END OF SECTION 03 30 00

SECTION 03 30 05 – VOID FORMS

PART 1 - GENERAL

1.01 SUMMARY:

A. Work under this Section consists of furnishing all labor, equipment, and materials necessary to install void forms and backfill retainers as indicated to create a temporary support for placement of structural concrete over expansive soils.

B. Unless otherwise shown or specified, design, place, and maintain void forms or carton forms for cast-in-place concrete work in compliance with the American Concrete Institute Standard ACI 347 – Guide to Formwork for Concrete.

C. Void forms are to be placed under grade beams, walls, and first floor slabs as detailed on the Contract Drawings, and are expected to be left in place after concrete placement.

1.02 RELATED REQUIREMENTS:

A. Section 03 30 00 - Concrete.

B. Section 31 20 00 - Site Preparation and Earthwork.

C. Section 31 63 29 - Drilled Shaft Foundations.

1.03 REFERENCE STANDARDS:

A. General:

1. Standards listed by reference, including revisions by issuing authority, form a part of this Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.

2. Where specifications and reference documents conflict, the Engineer shall make the final determination of applicable document.

3. Unless otherwise noted, the latest revision of the following reference standards shall apply to this Section.

B. Applicable Standards:

1. American Concrete Institute (ACI):

a. 347 – Guide to Formwork for Concrete

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Bid Submittals:

1. The void form and soil retainer manufacturer shall submit product data sheets on the void form system and soil retainers to Engineer verifying compliance with this Section.

C. Design and Pre-Construction Submittals:

1. Two weeks prior to mobilization, submit Shop Drawings and details of the proposed vendor, product type(s) and name(s), hardboard cover sheet, vapor barrier, backfill retainer, load carrying capacity, rate of deterioration, storage requirements, manufacturer's product selection guide, manufacturer's installation guidelines, and a contingency plan for a void form collapse.

D. Construction and Closeout Submittals:

1. Within 7 days after installation, contractor shall provide letter certifying that no capillary breaks exist between the void forms and the supporting soil.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Comply with requirements of DIVISION 01.

B. Materials shall be stored in accordance with manufacturer's recommendations and shall be protected from moisture and other means of damage prior to installation. Do not install or use void form that has received damage due to water, improper use/handling, storage or improper installation.
C. Backfill retainers composed of materials that are adversely affected by moisture shall not be used.

PART 2 - PRODUCTS

2.01 VOID FORMS:

A. Materials for void forms shall be the product of a reputable manufacturer regularly engaged in the commercial production of void forms.
B. Acceptable manufactures include the following:
   1. Surevoid
   2. Void Forms International
   3. Approved equal.
C. The void form components shall be constructed of double-faced, partially wax-impregnated corrugated fiberboard that is laminated with moisture-resistant adhesive. Fully wax-impregnated corrugated fiberboard is not acceptable due to resistance to deterioration. The interior construction shall be of a uniform, cellular configuration.
D. Soil retainers shall be composed of materials that are not adversely affected by moisture.
E. Grade beams and wall void forms shall be of rectangular construction, used in conjunction with soil retainers. Trapezoidal void forms shall not be used. Earth forming of footings and grade beams shall not be permitted.
F. Design and maintain void forms to support all temporary vertical and lateral loads that might be applied until such loads can be supported by the concrete structure. This includes, but is not limited to, live load, dead load, weight of moving equipment, height of concrete drop, vibrator frequency, ambient temperature, soil pressures, and lateral stability.
G. Void forms must have a minimum strength to sustain an average working construction load of 400 psf, or as otherwise determined necessary by Contractor's manufacturer representative for the concrete loads as determined from Drawings and based on manufacturer's recommendations.
H. Void form material shall be designed to lose its strength upon prolonged contact with the moisture which normally accumulates beneath slabs and beams on grade. Sufficient deterioration to cushion uplift forces in soil shall take place within a maximum time of eight weeks after placement of concrete.

PART 3 - EXECUTION

3.01 ASSEMBLY AND INSTALLATION:

A. Prepare the subgrade in accordance with Section 31 20 00 – Site Preparation and Earthwork prior to placement of void forms to provide a relatively flat and stable working surface.
B. Forms shall be protected from moisture prior to installation. If void forms become wet, contact the manufacturer to determine if the forms are still capable of performing as required. Any forms that are damaged due to exposure to moisture shall be replaced before concrete is placed at no additional cost to Owner or Engineer.
C. Forms shall be assembled and placed in accordance with the manufacturer's directions, and in a manner to provide tight joints that will prevent loss of paste during concrete placement. Provide seam pads at joints per manufacturer's directions.

D. End closures shall be provided on all grade beam and wall voids.
E. The upper 2 feet of each drilled shaft, when used, must be properly formed and contained to the designated diameter, and must be correctly voided at the intersection with the grade beams or structural slabs by using a pre-manufactured, non-field cut, sealed form with curved, radial, vertical edge adjacent to the drilled shaft.
F. Protective hardboard cover sheets must be placed over void forms at slabs and grade beams wider than 12 inches to distribute working loads, bridge small gaps, and protect void material from puncture and other damage during concrete placement. The minimum thickness of the cover sheets shall be 0.125 inch.
G. Forms must be properly placed and anchored as required to prevent displacement or flotation during placement of concrete.
H. Vapor barrier shall not be placed between the void forms and the supporting soil. It is acceptable to place vapor barrier over the top of the void forms, but the forms should not be wrapped with the vapor barrier.
I. If void forms collapse during concrete placement, concrete and reinforcing steel shall be removed from the affected area, the collapsed void forms replaced and concrete placement resumed at no additional cost to the Owner or Engineer. If normal concrete placement cannot resume, contact Engineer.
J. The manufacturer's representative shall be on-site during initial installation of the void forms to confirm compliance with the manufacturer's product selection and installation requirements.

END OF SECTION 03 30 05

SECTION 03 41 00 – PRECAST STRUCTURAL CONCRETE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This section covers precast, prestressed structural concrete construction, delegated design, manufacture, transportation, erection, and other related items such as anchorage, bearing pads, storage, and protection of precast concrete.

B. Precast includes:

1. Precast structural concrete.

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated. For international projects reference applicable metric code as required.

B. ACI International:

1. ACI 301 - Specifications for Structural Concrete.
2. ACI 318 - Building Code Requirements for Structural Concrete.
3. ACI 423.7 - Specification for Unbonded Single-Strand Tendon Materials.

C. ACI International/The Masonry Society.

1. ACI 216.1/TMS 0216 - Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies.

D. American Association of State Highway and Transportation Officials:

1. AASHTO M 251 - Specification for Plain and Laminated Elastomeric Bridge Bearings.

E. American National Standards Institute:

1. ANSI A108.10 (Reaffirmed 2010) - Specifications for Installation of Grout in Tilework.
2. ANSI A118.7 - Specifications for High Performance Cement Grouts for Tile Installation.

F. American Welding Society:

1. AWS C5.4 - Recommended Practices for Stud Welding.
2. AWS D1.1/D1.1M - Structural Welding Code - Steel.
3. AWS D1.4/D1.4M - Structural Welding Code - Reinforcing Steel.

G. ASTM International (ASTM):

1. ASTM A27 - Specification for Steel Castings, Carbon, for General Application.
2. ASTM A36 - Specification for Carbon Structural Steel.
3. ASTM A47 (Reapproved 2009) - Specification for Ferritic Malleable Iron Castings.
4. ASTM A108 - Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
5. ASTM A123- Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
6. ASTM A153- Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
7. ASTM A184 - Specification for Fabricated Deformed Steel Bar Mats for Concrete Reinforcement.
8. ASTM A276 - Specification for Stainless Steel Bars and Shapes.
9. ASTM A283 (Reapproved 2007) - Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
10. ASTM A307 - Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

11. ASTM A325- Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
12. ASTM A416 - Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
13. ASTM A490 - Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength.
14. ASTM A496 - Specification for Steel Wire, Deformed, for Concrete Reinforcement.
15. ASTM A500 - Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
16. ASTM A563 - Specification for Carbon and Alloy Steel Nuts.
17. ASTM A572 - Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
18. ASTM A615 - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
19. ASTM A666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
20. ASTM A675 - (Reapproved 2009) Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties.
21. ASTM A706 - Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
22. ASTM A722 - Specification for Uncoated High-Strength Steel Bars for Prestressing Concrete.
23. ASTM A767 - Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
24. ASTM A775 - Specification for Epoxy-Coated Reinforcing Steel Bars.
25. ASTM A780 (Reapproved 2006) - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
26. ASTM A884 - Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement.
27. ASTM A886 - Specification for Steel Strand, Indented, Seven-Wire Stress-Relieved for Prestressed Concrete.
28. ASTM A934 - Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars.
29. ASTM A1064 - Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
30. ASTM B633 - Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
31. ASTM C33/ - Specification for Concrete Aggregates.
32. ASTM C42/ - Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete Products.
33. ASTM C67 - Test Methods for Sampling and Testing Brick and Structural Clay Tile.
34. ASTM C144 - Specification for Aggregate for Masonry Mortar.
35. ASTM C150 - Specification for Portland Cement.
36. ASTM C260 - Specification for Air-Entraining Admixtures for Concrete.
37. ASTM C330 - Specification for Lightweight Aggregates for Structural Concrete.
38. ASTM C404 - Specification for Aggregates for Masonry Grout.
39. ASTM C494 - Specification for Chemical Admixtures for Concrete.
40. ASTM C567 - Test Method for Determining Density of Structural Lightweight Concrete.
41. ASTM C578- Specification for Rigid, Cellular Polystyrene Thermal Insulation.

42. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
43. ASTM C595 - Specification for Blended Hydraulic Cements.
44. ASTM C618 - Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
45. ASTM C642 - Test Method for Density, Absorption, and Voids in Hardened Concrete.
46. ASTM C881 - Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
47. ASTM C920 - Specification for Elastomeric Joint Sealants.
48. ASTM C979 - Specification for Pigments for Integrally Colored Concrete.
49. ASTM C989 - Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars.
50. ASTM C1017 - Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
51. ASTM C1077 - Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
52. ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
53. ASTM C1218- Test Method for Water-Soluble Chloride in Mortar and Concrete.
54. ASTM C1240 - Specification for Use of Silica Fume for Use as a Mineral Admixture in Hydraulic-Cement Concrete, Mortar, and Grout.
55. ASTM C1354 - Test Method for Strength of Individual Stone Anchorages in Dimension Stone.
56. ASTM C1582 - Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
57. ASTM C1610 - Test Method for Static Segregation of Self-Consolidating Concrete Using Column Technique.
58. ASTM C1611 - Test Method for Slump Flow of Self-Consolidating Concrete.
59. ASTM C1621 - Test Method for Passing Ability of Self-Consolidating Concrete by J-Ring.
60. ASTM C1712 - Test Method for Rapid Assessment of Static Segregation Resistance of Self-Consolidating Concrete Using Penetration Test.
61. ASTM D412 - Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
62. ASTM D2240- Test Method for Rubber Property-Durometer Hardness.
63. ASTM D4397- Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
64. ASTM E165 - Test Method for Liquid Penetrant Examination.
65. ASTM E329 - Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
66. ASTM E488 - Test Methods for Strength of Anchors in Concrete Elements.
67. ASTM E709 - Guide for Magnetic Particle Examination.
68. ASTM E1444 - Practice for Magnetic Particle Testing.
69. ASTM F436 - Specification for Hardened Steel Washers.
70. ASTM F593 (Reapproved 2008) - Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
71. ASTM F844 - Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.

72. ASTM F1852 - Specification for Twist-Off Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
73. ASTM F3125 – Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi and 150 ksi Minimum Tensile Strength

H. Master Painters Institute:
1. MPI#79-2004 - Alkyd Anti-Corrosive Metal Primer.

I. Military Specification and Standards:
1. MIL-C-882E - Cloth, Duck, Cotton or Cotton-Polyester Blend, Synthetic Rubber, Impregnated, and Laminated, Oil Resistant.

J. Precast/Prestressed Concrete Institute:
1. PCI MNL 116 - Manual for Quality Control for Plants and Production of Structural Precast Concrete Products.
2. PCI MNL 117 - Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products.
3. PCI MNL 120 - PCI Design Handbook - Precast and Prestressed Concrete.
4. PCI MNL 124 - Design for Fire Resistance of Precast Prestressed Concrete.
5. PCI MNL 127 - PCI Erector's Manual - Standards and Guidelines for the Erection of Precast Concrete Products.
6. PCI MNL 135 - Tolerance Manual for Precast and Prestressed Concrete Construction.
7. PCI TR-6 - Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants.
8. Architectural Precast Concrete - Color and Texture Selection Guide.

K. Research Council on Structural Connections:
1. RCSC Specification for Structural Joints Using ASTM High-Strength Bolts.

L. SSPC - The Society for Protective Coatings:
1. SSPC-PA 1 (Revised 2004) - Paint Application Specification No. 1 - Shop, Field, and Maintenance Painting of Steel.
2. SSPC-Paint 25 (Revised 2000) - Paint Specification No. 25 - Zinc Oxide, Alkyd, Linseed Oil Primer for Use Over Hand Cleaned Steel Type I and Type II.
3. SSPC-SP 3 (Revised 2004) - Surface Preparation Specification No. 3 - Power Tool Cleaning.

1.04 DEFINITIONS:

A. Professional Engineer: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated.

B. Engineering services are defined as those performed for installations that are similar to those indicated for this Project in material, design, and extent.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design precast structural concrete, including comprehensive engineering analysis by a qualified professional engineer, licensed in the state of Colorado, using performance requirements and design criteria indicated.

B. Design of units and embedments shall be performed by structural analysis in accordance with ACI 318 or PCI MNL-210.

C. Structural analysis shall include evaluations of the effects of connections, holes, discontinuities, concentrated loads, and joints.

D. Design, furnish, and install all necessary temporary bracing and connections required for erection.

E. Structural Performance: Provide precast structural concrete units and connections capable of withstanding the design loads within limits and under conditions indicated on the Contract Drawings.

1. Design precast structural concrete framing system and connections to maintain clearances at openings, to allow for fabrication and construction tolerances, to accommodate live-load deflection, shrinkage and creep of primary building structure, and other building movements. Maintain precast structural concrete deflections within limits of ACI 318 .

a. Thermal Movements: Allow for in-plane thermal movements resulting from annual ambient temperature changes of -18ºF to 120ºF (-28ºC to 49ºC).

1.06 SUBMITTALS:

A. Product Data: For each type of product indicated.

B. Design Mixtures: For each precast concrete mixture. Include compressive strength tests.

C. Shop Drawings: Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.

1. Indicate type, size, and length of welded connections by AWS standard symbols.
2. Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
3. Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
4. Include and locate openings larger than 12 inches. Where additional structural support is required, include header design.
5. Indicate location of each precast structural concrete unit by same identification mark placed on panel.
6. Indicate relationship of precast structural concrete units to adjacent materials.
7. Indicate estimated camber for precast double tees with concrete toppings.

D. Permissible Design Deviations:

1. Design deviations, supported by complete design calculations and drawings, shall be submitted for approval with explicit description of desired deviation included.
2. Design deviations shall provide an installation equivalent to the basic intent without incurring additional cost to the owner.
3. Design deviations shall not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.

E. Product Design Criteria:

1. Loadings for Design:
   a. Initial handling and erection stresses.
   b. All dead and live loads as specified on the Contract Drawings.
   c. All other loads specified for members, where applicable.
2. Design criteria shall state all applicable standards, codes, and specifications for which precast sections are to be designed.
3. Submit calculations sealed by a qualified professional engineer licensed in the state of Colorado.

F. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the

qualified professional engineer, licensed in the state of Colorado responsible for their preparation.

1. Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.
2. Engineers review is only for the limited purpose of:
   a. Verifying that performance and design criteria in the Contract were used.
   b. Checking for compliance with the engineers design concept.

G. Qualification Data: For testing agency.
H. Welding certificates.
I. Material Certificates: For the following, from manufacturer:
   1. Cementitious materials.
   2. Reinforcing materials and prestressing tendons.
   3. Admixtures.
   4. Bearing pads.
   5. Structural-steel shapes and hollow structural sections.
J. Material Test Reports: For aggregates, by a qualified testing agency.
K. Preconstruction test reports.
L. Source quality-control reports.
M. Field quality-control and special inspection reports.

1.07 QUALITY ASSURANCE:

A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
   1. Participates in PCI's Plant Certification program at time of bidding and is designated a PCI-certified plant as follows:
      a. Group C, Category C3 - Prestressed Straight Strand Structural Members or Category C4 - Prestressed Deflected Strand Structural Members.
B. Installer Qualifications: A precast concrete erector qualified at time of bidding, as evidenced by PCI's Certificate of Compliance, to erect Category S1 - Simple Structural Systems.
C. Installer Qualifications: An experienced precast concrete erector who, before erection of precast concrete, has retained a "PCI-Certified Field Auditor" to conduct a field audit of a project installed by erector in Category S1 - Simple Structural Systems and who produces an Erectors' Post-Audit Declaration according to PCI MNL 127.
D. Testing Agency Qualifications: Qualified according to ASTM C1077 and ASTM E329 for testing indicated.
E. Design Standards: Comply with ACI 318 and design recommendations in PCI MNL 120 applicable to types of precast structural concrete units indicated.
F. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 116.
G. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1 and AWS D1.4.
H. Preinstallation Conference: Conduct conference at Project Site.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Support units during shipment on nonstaining shock-absorbing material in same position as during storage.

B. Store units with adequate bracing and protect units to prevent contact with soil, to prevent staining, and to prevent cracking, distortion, warping or other physical damage.

1. Store units with dunnage across full width of each bearing point unless otherwise indicated.
2. Place adequate dunnage of even thickness between each unit.
3. Place stored units so identification marks are clearly visible, and units can be inspected.

C. Handle and transport units in a position consistent with their shape and design in order to avoid excessive stresses that would cause cracking or damage.

D. Lift and support units only at designated points shown on Shop Drawings.

1.09 COORDINATION:

A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

PART 2 - PRODUCTS

2.01 MOLD MATERIALS:

A. Molds: Rigid, dimensionally stable, non-absorptive material, warp and buckle free, that will provide continuous and true precast concrete surfaces within fabrication tolerances indicated; nonreactive with concrete and suitable for producing required finishes.

1. Mold-Release Agent: Commercially produced liquid-release agent that will not bond with, stain or adversely affect precast concrete surfaces and will not impair subsequent surface or joint treatments of precast concrete.

2.02 REINFORCING MATERIALS:

A. Reinforcing Bars: ASTM A615, Grade 60, deformed.

B. Low-Alloy-Steel Reinforcing Bars: ASTM A706, Grade 60, deformed.

C. Steel Bar Mats: ASTM A184, fabricated from ASTM A615 Grade 60 (Grade 420), deformed bars, assembled with clips.

D. Plain-Steel Welded Wire Reinforcement: ASTM A1064, flat sheet.

E. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

2.03 PRESTRESSING TENDONS:

A. Pretensioning Strand: ASTM A886, Grade 270 (Grade 1860), indented, 7-wire, low-relaxation strand.

B. Unbonded Post-Tensioning Strand: ASTM A416, Grade 270 (Grade 1860), uncoated, 7-wire, low-relaxation strand.

C. Post-Tensioning Bars: ASTM A722, uncoated high-strength steel bar.

2.04 CONCRETE MATERIALS:

A. Portland Cement: ASTM C150, Type I or Type III, gray, unless otherwise indicated.

B. Blended Hydraulic Cement: ASTM C595, Type IP, Portland-pozzolan cement.

C. Supplementary Cementitious Materials at Precaster's option:
   1. Fly Ash: ASTM C618, Class C or F, with maximum loss on ignition of 3%.
   2. Metakaolin Admixture: ASTM C618, Class N.
   3. Silica Fume Admixture: ASTM C1240, with optional chemical and physical requirement.
   4. Ground Granulated Blast-Furnace Slag: ASTM C989, Grade 100 or 120.

D. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C33, with coarse aggregates complying with 4S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
   a. Gradation: Uniformly graded.
   2. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand of same material as coarse aggregate unless otherwise approved by Engineer.

E. Lightweight Aggregates: Except as modified by PCI MNL 116, ASTM C330, with absorption less than 11%.

F. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.

G. Air-Entraining Admixture: ASTM C260, certified by manufacturer to be compatible with other required admixtures.

H. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15% chloride ions or other salts by weight of admixture.
   1. Water-Reducing Admixtures: ASTM C494, Type A.
   2. Water-Reducing and Retarding Admixture: ASTM C494, Type D.
   3. Water-Reducing and Accelerating Admixture: ASTM C494, Type E.
   4. High-Range, Water-Reducing Admixture: ASTM C494, Type F.

2.05 STEEL CONNECTION MATERIALS:

A. Carbon-Steel Shapes and Plates: ASTM A36.

B. Carbon-Steel-Headed Studs: ASTM A108, Grade 1010 through 1020, cold finished, AWS D1.1, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.

C. Carbon-Steel Plate: ASTM A283, Grade C.

D. Malleable-Iron Castings: ASTM A47, Grade 32510 or Grade 35028.

E. Carbon-Steel Castings: ASTM A27, Grade 60-30 (Grade 415-205).

F. High-Strength, Low-Alloy Structural Steel: ASTM A572.

G. Carbon-Steel Hollow Structural Sections: ASTM A500, Grade B.

H. Wrought Carbon-Steel Bars: ASTM A675, Grade 65 (Grade 450).

I. Deformed-Steel Wire or Bar Anchors: ASTM A496 or ASTM A706, Grade 60 (Grade 420).

J. Carbon-Steel Bolts and Studs: ASTM A307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A563; and flat, unhardened steel washers, ASTM F844.

K. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A123 or ASTM A153.
   1. For steel shapes, plates, and hollow sections to be galvanized, limit silicon content of steel to less than 0.03% or to between 0.15% and 0.25%, or limit sum of silicon and 2.5 times phosphorous content to 0.09%.
   2. Galvanizing Repair Paint: ASTM A780.

L. Welding Electrodes: Comply with AWS standards.

2.06 BEARING PADS:

A. Provide one of the following bearing pads for precast structural concrete units as recommended by precast fabricator for application:
   1. Elastomeric Pads: AASHTO M 251, plain, vulcanized, 100% polychloroprene (neoprene) elastomer, molded to size or cut from a molded sheet, Type A durometer hardness of 50 to 70, ASTM D2240; minimum tensile strength 2,250 psi , ASTM D412.

2.07 GROUT MATERIALS:

2.08 CONCRETE MIXTURES:

A. Prepare design mixtures for each type of precast concrete required.
   1. Limit use of fly ash to 20% replacement of Portland cement by weight and granulated blast-furnace slag to 20% of Portland cement by weight; metakaolin and silica fume to 10% of Portland cement by weight.
B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 (ACI 318M) or PCI MNL 116 when tested according to ASTM C1218/C1218M.

2.09 FABRICATION:

A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
   1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1 and AWS C5.4.
B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
D. Cast-in openings larger than 12 inches in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.
E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
   1. Clean reinforcement of loose rust and mill scale, earth, and other materials that reduce or destroy the bond with concrete. When damage to epoxy-coated reinforcement exceeds limits specified in ASTM A775, repair with patching material compatible with coating material and epoxy coat bar ends after cutting.
   2. Accurately position, support, and secure reinforcement against displacement during concrete-placement and consolidation operations. Completely conceal support devices to prevent exposure on finished surfaces.
   3. Place reinforcing steel and prestressing strand to maintain at least 3/4-inch minimum concrete cover. Increase cover requirements for reinforcing steel to 1-1/2 inches when units are exposed to corrosive environment or severe exposure conditions. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position while placing concrete. Direct wire tie ends away from finished, exposed concrete surfaces.

4. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh spacing and wire tie laps, where required by design. Offset laps of adjoining widths to prevent continuous laps in either direction.

F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.

G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
1. Delay detensioning or post-tensioning of precast, prestressed structural concrete units until concrete has reached its indicated minimum design release compressive strength as established by test cylinders cured under same conditions as concrete.
2. Detension pretensioned tendons either by gradually releasing tensioning jacks or by heat cutting tendons, using a sequence and pattern to prevent shock or unbalanced loading.
3. If concrete has been heat cured, detension while concrete is still warm and moist to avoid dimensional changes that may cause cracking or undesirable stresses.
4. Protect strand ends and anchorages with bituminous, zinc-rich, or epoxy paint to avoid corrosion and possible rust spots.

H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.

I. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast concrete units.

J. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air on surfaces. Use equipment and procedures complying with PCI MNL 116.

K. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.

L. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that will not show in finished structure.

M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.

N. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

2.10 FABRICATION TOLERANCES:

A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

2.11 SOURCE QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to evaluate precast structural concrete fabricator's quality-control and testing methods.
1. Allow testing agency access to material storage areas, concrete production equipment, concrete placement, and curing facilities. Cooperate with testing agency and provide samples of materials and concrete mixtures as may be requested for additional testing and evaluation.

B. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements.

C. Strength of precast structural concrete units will be considered deficient if units fail to comply with ACI 318 requirements for concrete strength.

D. If there is evidence that strength of precast concrete units may be deficient or may not comply with ACI 318 requirements, employ a qualified testing agency to obtain, prepare, and test cores drilled from hardened concrete to determine compressive strength according to ASTM C42.
   1. A minimum of three representative cores shall be taken from units of suspect strength, from locations directed by Engineer.
   2. Test cores in an air-dry condition or, if units will be wet under service conditions, test cores after immersion in water in a wet condition.
   3. Strength of concrete for each series of three cores will be considered satisfactory if average compressive strength is equal to at least 85% of 28-day design compressive strength and no single core is less than 75% of 28-day design compressive strength.
   4. Report test results in writing on same day that tests are performed, with copies to Engineer, Contractor, and precast concrete fabricator. Test reports shall include the following:
      a. Project identification name and number.
      b. Date when tests were performed.
      c. Name of precast concrete fabricator.
      d. Name of concrete testing agency.
      e. Identification letter, name, and type of precast concrete unit(s) represented by core tests; design compressive strength; type of break; compressive strength at breaks, corrected for length-diameter ratio; and direction of applied load to core in relation to horizontal plane of concrete as placed.

E. Patching: If core test results are satisfactory and precast structural concrete units comply with requirements, clean and dampen core holes and solidly fill with same precast concrete mixture that has no coarse aggregate, and finish to match adjacent precast concrete surfaces.

F. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Engineer's approval. Engineer reserves the right to reject precast units that do not match approved samples, sample panels, and mockups. Replace unacceptable units with precast concrete units that comply with requirements.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine supporting structural frame or foundation and conditions for compliance with requirements for installation tolerances, true and level bearing surfaces, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Do not install precast concrete units until supporting cast-in-place concrete has attained minimum allowable design compressive strength or until supporting steel or other structure is adequate to receive loads from precast concrete units.

3.02 INSTALLATION:

A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.

B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, supports, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.
   1. Install temporary steel or plastic spacing shims or bearing pads as precast structural concrete units are being erected. Tack weld steel shims to each other to prevent shims from separating.
   2. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
   3. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.

C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
   1. Do not permit connections to disrupt continuity of roof flashing.

D. Field cutting of precast units is not permitted without approval of the Engineer.

E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.

F. Welding: Comply with applicable requirements in AWS D1.1 and AWS D1.4 for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
   1. Protect precast structural concrete units and bearing pads from damage by field welding or cutting operations, and provide noncombustible shields as required.
   2. Clean weld-affected steel surfaces with chipping hammer followed by brushing, and apply a minimum 4.0-mil thick coat of galvanized repair paint to galvanized surfaces according to ASTM A780.
   3. Visually inspect and remove, reweld, or repair incomplete and defective welds.

G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
   1. Where slotted connections are used, verify bolt position and tightness. For sliding connections, properly secure bolt but allow bolt to move within connection slot.
   2. For pretensioned and slip critical connections, use method and inspection procedure approved by Engineer and coordinated with inspection agency.
   3. For pretensioned and slip critical connections, use one of the following methods to assure proper bolt pretension:
      a. Turn-of-Nut: According to RCSC "Specification for Structural Joints Using High-Strength Bolts."
      b. Calibrated Wrench: According to RCSC "Specification for Structural Joints Using High-Strength Bolts."
      c. Twist-off Tension Control Bolt: ASTM F1852.
      d. Direct-Tension Control Bolt: ASTM F1852.

H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.
   1. Place grout to finish smooth, level, and plumb with adjacent concrete surfaces.
   2. Fill joints completely without seepage to other surfaces.

3. Trowel top of grout joints on roofs smooth and uniform. Finish transitions between different surface levels not steeper than 1 to 12.
4. Promptly remove grout material from exposed surfaces before it affects finishes or hardens.
5. Keep grouted joints damp for not less than 24 hours after initial set.

3.03 ERECTION TOLERANCES:

A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Engineer.

3.04 FIELD QUALITY CONTROL:

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
   1. Erection of precast structural concrete members.
B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
C. Visually inspect field welds and test according to ASTM E165 or to ASTM E709 and ASTM E1444. High-strength bolted connections will be subject to inspections.
D. Testing agency shall report test results promptly and in writing to Contractor and Engineer.
E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.
G. Prepare test and inspection reports.

3.05 REPAIRS:

A. Repair precast structural concrete units if permitted by Engineer.
   1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.
B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet.
C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780.
D. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Engineer.

3.06 CLEANING:

A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.
B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
   1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
   2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 03 41 00

DIVISION 04 - MASONRY

SECTION 04 20 00 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes unit masonry assemblies consisting of the following:
   1. Concrete masonry units.
   2. Brick Veneer Units.
   3. Mortar and grout.
   4. Reinforcing steel.
   5. Masonry joint reinforcement.
   6. Ties and anchors.
   7. Embedded flashing.
   8. Miscellaneous masonry accessories.
   9. Cavity-wall insulation.

B. Products installed, but not furnished, under this Section include the following:
   1. Manufactured reglets in masonry joints for metal flashing, furnished under SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM.

1.02 REFERENCES:

A. American Concrete Institute (ACI):
   1. 315 - Details and Detailing of Concrete Reinforcement.
   2. 530.1/ASCE 6/TMS 402-13 and 602-13 - Specification for Masonry Structures.

B. American Society for Testing and Materials (ASTM):
   1. A36/A36M - Carbon Structural Steel.
   2. A82 - Steel Wire, Plain, for Concrete Reinforcement.
   3. A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   4. A307 - Carbon Steel Bolts and Studs, 6,000 psi Tensile Strength.
   5. A325/A325M - Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   6. A366/A366M - Steel Sheet, Carbon, Cold-Rolled, Commercial Quality.
   7. A563/A563M - Carbon and Alloy Steel Nuts.
   8. A615/A615M - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   9. A616/A616M - Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
   10. A617/A617M - Axle-Steel Deformed and Plain Bars for Concrete Reinforcement.
   11. A653/A653M - Steel Sheet Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   12. A767/A767M - Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   13. A951 - Masonry Joint Reinforcement.
   14. C67 - Test Methods For Sampling and Testing Brick and Structural Clay Tile.
   15. C90 - Loadbearing Concrete Masonry Units.
   16. C129 - Nonload-Bearing Concrete Masonry Units.
   17. C140 - Test Methods of Sampling and Testing Concrete Masonry Units.
   18. C143 - Test Method for Slump of Hydraulic Cement Concrete.
   19. C144 - Aggregate for Masonry Mortar.
   20. C150 - Portland Cement.
   21. C207 - Hydrated Lime for Masonry Purposes.
   22. C270 - Mortar for Unit Masonry.

23. C404 - Aggregates for Masonry Grout.
24. C476 - Grout for Masonry.
25. C494 - Chemical Admixtures in Concrete.
26. C578 - Rigid, Cellular Polystyrene Thermal Insulation.
27. C780 - Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
28. C1019 - Test Method of Sampling and Testing Grout.
29. C1093 - Practice for Accreditation of Testing Agencies for Unit Masonry.
30. C1289 - Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
31. C1314 - Test Method for Constructing and Testing Masonry Prisms Used to Determine Compliance with Specified Compressive Strength of Masonry.
32. C1329 - Mortar Cement.
33. D226 - Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
34. D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.

C. Code of Federal Regulations (CFR):
   1. 29 CFR 1926 - Standards for the Construction Industry (OSHA).

D. International Building Code (IBC - 2012).

E. National Concrete Masonry Association (NCMA):
   1. TEK 8-2 - Removal of Stains from Concrete Masonry Walls.

1.03 DEFINITIONS:

A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.04 PERFORMANCE REQUIREMENTS:

A. Provide unit masonry that develops the following net-area compressive strengths (f 'm) at 28 days. Determine compressive strength of masonry from net-area compressive strengths of masonry units and mortar types per the Prism Test that shall be performed according to Section 1.06 E.
   1. For Concrete Unit Masonry: f 'm = 2000 psi.

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Product Data: For each different masonry unit, accessory, and other manufactured product specified.

C. Shop Drawings: Show fabrication and installation details for the following:
   1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement."
   2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.

D. Samples for Initial Selection: For the following:
   1. Unit masonry Samples in small-scale form showing the full range of colors and textures available for each different exposed masonry unit required.
   2. Colored mortar Samples showing the full range of colors available.

E. Samples for Verification: For the following:
   1. Weeps.
   2. Accessories embedded in the masonry.
   3. Colored mortar Samples for each color required, showing the full range of colors expected in the finished construction. Make samples using the same sand and mortar

ingredients to be used on Project. Label Samples to indicate types and amounts of pigments used.

F. List of Materials Used in Constructing Mockups: List generic product names together with manufacturers, manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply, and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.
   1. Submittal is for information only. Neither receipt of list nor approval of mockup constitutes approval of deviations from the Contract Documents, unless such deviations are specifically brought to the attention of the Engineer and approved in writing.

G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

H. Material Test Reports: No more than two years old from a qualified testing agency employed and paid by Contractor or manufacturer indicating and interpreting test results of the following for compliance with requirements indicated:
   1. Each type of masonry unit required.
      a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
      b. Include test results, measurements, and calculations establishing net-area compressive strength of masonry units.
   2. Mortar complying with property requirements of ASTM C270.
   3. Grout mixes complying with compressive strength requirements of ASTM C476. Include description of type and proportions of grout ingredients.

I. Material Certificates: Signed by manufacturers certifying that each of the following items complies with requirements:
   1. Each type of masonry unit required.
      a. Include size-variation data for brick, verifying that actual range of sizes falls within specified tolerances.
      b. Include test data, measurements, and calculations establishing net-area compressive strength of masonry units.
   2. Each cement product required for mortar and grout, including name of manufacturer, brand, type, and weight slips at time of delivery.
   3. Each combination of masonry unit type and mortar type. Include statement of net-area compressive strength of masonry units, mortar type.
   4. Each material and grade indicated for reinforcing bars.
   5. Each type and size of joint reinforcement.
   6. Each type and size of anchor, tie, and metal accessory.

J. Cold-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.

1.06 QUALITY ASSURANCE:

A. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Engineer/Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM C1093, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.

C. Provide masonry from local manufacturer(s).

D. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from one manufacturer for each cementitious component and from one source or producer for each aggregate.

E. Preconstruction Testing: Determine the compressive strength of unit masonry assembly by the prism test method in accordance with ASTM C1314. Contractor shall be responsible for construction of assembly to be used in testing. An independent testing laboratory will be selected and paid by the Owner to perform the required laboratory tests and statistical evaluations.

F. Single-Source Responsibility for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from one source and by a single manufacturer for each different product required.

G. Single-Source Responsibility for Mortar Materials: Obtain mortar ingredients of a uniform quality from one manufacturer for each cementitious component and from one source or producer for each aggregate.

H. Mockup: Prior to installing unit masonry, construct sample wall panel in a quality manner to verify selections made under sample submittals and to demonstrate aesthetic effects of materials and execution. Build mockup to comply with the following requirements, using materials indicated for final unit of Work.
   1. Locate mockups on site as directed by Engineer/Architect.
   2. Build 4 ft.-0 inches H. by 4 ft.-0 inches W. mockup to show all aspects of the wall including:
      a. Concrete Masonry Units (CMU).
      b. Smooth Face Masonry Veneer Unit.
      c. Brick Veneer.
      d. Colored mortar.
      e. Colored sealant.
      f. Weep vents.
      g. Horizontal reinforcing.
      h. Thru-wall flashing, unsupported over SST drip flashing.
      i. Mortar Net.
      j. Insulation.
      k. Window head and sill.
   3. Clean exposed faces of mockups with masonry cleaner indicated.
   4. Notify Engineer/Architect one week in advance of the dates and times when mockups will be constructed.
   5. At the time the sample panel is reviewed, a pre-construction meeting will be held to review scope of work and coordination of masonry work with other trades.
   6. Protect accepted mockup from the elements with weather-resistant membrane.
   7. Retain and maintain mockup during construction in an undisturbed condition as a standard for judging the completed work.
      a. Acceptance of mockup is for color, texture, and blending of masonry units; relationship of mortar and brick colors; tooling of joints; aesthetic qualities of workmanship; and other material and construction qualities specifically approved by Engineer/Architect in writing.
      b. Acceptance of mockup does not constitute approval of deviations from the Contract Documents contained in mockup, unless such deviations are specifically approved by Engineer/Architect in writing.
      c. When directed, demolish and remove mockup from Project Site.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
   1. Protect concrete masonry units from moisture absorption so that, at the time of installation, the moisture content is not more than the maximum allowed at the time of delivery.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.08 PROJECT CONDITIONS:

A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
   1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
   2. Where one wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.

C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
   1. Protect base of walls from rain-splashed mud and from mortar splatter by coverings spread on ground and over wall surface.
   2. Protect sills, ledges, and projections from mortar droppings.
   3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
   4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602. Cold weather requirements become mandatory when the unit temperature or the air temperature on site falls below 40°F.
   1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40°F and above and will remain so until masonry has dried, but not less than seven days after completing cleaning.

E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
   1. When ambient temperature exceeds 100°F, or 90°F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

1.09 WARRANTY
A. The Manufacturer shall warrant that all material shall be free from defects caused by faulty material or workmanship for a minimum period of two (2) years from the date of Substantial Completion, unless otherwise specified.
B. Warranties shall comply with the requirments of Section 01 78 36.

PART 2 - PRODUCTS

2.01 CONCRETE MASONRY UNITS:
A. General: Provide shapes indicated and as follows:
   1. Provide special shapes for corners, jambs, sash, control joints, headers, bonding, and other special conditions.
   2. Provide square-edged units for outside corners.
B. Concrete Masonry Units: ASTM C90 and as follows:
   1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2800 psi.
   2. Weight Classification: Normal Weight
   3. Provide Type I, moisture-controlled units.
   4. Size (Width): Manufactured to the following dimensions:
      a. 4 inches nominal; 3-5/8 inches actual.
      b. 8 inches nominal; 7-5/8 inches actual.
      c. 12 inches nominal; 11-5/8 inches actual.
   5. Exposed Faces: Manufacturer's standard color and texture.

2.02 BRICK VENEER:
A. Regional Materials: Brick shall be manufactured within 500 miles (800 km) of Project site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles (800 km) of Project site.
B. General: Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units.
   1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
   2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
   3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
   4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
C. Face Brick: Facing brick complying with ASTM C216.
   1. Products: Subject to compliance with requirements, provide the following:

a. Modular size, velour finish. Color and texture to match existing buildings on site.
(1) Basis of Design: Bronzestone
(a) Interstate Brick
2. Denver, CO
3. 303-292-2435
(1) Or Architect approved equal.
4. Grade: SW.
5. Type: FBX-FACING
6. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive according to ASTM E514, with test period extended to 24 hours, show no visible water or leaks on the back of the test specimen.
7. Initial Rate of Absorption: Less than 30 g/30 sq. inches (30 g/194 sq. cm) per minute when tested per ASTM C67.
8. Efflorescence: Provide block that has been tested according to ASTM C67 and is rated "not effloresced."
9. Surface Coating: Brick with colors or textures produced by application of coatings shall withstand 50 cycles of freezing and thawing per ASTM C67 with no observable difference in the applied finish when viewed from 10 feet (3 m).
10. Size (Actual Dimensions): 3-5/8 inches (92 mm) wide by 2-1/4 inches (57 mm) high by 7-5/8 inches (194 mm) long.

2.03 SPLIT AND SMOOTH FACE MASONRY VENEER UNITS:

A. General: Provide shapes indicated and as follows for each form of split and smooth face masonry unit required.
1. Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.
2. Provide square-edged units for outside corners.

B. Concrete block, conforming to ASTM C90, Type I.
1. Size: Nominal face dimensions of 16-inch length x 8-inch height x 4-inch thick.
2. Color and Pattern:
a. Light Color: Basis of Design to be Midwest Block & Brick “Snow”
b. Dark Color: Interstate Light Tan Basalite
c. Pattern to be split face as indicated on the drawings. Please submit to architect for approval.

C. Integral Water Repellent: Provide units made with liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strenght. Units made with integral water repellents, when tested as a wall assmebly made with mortar containing integral water-repellent manufacturer’s mortar additic according to ASTM E514, with test perios extended to 24 hours, show no visible water or leaks on the back of the test specimen.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Addiment Inc,: Block Plus W-10
b. W.R. Grace & Co., Construction Products Division: Dry-Block
c. Masters Builders: Rheopel

D. Efflorescence: Provide block that has been tested according to ASTM C67 and is rated “Not efflorescent.”

E. Contact:

(a) Interstate Brick
2. Denver, CO
3. 303-292-2435

2.04 MORTAR AND GROUT MATERIALS:

A. Portland Cement: ASTM C150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
B. Hydrated Lime: ASTM C207, Type S.
C. Portland Cement-Lime Mix: Packaged blend of Portland cement complying with ASTM C150, Type I, or Type III, and hydrated lime complying with ASTM C207.
D. Mortar Cement: ASTM C1329.
   1. For pigmented mortar, use a colored cement formulation as required to produce the color indicated or, if not indicated, as selected from manufacturer's standard formulations.
      a. Pigments shall not exceed 10% of Portland cement by weight for mineral oxides or 2% for carbon black.
E. Aggregate for Mortar: ASTM C144; except for joints less than 1/4-inch-thick, use aggregate graded with 100% passing the No. 16 sieve.
F. Aggregate for Grout: ASTM C404.
G. Cold-Weather Admixture: Nonchloride, noncorrosive, accelerating admixture complying with ASTM C494, Type C, and recommended by the manufacturer for use in masonry mortar of composition indicated.
H. Water: Potable.
I. Products: Subject to compliance with requirements, provide one of the following:
   1. Mortar Cement:
      a. Blue Circle Cement: Magnolia Superbond Mortar Cement.
      b. Lafarge Corporation: Lafarge Mortar Cement.
   2. Cold-Weather Admixture:
      a. Euclid Chemical Co.: Accelguard 80.
      b. W. R. Grace & Co., Construction Products Division: Morseled.
      c. Sonneborn, div. of ChemRex, Inc.: Trimix-NCA.
J. Preblended mortar and grout mixes that meet the criteria above are acceptable.

2.05 REINFORCING STEEL:

A. Uncoated Steel Reinforcing Bars: ASTM A615/A615M; ASTM A616/A616M, including Supplement 1; or ASTM A617/A617M, Grade 60 (Grade 400).
B. Deformed Reinforcing Wire: ASTM A496, with ASTM A153 Class B2 zinc coating.
C. Welded-Wire Fabric: ASTM A185.

2.06 MASONRY JOINT REINFORCEMENT:

A. General: ASTM A951 and as follows:
   1. Hot-dip galvanized, carbon-steel wire for both interior and exterior walls.
   2. Wire Size for Side Rods: 9 gage.
   3. Wire Size for Cross Rods: 9 gage.
   4. Provide in lengths of not less than 10 ft., with prefabricated corner and tee units where indicated.
B. For single-wythe masonry, provide ladder type with single pair of side rods and cross rods spaced not more than 16 inches o.c.

C. For multi-wythe masonry, provide type as follows:
   1. Ladder-eye design with perpendicular cross rods and adjustable wall tie spaced not more than 16 inches o.c.

2.07 TIES AND ANCHORS, GENERAL:

A. General: Provide ties and anchors, specified in subsequent articles, made from materials that comply with this Article, unless otherwise indicated.

B. Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.
   1. Anchor plates: Not less than 0.075 inch (1.91 mm) thick, designed for fastening to structural backup through sheathing by two fasteners.
   2. Wire Ties: Manufacturer's standard shape, 0.1875 inch (4.75 mm) thick. Galvanized Steel Sheet: ASTM A653/A653M, G60 (Z180), commercial-quality, steel sheet zinc coated by hot-dip process on continuous lines before fabrication.
   3. Vertical adjustment: Not less than 3-1/2 inches (89 mm).

C. Steel Plates, Shapes, and Bars: ASTM A36/A36M.

2.08 ANCHORS FOR CONNECTING TO CONCRETE:

A. General: Provide two-piece assemblies that allow vertical or horizontal adjustment but resist tensions and compression forces perpendicular to plane of wall/
   1. Anchor Section: 3/16” diameter Galvanized Dovetail triangular tie with dovetail clip and dovetail slot.
   2. Triangular Section: Sized to extend 3 inches into veneer course.

2.09 MISCELLANEOUS ANCHORS:

A. Anchor Bolts: Steel bolts complying with ASTM A307, Grade A (ASTM F568, Property Class 4.6); with ASTM A563 hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A153, Class C; of diameter and length indicated and in the following configurations:
   1. Headed bolts.
   2. Nonheaded bolts, straight or bent in manner indicated.

2.10 EMBEDDED FLASHING MATERIALS:

A. Copper-Laminated Flashing: Laminated flashing consisting of 5-oz./sq. ft. sheet copper with non-asphaltic bonding between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

B. Products: Subject to compliance with requirements, provide one of the following:
   1. Copper-Laminated Flashing:
      a. Hohmann & Barnard, Inc.: H & B C-Fab Flashing.
      b. Sandell Manufacturing Co., Inc.: Copper Fabric Flashing.
      c. York Manufacturing, Inc.: York Copper Fabric Flashing.
         (1) Multi-Flash 500.
   2. Unsupported flashing over SST drip flashing.

2.11 MISCELLANEOUS MASONRY ACCESSORIES:

A. Compressible Filler: Premolded filler strips complying with ASTM D1056, Grade 2A1; compressible up to 35%; of width and thickness indicated; formulated from neoprene or PVC.

B. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D226, Type I (No. 15 asphalt felt).
C. Weep Vent @ head and sill of wall: Mortar Net Solutions weep vents; ½" thick, 3 ½" high, 2 $^{5}/_{8}$" long for weeps in brick veneer @ 1'-4" o.c. to be selected by engineer from manufacturer's full range, or engineer approved equal.
D. Mortar Net: High density polyethylene (HDPE) or nylon strands woven into a 90% open mesh 10 inches high by thickness required. Provide the following:
   1. Mortar Net USA, Ltd.
E. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells with loops for holding reinforcing bars in center of cells. Units are formed from 0.142-inch steel wire, hot-dip galvanized after fabrication.
   1. Provide units with either two loops or four loops as needed for number of bars indicated.
F. Products: Subject to compliance with requirements, provide one of the following:
   1. Reinforcing Bar Positioners:
      a. Dur-O-Wal, Inc.: D/A 811.
      b. Dur-O-Wal, Inc.: D/A 816.
      c. Heckman Building Products, Inc.: No. 376 Rebar Positioner.
      d. Hohmann & Barnard, Inc.: #RB Rebar Positioner.
      e. Hohmann & Barnard, Inc.: #RB-Twin Rebar Positioner.

2.12 FOUNDATION INSULATION:

A. Polyisocyanurate Board: Complies with ASTM C1289, faced as required to meet the required R-value, Type I, Class 1 or 2, close-celled.
   1. Fire Propagation Characteristics: Passes NFPA 285 testing as part of an approved assembly
   2. Thickness: 2 inches.
   3. R-value: 5.7 (minimum per inch).
B. Adhesive: Type recommended by insulation board manufacturer for application indicated.
C. Dow Froth Pak 620 Spray Foam Sealant or engineer approved equal
   1. Thickness: 2 inches
   2. R-value: 6.1 (minimum per inch)
   3. Location: spray as needed in gaps between polyisocyanurate boards.

2.13 CAVITY-WALL INSULATION

1. Polyisocyanurate (ISO) Board Insulation with Facers Both Sides: Rigid cellular foam, complying with ASTM C1289.
   a. Classifications:
   b. Type I: Faced with aluminum foil on both major surfaces of core foam.
      (1) Class 1 - Non-reinforced core foam, closed-cell.
      (2) Compressive Strength: 16 psi (110 kPa), minimum.
      (3) Thermal Resistance: R-value (RSI-value) of 6.5 (1.14) per 1 inch (25 mm) determined in accordance with ASTM C518 using stabilized R-Values @ 75 degrees F (23.8 degrees C) mean temperature.
2. Flame Spread Index (FSI): Class A - 0 to 25, when tested in accordance with ASTM E84.
3. Smoke Developed Index (SDI): 450 or less, when tested in accordance with ASTM E84.
4. Board Edges: Square.
5. Contains no HCFCs.

6. Zero ozone depleting blowing agent that has warming potential (100 years) of less than 750.
7. Recycled Content: Minimum 20%, certified by independent third party such as SCS Global Services.
8. Manufacturers
   a. Hunter Panels; XCI Foil: www.hunterpanels.com
   b. Johns Manville; AP Foil-faced: www.jm.com
   c. Rmax Inc; ECOMAXci: www.rmax.com
   d. Or Architect approved equal
9. Adhesive: Type recommended by insulation board manufacturer for application indicated.
   a. Confirm compatibility of adhesive application over air barrier.
10. Dow Froth Pak 620 Spray Foam Sealant or engineer approved equal
    a. Thickness: 2 inches
    b. R-value: 6.1 (minimum per inch)
    c. Location: spray as needed in gaps between polyisocyanurate boards.

2.14 MASONRY CLEANERS:

A. Use ProSoCo, Inc. or approved equal masonry cleaners as recommended by manufacturer.

2.15 MORTAR AND GROUT MIXES:

A. General: Do not use admixtures, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
   1. Do not use calcium chloride in mortar or grout.
   2. Add cold-weather admixture (if used) at the same rate for all mortar, regardless of weather conditions, to ensure that mortar color is consistent.

B. Mortar for Unit Masonry:
   1. Comply with ASTM C270, Proportion Specification, for types of mortar indicated below.
      a. Limit cementitious materials in mortar to Portland cement and lime. Masonry cement will not be acceptable.
      b. For all masonry:
         (1) Type: S.

C. Grout for Unit Masonry: Comply with ASTM C476. Use grout of consistency at time of placement that will completely fill spaces intended to receive grout.
   1. Use fine grout in grout spaces less than 2 inches in horizontal dimension, unless otherwise indicated.
   2. Use coarse grout in grout spaces 2 inches or more in least horizontal dimension, unless otherwise indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine conditions with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Verify that foundations are within tolerances specified.
   2. Verify that reinforcing dowels are properly placed.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Before installation, examine rough-in and built-in construction to verify actual locations of piping connections.

3.02 INSTALLATION, GENERAL:

A. Thickness: Build cavity and composite walls and other masonry construction to the full thickness shown. Build interior single-wythe walls to the actual width of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this Section and in other Sections of the Specifications.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to the opening.

D. Cut masonry units with motor-driven saws to provide clean, sharp, unchipped edges. Cut units as required to provide a continuous pattern and to fit adjoining construction. Where possible, use full-size units without cutting. Allow units cut with water-cooled saws to dry before placing, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.

1. Mix units from several pallets or cubes as they are placed.

3.03 CONSTRUCTION TOLERANCES:

A. Comply with tolerances in ACI 530.1/ASCE 6/TMS 602 and the following:

B. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/4 inch in 20 ft., nor 1/2 inch maximum.

C. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 ft., or 1/2 inch maximum.

D. For conspicuous horizontal lines, such as exposed lintels, sills, parapets, and reveals, do not vary from level by more than 1/4 inch in 20 ft., nor 1/2 inch maximum.

E. For exposed bed joints, do not vary from thickness indicated by more than ±1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

F. For exposed head joints, do not vary from thickness indicated by more than ±1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.

3.04 LAYING MASONRY WALLS:

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.

B. Lay exposed masonry in the following bond pattern; do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

1. One-half running bond with vertical joint in each course centered on units in courses above and below.

C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch horizontal face dimensions at corners or jambs.

D. Stopping and Resuming Work: In each course, rack back one-half-unit length for one-half running bond or one-third-unit length for one-third running bond; do not tooth. Clean exposed surfaces of set masonry, wet clay masonry units lightly if required, and remove loose masonry units and mortar before laying fresh masonry.
E. Built-in Work: As construction progresses, build in items specified under this and other Sections of the Specifications. Fill in solidly with masonry around built-in items.
F. Fill space between hollow-metal frames and masonry solidly with mortar, unless otherwise indicated.
G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath in the joint below and rod grout into core.
H. Fill cores in hollow concrete masonry units with grout 24 inches under bearing plates, beams, lintels, posts, and similar items, unless otherwise indicated.
I. Build non-load-bearing interior partitions as indicated.

3.05 MORTAR BEDDING AND JOINTING:

A. Lay hollow masonry units as follows:
   1. Lay vertical-cell units with full head joints. Provide bed joints with full mortar coverage on face shells and webs.
   2. Lay horizontal-cell units with full bed joints. Keep drainage channels free of mortar. Form head joints with sufficient mortar so excess will be squeezed out as units are placed in position. Butter both sides of units to be placed, or butter one side of unit in place and one side of unit to be placed.
   3. Maintain joint widths indicated, except for minor variations required to maintain bond alignment. If not indicated, lay walls with 1/4- to 3/8-inch joints.
   4. Bed webs in mortar in starting course on footings and where adjacent to cells or cavities to be filled with grout.
   5. For starting course on footings where cells are not grouted, spread out full mortar bed, including areas under cells.
B. Tool exposed joints when thumbprint hard, using a jointer larger than the joint thickness, unless otherwise indicated.
   1. Slightly concave at all CMU and brick joints.

3.06 BONDING OF MULTI-WYTHE MASONRY:

A. Use individual metal ties installed in horizontal joints to bond wythes together. Provide ties as shown. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches o.c. vertically.
B. Use masonry joint reinforcement installed in horizontal mortar joints to bond wythes together.
C. Corners: Provide interlocking masonry unit bond in each wythe and course at corners, unless otherwise indicated.
   1. Provide continuity with masonry joint reinforcement at corners by using prefabricated "L" units as well as masonry bonding.
D. Intersecting and Abutting Walls: Unless vertical expansion or control joints are shown at juncture, bond walls together as follows:
   1. Provide continuity with masonry joint reinforcement by using prefabricated "T" units.
   2. Provide rigid metal anchors not more than 24 inches o.c. If used with hollow masonry units, embed ends in mortar-filled cores.

3.07 CAVITIES:

A. Keep cavities clean of mortar droppings and other materials during construction. Strike joints facing cavities flush.
   1. Place temporary wood strips in cavity to collect mortar droppings. As Work progresses, remove strips, clean off mortar droppings, and replace in cavity.

B. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown.
   1. Fill cracks and open gaps in insulation with crack sealer compatible with insulation and masonry.

3.08 MASONRY JOINT REINFORCEMENT:

A. General: Provide continuous masonry joint reinforcement as indicated. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.
   1. Space reinforcement as indicated on drawings.
   2. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings.
      a. Reinforcement above is in addition to continuous reinforcement.

B. Cut or interrupt joint reinforcement at control and expansion joints, unless otherwise indicated.

C. Provide continuity at corners and wall intersections by using prefabricated "L" and "T" sections. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, and other special conditions.

3.09 MOVEMENT JOINTS:

A. General: Install expansion joints in unit masonry where indicated. Build-in related items as masonry progresses. Do not form a continuous span through movement joints unless provisions are made to prevent in-plane restraint of wall or partition movement.

B. Form control joints in Veneer as follows:
   1. Form open joint of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in SECTION 07 92 00 - JOINT SEALANTS. Keep joint free and clear of mortar.

3.10 LINTELS:

A. Install steel angles where indicated.

B. Provide masonry lintels where shown and where openings of more than 12 inches for brick-size units and 24 inches for block-size units are shown without structural steel or other supporting lintels.
   1. Provide prefabricated or built-in-place masonry lintels. Use specially formed bond beam units with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.11 TIES AND ANCHORS:

A. General: Install ties and anchors in poured concrete walls with face brick.

1. Anchor into shotcrete with stainless-steel Tapcon anchor (maximum embedment 1 inch).
2. Install vertically at 16 inches o.c.
3. Install horizontally at 24 inches o.c.

3.12 FLASHING AND WEEP VENTS:

A. General: Install embedded flashing and weep vents in masonry at shelf angles, lintels, ledges, base and top of wall, other obstructions to downward flow of water in wall, and where indicated.

B. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Unless otherwise indicated, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.

C. Install flashing as follows:
   1. At multi-wythe masonry walls, including cavity walls, extend flashing from exterior face of outer wythe of masonry, through outer wythe, turned up a minimum of 8 inches, and install as indicated.
   2. At lintels and shelf angles, extend flashing a minimum of 4 inches into masonry at each end. At heads and sills, extend flashing 4 inches at ends.
   3. Cut flashing off flush with face of wall after masonry wall construction is completed.

D. Install weep vents in the head joints in exterior wythes of the first course of masonry immediately above embedded flashing and as follows:
   1. Use weep vents to form weeps.
   2. Space weeps at 1 ft.-4 inches on center.
   3. Place cavity drainage material (Mortar Net) in cavities as indicated.

3.13 REINFORCED UNIT MASONRY INSTALLATION:

A. Temporary Formwork and Shores: Construct formwork and shores to support reinforced masonry elements during construction.
   1. Construct formwork to conform to shape, line, and dimensions shown. Make it sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
   2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other temporary loads that may be placed on them during construction.

B. Placing Reinforcement: Comply with requirements of ACI 530.1/ASCE 6/TMS 602.

C. Grouting: Do not place grout until entire height of masonry to be grouted has attained sufficient strength to resist grout pressure.
   1. Comply with requirements of ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.

3.14 FIELD QUALITY CONTROL:

A. Testing Frequency: Tests and Evaluations listed in this Article will be performed during construction for each 5000 sq. ft. of wall area or portion thereof.

B. Determine the compressive strength of unit masonry assembly by the prism test method in accordance with ASTM C1314.

3.15 REPAIRING, POINTING, AND CLEANING:

A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application.

C. In-Progress Cleaning: Clean unit masonry as Work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry and mortar joints by methods and products as recommended by brick manufacturer.

1. Remove large mortar particles with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Design Engineer's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and nonmasonry surfaces from contact with cleaner by covering surfaces with liquid strippable masking agent, polyethylene film, or waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing the surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2 applicable to type of stain on exposed surfaces.
7. Clean limestone units to comply with recommendations in the Indiana Limestone Institute of America's "Indiana Limestone Handbook."

E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.16 MASONRY WASTE DISPOSAL:

A. Excess Masonry Waste: Remove excess masonry waste and extra unused bricks and legally dispose of off Owner's property.

END OF SECTION 04 20 00

DIVISION 05 – METALS

SECTION 05 05 19 – POST-INSTALLED ANCHORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This section includes post installed adhesive anchors, mechanical anchors and epoxy anchorage of rebar in hardened concrete.

1.03 RELATED WORK SPECIFIED ELSEWHERE:

1. Concrete Reinforcement: Section 03 20 00
2. Concrete: Section 03 30 00
3. Cold Formed Metal Trusses: Section 05 44 00
4. Aluminum: Section 05 45 00
5. Hangers and Supports for Plumbing Piping: Section 22 05 29.
6. Metal Ducts: Section 23 31 13.
7. Hangers and Supports for Electrical Systems: Section 26 05 29.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   1. International Building Code (IBC).
   2. American Concrete Institute (ACI):
      a. 318 – Building Code Requirements for Reinforced Concrete.
      b. 355.2 – Qualification of Post-Installed Mechanical Anchors in Concrete.
      c. 355.4 – Qualification of Post-Installed Adhesive Anchors in Concrete
   3. International Code Council Evaluation Service (ICC-ES)
      a. AC01 – Acceptance Criteria for Expansion Anchors in Masonry Elements
      b. AC58 – Acceptance Criteria for Adhesive Anchors in Masonry Elements
      c. AC60 - Acceptance Criteria for Anchors in Unreinforced Masonry Elements
      d. AC193 – Acceptance Criteria for Mechanical Anchors in Concrete Elements
      e. AC308 – Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements
   4. International Association of Plumbing and Mechanical Officials (IAPMO)

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Include but not limited to, the following:
   1. Product specification data with recommended design values and physical characteristics for epoxy dowels, expansion and undercut anchors.
   2. Quality Assurance Submittals:
      a. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
      b. Certificates:
         (1) ICC ES Evaluation Reports.
   3. Manufacturer's installation instructions.

4. Installer Qualifications & Procedures: Submit installer qualifications as stated in Section 1.06.B. Submit a letter of procedure stating method of drilling, the product proposed for use, the complete installation procedure, manufacturer training date, and a list of the personnel to be trained on anchor installation.

C. Closeout Submittals: Submit the following:
1. Record Documents: Project record documents for installed materials in accordance with Division 1 Closeout Submittals Section.

1.06 QUALITY ASSURANCE

A. Installer Qualifications:
1. Drilled-in anchors for life safety applications shall be installed by a contractor with at least three years of experience performing similar installations.
2. All personnel installing adhesive anchors shall be ACI adhesive anchor certified.

B. Installer Training: Conduct a thorough training with the manufacturer or the manufacturer's representative for the contractor on the project. Training to consist of a review of the complete installation process for drilled-in anchors, to include but not limited to:
1. hole drilling procedure
2. hole preparation & cleaning technique
3. adhesive injection technique & dispenser training / maintenance
4. rebar dowel preparation and installation
5. proof loading/torquing

C. Certifications: Unless otherwise authorized by the Engineer, anchors shall have one of the following certifications:
1. ICC ES Evaluation Report indicating conformance with current applicable ICC ES Acceptance Criteria.
2. IAPMO UES Evaluation Report indicating conformance with current applicable acceptance criteria.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to job site in manufacturer's clearly labeled unopened packaging, complete with installation instructions.

B. Protect and handle materials in accordance with manufactures recommendations to prevent damage or deterioration.

PART 2 - PRODUCTS:

2.01 MATERIALS

A. Fasteners and Anchors:
1. Bolts and Studs: ASTM A307; ASTM A449 where "high strength" is indicated on the Drawings.
2. Carbon and Alloy Steel Nuts: ASTM A563.
3. Carbon Steel Washers: ASTM F436.
4. Carbon Steel Threaded Rod: ASTM A36; or ASTM A193 Grade B7; or ISO 898 Class 5.8.
5. Wedge Anchors: ASTM A510; or ASTM A108.
6. Stainless Steel Bolts, Hex Cap Screws, and Studs: ASTM F593.
7. Stainless Steel Nuts: ASTM F594.
8. Zinc Plating: ASTM B633.
9. Hot-Dip Galvanizing: ASTM A153.

10. Metric Anchor Bolts, Screws, and Studs: ISO 898 Part 1.
11. Metric Anchor Nuts: EN 24033.
12. Metric Anchor Stainless Steel Bolts, Screws, and Studs: ISO 3506 Part 1.
13. Metric Anchor Stainless Steel Nuts: ISO 3506 Part 2.
14. Reinforcing Dowels: ASTM A615

2.02 MECHANICAL ANCHORS

A. Mechanical anchors shall meet the qualification criteria of ACI 355.2, ICC-ES AC01 (masonry) or AC193 (concrete).
B. Use of mechanical anchors in permanently submerged conditions shall not be permitted.
C. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel anchors with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
D. Exterior Use: Unless otherwise indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 and Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. Stainless steel nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
E. The type of anchors shall be as follows:
    1. Wedge type, torque-controlled, with impact section to prevent thread damage complete with required nuts and washers.
        a. Life safety applications (Including but not limited to handrail and direct tension hangers)
            (1) Simpson Strong Tie – Strong Bolt 2
            (2) Hilti Kwik Bolt TZ2
            (3) DeWalt – Power-Stud SD2
        b. Low risk to life safety (small pipe stands, Unistrut, etc.)
            (1) Simpson Strong Tie – Wedge All
            (2) Hilti Kwik Bolt 3
            (3) DeWalt – Power-Stud SD1
    2. Screw Anchors: screw type. Pre-drilling of the hole requires a standard ANSI drill bit with the same diameter as the anchor and installing the anchor will be done with an impact wrench. Provide anchors with a diameter and anchor length marking on the head. Type and size as indicated on Drawings.
        a. Hilti Kwik-KH-EZ
        b. Simpson Titen HD
    3. Heavy Duty Undercut Anchors: Bearing type. Installed anchor shall have a minimum tension bearing area in the concrete, measured as the horizontal projection of the bearing surface, not less than two times the net tensile area of the anchor bolt. The installed anchor shall exhibit a form fit between the bearing elements and the undercut in the concrete. Type and size as indicated on Drawings.
        a. Simpson Strong Tie – TCA
        b. Hilti HDA Undercut Anchor
        c. DeWalt – Atomic+ Undercut
        d. Use only where specifically called for on drawings

2.03 ADHESIVE ANCHORS

A. Adhesive anchors shall meet the qualification criteria of ACI 355.4, ICC-ES A58 (masonry) or A308 (concrete).

B. Adhesive anchors shall not be installed in concrete less than 21 days of age.
C. Interior Use: Unless otherwise indicated on the Drawings, provide carbon steel threaded rods conforming to ASTM A36, ASTM A 193 Type B7 or ISO 898 Class 5.8 with zinc plating in accordance with ASTM B633, Type III Fe/Zn 5 (SC1).
D. Exterior Use: Unless otherwise indicated on the Drawings, provide stainless steel anchors. Stainless steel anchors shall be AISI Type 304 and Type 316 stainless steel provided with stainless steel nuts and washers of matching alloy group and minimum proof stress equal to or greater than the specified minimum full-size tensile strength of the externally threaded fastener. All nuts shall conform to ASTM F594 unless otherwise specified. Avoid installing stainless steel anchors in contact with galvanically dissimilar metals.
E. Reinforcing dowels shall be A615 Grade 60.
F. The type of anchors shall be as follows:
    1. Epoxy Anchors – Life safety applications.
        a. Simpson Strong Tie – SET 3G
        b. Hilti – HIT-RE500 V3
        c. Hilti – HIT-HY200
        d. DeWalt– PE1000+
        e. Adhesives Technology – Ultrabond HS-1CC
    2. Adhesive Anchors: (Used for non-vibrating equipment anchorage and other non-life safety attachments)
        a. Simpson Strong Tie – AT-XP
        b. Hilti – HIT-HY200
        c. DeWalt– AC200+
        d. Adhesives Technology – Ultrabond EXP-3CC
    3. Epoxy Rebar Dowels:
        a. Simpson Strong Tie – SET 3G
        b. Hilti HIT-RE500 V3
        c. Adhesives Technology – Ultrabond HS-1CC
    4. Anchorage to Masonry, ICC-ES AC58 & AC60:
        a. Hilti HIT-HY270
            (1) Provide Hilti HIT-SC mesh sleeve when anchoring to hollow masonry.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Drilled-In Anchors:
    1. Drill holes with rotary impact hammer drills using carbide-tipped bits, hollow drill bit system, or core drills using diamond core bits. Drill bits shall be of diameters as specified by the anchor manufacturer. Unless otherwise shown on the Drawings, all holes shall be drilled perpendicular to the concrete surface.
        a. Cored Holes: Where anchors are permitted to be installed in cored holes, use core bits with matched tolerances as specified by the manufacturer. Properly clean cored hole per manufacturer's instructions.
        b. Embedded Items: Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Exercise care in coring or drilling to avoid damaging existing reinforcing or embedded items. Take precautions as necessary to avoid damaging prestressing tendons, electrical and telecommunications conduit, and gas lines.

(1) Notify the Engineer prior to abandoning and relocating anchor holes if reinforcing steel or other embedded items are encountered during drilling and the specified embedment depth has not been met.

c. Base Material Strength: Unless otherwise specified, do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

2. Perform anchor installation in accordance with manufacturer instructions.
3. Wedge Anchors, Heavy-Duty Sleeve Anchors, and Undercut Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in part to be fastened. Set anchors to manufacturer's recommended torque, using a torque wrench. Following attainment of 10% of the specified torque, 100% of the specified torque shall be reached within 7 or fewer complete turns of the nut. If the specified torque is not achieved within the required number of turns, the anchor shall be removed and replaced unless otherwise directed by the Engineer.
4. Cartridge Injection Adhesive Anchors: Clean all holes per manufacturer instructions to remove loose material and drilling dust prior to installation of adhesive. Inject adhesive into holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive. Follow manufacturer recommendations to ensure proper mixing of adhesive components. Sufficient adhesive shall be injected in the hole to ensure that the annular gap is filled to the surface. Remove excess adhesive from the surface. Shim anchors with suitable device to center the anchor in the hole. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
5. Capsule Anchors: Perform drilling and setting operations in accordance with manufacturer instructions. Clean all holes to remove loose material and drilling dust prior to installation of adhesive. Remove water from drilled holes in such a manner as to achieve a surface dry condition. Capsule anchors shall be installed with equipment conforming to manufacturer recommendations. Do not disturb or load anchors before manufacturer specified cure time has elapsed.
6. Observe manufacturer recommendations with respect to installation temperatures for cartridge injection adhesive anchors and capsule anchors.

3.02 REPAIR OF DEFECTIVE WORK

A. Remove and replace misplaced or malfunctioning anchors. Fill empty anchor holes and patch failed anchor locations with high-strength non-shrink, nonmetallic grout. Anchors that fail to meet proof load or installation torque requirements shall be regarded as malfunctioning.

3.03 FIELD QUALITY CONTROL

A. Mechanical anchor installation shall have periodic special inspection per IBC.
B. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tensions loads shall have continuous special inspection per IBC.
   1. All other adhesive anchors not described above shall have periodic special inspection per IBC.
C. Minimum anchor embedments shall be as shown on the Drawings.

END OF SECTION 05 05 19

SECTION 05 12 00 – STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes fabrication and erection of the structural steel and other steel or metal items as defined in AISC Manual, Code of Standard Practice.

1.03 RELATED REQUIREMENTS:

A. Concrete: Division 03.
B. Section 05 13 00 – Structural Stainless Steel
C. Section 05 45 00 – Aluminum
D. Section 09 90 00 – Protective Coatings

1.04 REFERENCE STANDARDS:

A. American Institute of Steel Construction (AISC):
   1. Steel Construction Manual.
B. American Welding Society (AWS):
   1. D1.1 - Structural Welding Code - Steel.
   2. D1.6 - Structural Welding Code - Stainless Steel.
   3. QC1 - Standard for AWS Certification of Welding Inspectors.
C. ASTM International:
   1. A6 - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
   2. A36 - Carbon Structural Steel.
   3. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   4. A106 - Seamless Carbon Steel Pipe for High-Temperature Service.
   5. A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   6. A143 - Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   7. A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
   8. A240 - Chromium and Chromium-Nickel Stainless-Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   9. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   10. A312 - Seamless, Welded, and Heavily Cold Worked Austenitic Stainless-Steel Pipes.
   11. A384 - Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
   12. A385 - Providing High-Quality Zinc Coatings (Hot-Dip)
   13. A449 - Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use.
   14. A500 - Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   15. A563 - Carbon and Alloy Steel Nuts.
   16. A572 - High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   17. A588 - High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Point, with Atmospheric Corrosion Resistance - AASHTO No.: M222.
   18. A780 - Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.

19. A786 - Hot-Rolled Carbon Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
20. A992 - Structural Steel Shapes.
21. A1011/A1011M - Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
22. B695 - Coatings of Zinc Mechanically Deposited on Iron and Steel.
23. C1107 - Packaged, Dry Hydraulic Cement Grout (Non-shrink).
24. F436 - Hardened Steel Washers.
25. F593 - Stainless-Steel Bolts, Hex Cap Screws, and Studs.
26. F594 - Stainless-Steel Nuts.
27. F959 - Compressible-Washer-Type Direct Tension Indicator for Use with Structural Fasteners.
28. F1554 - Anchor Bolts, Steel, 36-, 55-, and 105-ksi Yield Strength.
29. F2329 - Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.
30. F3125 - Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions

D. The National Association of Architectural Metal Manufacturers (NAAMM):
   1. MBG 531 - Metal Bar Grating Manual.
   2. MBG 532 - Heavy Duty Metal Bar Grating Manual.
   3. MBG 533 - Welding Specifications for Fabrication of Steel, Aluminum and Stainless-Steel Bar Grating.

E. Research Council on Structural Connections (RCSC):
   1. Specification for Structural Joints Using High-Strength Bolts.
   2. SP10 - Near-White Blast Cleaning.
   3. SP11 - Power Tool Cleaning to Bare Metal.

F. Occupational Safety and Health Administration (OSHA) - All applicable OSHA regulations, including, but not limited to 29 CFR Part 1910 and Part 1926 Subpart R - Steel Erection.

1.05 SUBMITTALS:

A. Submit as specified in Division 01.

B. Includes, but not limited to, the following:
   1. Fabrication and erection drawings for all Work. A reproduction of Engineer-prepared Contract Drawings may be used for erection drawings such as to indicate information on erection or to identify detail drawing references. Where the drawings are revised to show this additional information, Engineer's title block and professional seal shall be removed from the drawing. These erection drawings shall be revised for subsequent Engineer revisions to the Contract Drawings.
   2. Fabrication and erection drawings shall be grouped in sets or sequences and shall be identified separately for each building, structure, or area.
   3. Fabrication and erection drawings shall be prepared using a three-dimensional steel modeling and detailing software system. All miscellaneous steel items such as stairs, and ladders shall be included in the same three-dimensional model as main structural steel and detailed using the same system.
   4. In the event that drawing revisions are necessary, fabrication and erection drawings shall be clearly clouded showing all changes from the previous revision.

5. All necessary information for the fabrication, including connection material specifications and sizes as well as filler metal for welds, of the component part of the structure, presented on drawings to conform to recognized standard practice, AISC Manual and AWS Code.
6. Drawings indicating stud shear connector spacing regardless of whether connectors are shop-applied or field-applied.
7. Drawings showing each piece including anchor bolts marked for identification to correspond to erection drawings.
8. Proposed method and location for erection piece mark numbering.
9. Manufacturer's literature on products including, but not limited to, grating, stair treads, stair nosings, stud shear connectors, grout, concrete anchors, and protective coatings.
10. AWS Certified Welding Inspector Certificates.
11. Welder qualification records.
12. Qualified welding procedure specifications and procedure qualification test results if welding processes differ from those prequalified by AWS.

C. High-Strength Connection Bolt and Nut Manufacturer's Inspections Certificate:
1. Certify that bolts, nuts, and washers furnished comply with all of the requirements of these Specifications, and shall provide complete manufacturer's mill test reports (Manufacturer's Inspections Certificate).
2. Certificate numbers shall appear on the product containers and correspond to the identification numbers on the mill test reports.
3. Manufacturer's symbol and grade markings shall appear on all bolts and nuts.

1.06 QUALITY ASSURANCE:

A. Each piece of mill material shall be legibly marked with the heat number, size of section, length, and mill identification marks in accordance with ASTM A6 plus the fabrication mill order number. Alternate material tracking procedures may be used when approved by Engineer.

B. For material other than ASTM A36/A36M, the appropriate specification number, grade, heat number and fabrication mill order number shall be transferred to the remnant.

C. Mill material with specified minimum yield strength higher than 36ksi (250 MPa) shall be marked with the color designated in ASTM A6/A6M. Alternate material tracking procedures may be used if approved by the purchaser.

D. Welder Qualifications:
1. Welders shall be previously qualified by passing the tests prescribed in the AWS D1.1 or by passing such other tests as Engineer may accept. Welders of stainless steel shall be previously qualified in accordance with AWS D1.6.
2. Welders shall have been tested within the past 12 months, and their qualification shall be considered as remaining in effect unless the welder is not engaged in a given process of welding for a period exceeding 6 months.

E. Inspection: Material or workmanship may be subject to inspection in the shop and field. Engineer shall have unrestricted entry to fabrication facilities and erection site at all times while work is being performed.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Handle and store all steel and appurtenances as specified in Division 01.

B. Deliver steel in the order needed for erection as follows:
1. Loose base plates.
2. Steel embedded in concrete.

3. Erection bolts.
4. First tier columns and framing for all its levels (including stairs, ladders, and guardrail).
5. Columns and framing for remaining tiers in order.

C. Railcars and/or trucks shall be loaded and cribbed so they can be readily unloaded.

D. All steel and its coatings shall be protected from damage caused by handling, storage, and shipping.

E. All materials and documentation shall be inspected immediately upon receipt at the erection site to determine that all items in the bill of material have been supplied, to assure that all documentation has been received, and to check for any damage.

F. Store all steel and appurtenances blocked-up off the ground and in orderly stacks.

G. Protect all items with shop applied protective coatings from corrosion. Store in an environment and manner consistent with type of coating.

PART 2 - PRODUCTS

2.01 BASIC MATERIALS:

A. Steel: Conform to the following unless otherwise indicated or specified.
1. Wide flange (WF) shapes and tees cut from WF: ASTM A992 (50ksi yield strength) or ASTM A572, Grade 50.
2. M shapes, S shapes, HP (bearing piles), channels, and angles: ASTM A36.
3. Structural plates and bars: ASTM A36.

B. Stainless or Heat-Resisting Chromium-Nickel Steel: Conform to ASTM A167 and A240.

C. Connection Bolts, Nuts, Washers, and Compressible Washer-Type, Direct Tension Indicators:
1. Conform to ASTM F3125 Grade A325, Type 1, unless otherwise indicated or specified.
2. Be galvanized when connecting galvanized steel.
3. Conform to F3125, Type 3, for use with A588, Grade 50.
4. Compressible Washer-Type, Direct-Tension Indicators:
   a. ASTM F959 Type 325 for use with A325 bolts.
   b. Galvanized for use with galvanized bolts.
5. Nuts: Heavy Hex conforming to ASTM A563 Grade DH.
6. Flat and beveled washers: Conform to ASTM F436.

D. Anchor Bolts:
1. Conform to ASTM F1554, Grade 36, unless otherwise indicated to be stainless steel or high strength.
2. Machine Bolts: Conform to ASTM F1554, Grade 36.
3. Stainless Steel: Conform to ASTM F593, Type 304, with nuts conforming to ASTM F594. Sleeves shall conform to ASTM A312.
4. High Strength: Conform to ASTM A449 with nuts conforming to ASTM A563.
5. Washers:
   a. For ASTM F1554 and A449 Bolts: Conform to F436.
   b. For Stainless-Steel Bolts: Conform to ASTM A167, Type 304, and dimensional tolerances of F436.
6. Galvanize all anchor bolts, nuts, and washers except stainless steel.

E. Pipe for Structural Uses: Conform to ASTM A53, Type E or S, Grade B, or ASTM A106, Grade B.

F. Square and Rectangular Tubing Hollow Structural Sections (HSS): Conform to ASTM A500, Grade C.

G. Grating:
1. Main Bars: Conform to ASTM A1011, Commercial Steel (Type B).

2. Cross Bars: Same as main bars.

H. Checkered Plate: Conform to ASTM A786 with A36 material and with deformations of the 4-way type.

I. Threaded Rods: Conform to ASTM A36.

J. Welding:
1. For ASTM A36 steel, use E70 electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1 AWS D1.1.
2. For ASTM A588 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Tables 3.1 and 3.3, AWS D1.1.
3. For ASTM A572, Grade 50 steel or ASTM A992 steel, use E70 low-hydrogen electrodes for shielded metal arc welding, F7 series electrodes for submerged arc welding, E70T series electrodes for flux-cored arc welding, and ER70S series electrodes for gas metal arc welding. Select "matching" electrodes in accordance with Table 3.1, AWS D1.1.
4. For ASTM A167 or ASTM A312 stainless steel, use shielded metal arc welding, gas metal arc welding, gas tungsten arc welding, or flux-cored arc welding. Select "matching" electrodes in accordance with Table 3.3 of AWS D1.6.

K. Galvanizing:
1. Conform to ASTM A123.
2. Nuts, bolts, and washers shall be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.

2.02 STEEL FABRICATION:

A. Fabricate all steel to conform to AISC Code of Standard Practice for Structural Steel Buildings and Bridges, AISC 360, and applicable portions of OSHA 29 CFR Part 1910 and Part 1926.

B. Permissible variations for sweep, camber, length, and cross section of all steel members shall conform to ASTM A6, AISC Manual, Part 1 and AISC Code of Standard Practice unless indicated otherwise.

C. Field-measure existing steel and structures where necessary to ensure fabrication fit-up of new steel.

D. All pieces shall be clearly marked with a permanent identifying erection mark number. Method and location of marking shall be approved by Engineer. Erection markings for galvanized steel shall be mechanically stamped on steel tags with 1/8-inch minimum thickness. Tags shall be bent to provide clearance for galvanizing between the member and the tag, except at the tag ends. Tag ends shall be welded to the member.

E. Fabricator shall mark all shear connector locations (if field-applied) for composite beams by means of center punch and paint circle or other approved means so that field layout of shear connectors is not required. Do not paint shear connector contact surface.

F. Provide grout holes in base plates having the least dimension greater than 24 inches. Holes shall be as close to center as practicable and minimum of 2 inches in diameter.

G. Shop Milling:
1. Perform at the base of columns and at the top of column base plates, except that rolled-steel bearing plates of 4-inch thickness or less may be straightened by pressing.
2. Perform on butted ends for bolted or partial penetration-welded column splices. Shop milling is not required for welded column splices with full penetration welds.
3. Perform at ends of columns which butt against a plate.

H. Welding:
   1. All welding shall be shielded metal arc, submerged arc, or flux-cored arc, or gas metal arc. For gas metal arc welding, the short-circuiting mode of filler metal transfer is not permitted. Other welding processes may be used provided they are qualified by applicable tests as prescribed in the AWS D1.1 (AWS D1.6 for stainless steel) and approved by Engineer prior to use. For the use of any other welding process, submit a qualified welding procedure specification and the procedure qualification test results. Welding processes shall be approved for use only after receipt of specific written approval from the Engineer.
   2. Conform to AWS Code and AISC Manual.
   3. Perform fabrication welding inspection in accordance with AWS D1.1. (AWS D1.6 for stainless steel). This welding inspection shall be performed by AWS Certified Welding Inspector(s) (CWI). All such Certified Welding Inspectors shall be qualified and certified in accordance with the provisions of AWS QC1. Only individuals so qualified shall be authorized to perform fabrication/erection or verification inspection of the welding performed under the provisions of AWS D1.1 (AWS D1.6 for stainless steel) and these Contract Documents. Certifications verifying the qualifications of welding inspectors shall be submitted prior to commencement of structural welding operations or prior to welding inspection performed by an individual welding inspector. Defective welds shall be corrected.

I. Shop Connections:
   1. Weld or bolt except when otherwise indicated or specified.
   2. Shop portions of connections may be welded equivalent to any bolted connection specified if Engineer concurs.
   3. Welded connections shall be as indicated or in accordance with acceptable alternative designs:
      a. Welds of connection angles to beam webs shall conform to AISC Manual, Part 10, Table 10-2 with particular regard for minimum web thickness. Provide longer connection angles or reinforce web as required.
      b. All butt-joint groove welds shall be complete penetration welds unless otherwise indicated and shall conform to the applicable standards in AISC Manual, Part 8, with special emphasis on maintaining root opening. Accomplish this for single-bevel, butt-joint welds by using backup plates or by chipping out and welding on the opposite side.
      c. Prepare weld bevels with a mechanically guided cutting torch or by grinding.
      d. Remove all run-out tabs.
   4. Bolted connections shall conform to AISC Manual, Parts 9 and 10.
      a. All bolted connections shall be made with Bearing Type connections using 3/4-inch bolts, nuts, and washers unless otherwise indicated or specified.
      b. Bearing Type Connections: Capacity of beam connections shall have a minimum capacity of that specified in AISC Manual, Part 10, Table 10.1 for "Standard Holes" in bearing type connections (thread condition N) with the number of bolt rows indicated. A minimum of one hardened washer shall be supplied with each bolt.
      c. Use the minimum number of rows of bolts for beam connections so that bottom row is at or below the centerline of the beam.
      d. Bolts to be installed in the shop shall be tightened in accordance with the provisions for field connections in PART 3.

J. Provisions for Field Connections:

1. Provide with bolted connections unless otherwise indicated or specified. The number of rows and number of bolts indicated on the Drawings or stated in the Specifications is the minimum number of rows or bolts. Provide additional bolts or connection devices, if necessary, to comply with OSHA regulation 29 CFR 1926, Subpart R - Steel Erection.
2. Provide for field welding only when so indicated or where approved by Engineer.
3. Provide all members to be field-welded with bolted erection connections adequate to resist erection stresses prior to field welding.

K. Comply with OSHA 29 CFR 1926, Subpart R - Steel Erection.

2.03 COLUMN BASE AND EQUIPMENT ANCHOR BOLTS:

A. Furnish for all columns and equipment furnished and installed under this Contract, (and as required to install all equipment furnished by others for installation under this Contract unless otherwise indicated).

2.04 GUARDRAIL AND HANDRAIL:

A. See Section 05 45 00 - Aluminum

2.05 EDGE ANGLES, PLATES, AND LINTELS:

A. Furnish around and over openings as indicated.
B. Keep plates and edge angles flush at intersections and fillet-weld to give a neat appearance at the exposed intersecting surfaces.
C. Provide lintel length of opening width +1 foot 4 inches unless otherwise indicated.
D. Properly align, level, and plumb edge angles and plates before concrete is placed.

2.06 STAIRS:

A. General Construction:
   1. Stringer sizes indicated are minimum acceptable size.
   2. Cross-brace stringers to provide lateral stability where the horizontal run exceeds 12 feet.
   3. Provide struts and hangers where indicated or as otherwise required for proper support.
B. Treads:
   1. Shall be aluminum grating. See Section 05 45 00 – Aluminum.

2.07 CONCRETE ANCHORS:

A. For post-installed anchors wee Section 05 05 19 – Post-Installed Concrete anchors

2.08 SHOP-PROTECTIVE COATING:

A. Prepare surface and apply primer (first coat) as specified in Section 09 90 00.
B. Apply primer in shop to all steel including connections, except for the following surfaces:
   1. Where encased in concrete.
   2. Covered with gunite.
   3. Within 3 inches adjacent to field welds.
   4. On faying surfaces of bolted connections when using alkyd primer.
   5. Top flange and anchors on composite beams.

2.09 GALVANIZING:

A. General:
   1. Galvanize all steel (including structural steel members, grating, floor plate, and fasteners) after fabrication.
   2. Conform to ASTM A123 for structural shapes and plates.

3. Nuts, bolts, and washers shall be hot-dip galvanized to conform to ASTM F2329 or mechanically galvanized to conform to ASTM B695.

B. Fabrication:
1. Safeguard against embrittlement in accordance with ASTM A143.
2. Safeguard against warping and distortion in accordance with ASTM A384.
3. Fabrication details shall be in accordance with ASTM A385 to allow for the creation of high-quality zinc coatings.
4. Cutting, drilling, and welding shall be performed before galvanizing.
5. Weld slag shall be removed before galvanizing.
6. Edges of tightly contacting surfaces shall be seal welded using minimum 1/8-inch fillet welds.
7. Vent holes shall be provided for piping or tubular assemblies (including guardrail and handrail) as required by ASTM A385.
8. Potential issues which could cause a problem in galvanizing shall be brought to the Engineer's attention prior to galvanizing.

C. Galvanizing of Steel Hardware:
1. Nuts shall be tapped oversize in accordance with ASTM A563.
2. Nut threads shall be re-tapped after hot-dip galvanizing to provide proper fit.
3. Direct tension indicators shall be mechanically galvanized by the manufacturer in accordance with Class 50 of ASTM B695.

D. Repair:
1. Any damage to galvanizing shall be repaired in accordance with ASTM A780.
2. Before repair of damaged galvanized coating, exposed substrate metal shall be cleaned to bright metal and free of all visual rust, oil, or grease. Any non-adhering galvanizing shall be removed to the extent that the surrounding galvanizing is integral and adherent.
3. If surface defects exceed 2% of a member's area, the defects shall be repaired by redipping the member in the zinc bath.
4. Cold repair using an organic zinc rich coating shall be permitted if the following conditions exist:
    a. Total damaged area is less than 1% of the total coated area of the member being repaired.
    b. No single repair is greater than 2 square inches (1300 mm^2).
    c. No single repair is greater than 12 inches (300 mm) long.
5. For cold repair:
    a. Repair areas in accordance with ASTM A780, Method A2.
    b. Apply organic zinc-rich primer containing a minimum of 93% zinc in dry film by weight. Apply in multiple coats (allowing proper recoat time) to achieve 8-mil dry film thickness.
    c. Color shall approximately match the color of galvanizing.
    d. Cold galvanizing compound shall be one of the following:
        (1) Crown North American Professional Products Co. Inc. - Cold galvanizing compound.
        (2) Sentry Chemical Company - Galvonic.
        (3) Subox, Division of Carboline - Galvanox Type II.
        (4) ZRC Worldwide - Cold Galvanizing Compound.
6. Hot repairs shall be made in the shop if any of the following conditions exist:
    a. Total damaged area is greater than 1% but less than 2% of the total coated area of the member being repaired.
    b. Any single repair is at least 2 square inches (1300 mm^2) in area.

c. Any single repair is 12 inches (300 mm) long or more.

7. Hot repair shall be made using zinc alloy rod or powder manufactured for the repair of galvanized steel.
8. Flux, heavy ash, or heavy dross inclusions shall be removed by brushing, grinding, or filing as required.
9. Galvanized steel which has been rejected shall be stripped, regalvanized, and submitted again for inspection.
10. Correction of excessive warpage that exceeds ASTM A6/A6M criteria shall be performed by press straightening if possible.
11. The application of localized heating to straighten shall be approved by Engineer.
12. If galvanized tension control bolts are used, all bare steel surfaces (i.e., bolt ends) shall be repair galvanized in accordance with this Section.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Field-check location and elevation of column anchor bolts and footings before erecting structural steel columns.
B. Field-measure existing steel for plumbness and elevation at connecting points.
C. Submit the method and sequence of erection for acceptance.
D. Assure that all preassemblies not specifically indicated on Contract Drawings to be preassembled before lifting shall maintain structural integrity during lifting.

3.02 STEEL ERECTION:

A. Erect all steel to conform to AISC specifications, codes, and standards or any local, state or federal codes which may exceed such requirements. Comply with applicable OSHA regulations including 29 CFR 1926, Subpart R - Steel Erection.
B. Protect existing structure from weather when connecting steel to existing structure.
C. Protect steel and anchor bolt sleeves from entrapped water that can cause damage from freezing or corrosion.
D. Column Base Plates:
   1. Prior to setting base plates, clean out sleeves of all foreign material and liquid. Clean bearing surface on foundation and bottom of base plate.
   2. Grout under base plates with a flowable non-shrink grout, taking special care not to disturb their grade and alignment.
   3. Flowable non-shrink grout shall conform to ASTM C1107 and be one of the following:
      a. Cormix Construction Chemicals, Dallas, Texas - Supreme Grout.
      b. L&M Construction Chemicals, Inc., Omaha, Nebraska - Crystex.
      c. Master Builders Company, Cleveland, Ohio - Masterflow 713 Grout.
      d. Sauereisen Cement Company, Pittsburgh, Pennsylvania - Sauereisen F100.
      e. Five Star Products, Inc., Fairfield, Connecticut - Five Star Grout.
   4. Cut off exposed edges of the grout at 45 degrees along the edges of the base plates after grout has acquired its initial set.
   5. In hot or cold weather conform to manufacturer's recommendations for temperature control for grouting operations.
E. Erection Bracing:
   1. Provide all necessary erection bracing and be responsible for structural adequacy, design, engineering, and construction of erection bracing.

2. Provide all necessary temporary struts, ties, cables, temporary flooring, planking, and scaffolding in connection with the erection of the structural steel or support of erection machinery.
3. Place as required to maintain proper position against loads from erection equipment, construction material, and wind.
4. Leave bracing in place until sufficient steel connections, concrete slabs, exterior walls, and roof decks are in place to ensure stability of the structure.

F. Connections:
1. Unless otherwise indicated, connections shall be bolted bearing type.
2. Tighten high-strength bolts to correct bolt tension in accordance with AISC Manual, Part 16, "Specification for Structural Joints Using High-Strength Bolts."
   a. Bearing Type Connections: Tighten all bolts to the pretensioned condition, except that beam-to-beam connections in floor framing which do not connect to any bracing members may be tightened to the snug-tightened condition:
   b. Furnish the inspecting wrench and one man to assist the Engineer when inspections are performed.
   c. Provide Skidmore-Wilhelm Bolt-Tension calibrator or approved equal for adjusting inspection wrench in accordance with "Specification for Structural Joints Using High-Strength Bolts", Section 9.
   d. Three bolt, nut, and washer assemblies from each lot supplied shall be tested in a tension measuring device at the jobsite at the beginning of the bolting start-up to demonstrate that the bolts and nuts, when used together, can develop tension not less than that provided in "Specification for Structural Joints Using High-Strength Bolts", Table 8.1 for the size and grade. The bolt tension shall be developed by tightening the nut.
   e. The job-inspecting torque shall be determined in accordance with "Specification for Structural Joints Using High-Strength Bolts", Section 8.
   f. The minimum number of bolts inspected and any required retightening shall be per "Specification for Structural Joints Using High-Strength Bolts", Section 9.
   g. Comply with OSHA regulation 29 CFR 1926, Subpart R - Steel Erection.
3. Compressible Washer-Type, Direct-Tension Indicators:
   a. The use of compressible washer-type, direct-tension indicators is an acceptable alternative to the requirements of PART 3, Paragraph 2.F. - Connections, this Section, in determining specified minimum bolt tension.
   b. Direct-tension indicators shall be manufactured by one of the following:
      (1) Turnasure, L.L.C., Langhorne, Pennsylvania.
      (2) Applied Bolting Technology Products, Inc.
      (3) Approved equal.
   c. Manufacture, install, and store in accordance with manufacturer's written instructions and ASTM F959.
   d. Provide Skidmore-Wilhelm Bolt Tension Calibrator or approved equal to allow Engineer random verification that the direct-tension indicators provide proper bolt tension.
4. Where required for connection fit-up, bolt holes may be adjusted in one of the following manners (flame cutting or flame enlargement of holes is not allowed):
   a. Reamed to AISC allowable maximum size for oversized holes.
   b. Holes may be filled with weld metal, ground smooth, and field-drilled.
   c. Other Engineer-approved method.
5. Welded Connections:

a. Make welded connections as indicated and leave all erection bolts in place after completion of welding unless otherwise indicated.
b. Reinforce connections when members requiring fillet welds are not in contact.
c. Use backup bars or spacer bars on all butt welds where root opening exceeds 3/16-inch.
d. Remove all run-out tabs.

G. Welding and Welders:
1. The requirements for erection welding and welders shall be the same as specified for basic materials and for steel fabrication.
2. All welds shall be stamped with a mark identifying the welder. Remove welders from Work after two defective welds.
3. Perform erection-welding inspection in accordance with AWS D1.1. (AWS D1.6 for stainless steel.) This welding inspection shall be performed by AWS Certified Welding Inspector(s) (CWI). All such Certified Welding Inspectors shall be qualified and certified in accordance with the provisions of AWS QC1. Only individuals so qualified shall perform fabrication/erection or verification inspection of the welding performed under the provisions of AWS D1.1 Code (AWS D1.6 for stainless steel) and these Contract Documents. Certifications verifying the qualifications of welding inspectors shall be submitted prior to commencement of structural welding operations or prior to welding inspection performed by an individual welding inspector. Defective welds shall be corrected.

H. Protect pipe sleeves, other anchorage members, and concrete bases from deleterious materials at all times, and from water which may cause ice damage during freezing weather.

3.03 FIELD-PROTECTIVE COATINGS:

A. Surface preparation, priming, and finish coating are specified in Section 09 90 00.

3.04 REPAIR OF GALVANIZED SURFACES:

A. Repair all damaged galvanized surfaces in accordance with the "Galvanizing" paragraph in PART 2, this Section.

END OF SECTION 05 12 00

SECTION 05 44 00 – COLD-FORMED METAL TRUSSES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes cold-formed steel framing in the form of the following:
   1. Cold-formed steel trusses for roofs.
B. Related Requirements:
   1. Section 05 05 19 – Post-Installed Concrete Anchors

1.03 REFERENCES

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
   1. International Code Counsel (ICC), International Building Code Edition
   2. American Society of Civil Engineers (ASCE), Minimum Design Loads for Buildings and Other Structures (ASCE 7)
   3. ANSI/AISI/S100: North American Specification for the Design of Cold-Formed Steel Structural Members; American Iron and Steel Institute.
   4. ANSI/AISI/S200: North American Standard for Cold-Formed Steel Framing - General Provisions.
   5. ANSI/AISI/S202: Code of Standard Practice for Cold-Formed Steel Structural Framing.
   6. ANSI/AISI/S214: North American Standard for Cold-Formed Steel Framing - Truss Design.
   7. ASTM A370 - Standard Test Methods and Definitions for Mechanical Testing of Steel Products.
   8. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
   9. ASTM A653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   10. ASTM A780 – Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   11. CFSBCSI - Cold-Formed Steel Building Components Safety Information; Cold-Formed Steel Council (CFSC).
   12. CFSEI Technical Note 551e - Design Guide for Permanent Bracing of Cold-Formed Steel Trusses; Cold-Formed Steel Engineers Institute.

1.04 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.05 ACTION SUBMITTALS

A. Submit as specified in Division 01.
B. Product Data: For each type of product.
C. Shop Drawings:
   1. Include layout, spacings, sizes, thicknesses, and types of cold-formed steel trusses; fabrication; and fastening and anchorage details, including mechanical fasteners.

2. Indicate reinforcing channels, opening framing, supplemental framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
3. Deviations from stamped construction drawings shall be approved, in writing, by the engineer prior to submittal.

D. Delegated-Design Submittal: For cold-formed steel trusses, including drawings and calculations sealed by a Professional Engineer licensed in the State of Colorado.

1.06 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.
B. Product Test Reports: For each listed product.
1. Steel sheet.
2. Expansion anchors.
3. Power-actuated anchors.
4. Mechanical fasteners.
5. Miscellaneous structural clips and accessories.
C. Evaluation Reports: For post-installed anchors and power-actuated fasteners, from ICC-ES or other qualified testing agency, acceptable to authorities having jurisdiction.
D. Field quality-control reports.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated.
B. Product Tests: Mill certificates or data from a qualified independent testing agency steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, and metallic-coating thickness.
C. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Delegated Design: Engage with a Licensed Professional Engineer in the State of Colorado to design cold-formed steel trusses and connections between trusses.
B. Structural Performance: Provide cold-formed steel trusses capable of withstanding design loads within limits and under conditions indicated.
1. Design Loads: As indicated on Drawings.
2. Deflection Limits: Design trusses to withstand design loads without deflections greater than the following:
a. Roof Trusses: Vertical deflection of L/240 for total loads and L/360 for snow loads.
3. Design trusses to provide for movement of truss members located outside the insulated building envelope without damage or overstressing, sheathing failure, connection failure, undue strain on fasteners and anchors, or other detrimental effects when subject to a maximum ambient temperature change of 120 deg F (67 deg C).
C. Cold-Formed Steel Truss Standards: Unless more stringent requirements are indicated, trusses shall comply with the following:
1. Lateral Design: AISI S213.
2. Roof Trusses: AISI S214.

2.02 COLD-FORMED STEEL TRUSS MATERIALS

A. Steel Sheet: ASTM A1003/A1003M, Structural Grade, Type H, metallic coated, of grade and coating designation as follows:
   1. Grade: As required by structural performance.
   2. Coating: G60 (Z180).

2.03 ROOF TRUSSES

A. Roof Truss Members: Manufacturer's standard C-shaped steel sections or as approved.
   1. Connecting Flange Width: 1-5/8 inches (41 mm), minimum at top and bottom chords connecting to sheathing or other directly fastened construction.
   2. Minimum Base-Metal Thickness: 0.0428 inch (1.09 mm).
   3. Section Properties: As required by structural analysis.

2.04 TRUSS ACCESSORIES

A. Fabricate steel-truss accessories from steel sheet, ASTM A1003/A1003M, Structural Grade, Type H, metallic coated steel sheet, of same grade and coating designation used for truss members.
B. Provide accessories of manufacturer's standard thickness and configuration unless otherwise indicated.

2.05 ANCHORS, CLIPS, AND FASTENERS

A. Steel Shapes and Clips: ASTM A36/A36M, zinc coated by hot-dip process according to ASTM A123/A123M.
B. Anchor Bolts: ASTM F1554, Grade 36, threaded carbon-steel hex-headed bolts, carbon-steel nuts, and flat, hardened-steel washers; zinc coated by hot-dip process according to ASTM A153/A153M, Class C.
C. Post-Installed Anchors: Comply with Section 05 05 19 and the following: Fastener systems with bolts of same basic metal as fastened metal, if visible, unless otherwise indicated; with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction.
   1. Uses: Securing cold-formed steel trusses to structure.
   2. Type: Adhesive anchor or as approved.
   3. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941 (ASTM F1941M), Class Fe/Zn 5, unless otherwise indicated.
D. Power-Actuated Fasteners: Fastener systems with working capacity greater than or equal to the design load, according to an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
E. Mechanical Fasteners: ASTM C1513, corrosion-resistant-coated, self-drilling, self-tapping steel drill screws.
   1. Head Type: Low-profile head beneath sheathing; manufacturer's standard elsewhere.
F. Welding Electrodes: Comply with AWS standards.

2.06 MISCELLANEOUS MATERIALS

A. Galvanizing Repair Paint: ASTM A780/A780M.
B. Shims: Load-bearing, high-density multimonomer, non-leaching plastic; or cold-formed steel of same grade and metallic coating as truss members supported by shims.

2.07 FABRICATION

A. Fabricate cold-formed steel trusses and accessories plumb, square, and true to line, and with connections securely fastened, according to referenced AISI's specifications and standards, manufacturer's written instructions, and requirements in this Section.
   1. Fabricate trusses using jigs or templates.
   2. Cut truss members by sawing or shearing; do not torch cut.
   3. Fasten cold-formed steel truss members by welding, screw fastening, clinch fastening, pneumatic pin fastening, or riveting as standard with fabricator.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
   4. Fasten other materials to cold-formed steel trusses by welding, bolting, pneumatic pin fastening, or screw fastening, according to Shop Drawings.

B. Reinforce, stiffen, and brace trusses to withstand handling, delivery, and erection stresses. Lift fabricated trusses by means that prevent damage or permanent distortion.

C. Tolerances: Fabricate assemblies level, plumb, and true to line to a maximum allowable variation of 1/8 inch in 10 feet (1:960) and as follows:
   1. Spacing: Space individual truss members no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.
   2. Squareness: Fabricate each cold-formed steel truss to a maximum out-of-square tolerance of 1/8 inch (3 mm).

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, conditions, and abutting trusses and framing for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install bridge, and brace cold-formed steel trusses according to AISI S200, AISI S202, AISI S214, and manufacturer's written instructions unless more stringent requirements are indicated.
   1. Coordinate with wall framing to align webs of bottom chords and load-bearing studs or continuously reinforce track to transfer loads to structure.
   2. Anchor trusses securely at all bearing points.
   3. Install continuous bridging and permanently brace trusses as indicated on Shop Drawings and designed according to CFSEI's Technical Note 551e, "Design Guide: Permanent Bracing of Cold-Formed Steel Trusses.

B. Install cold-formed steel trusses and accessories true to line and location, and with connections securely fastened.
   1. Erect trusses with plane of truss webs plumb and parallel to each other. Align and accurately position trusses at required spacings.
   2. Erect trusses without damaging truss members or connections. Damaged trusses or connections should be repaired per manufacturers recommendations. Repairs to be sealed by a registered professional engineer in the State of Colorado.
   3. Fasten cold-formed steel trusses by welding or mechanical fasteners.
      a. Comply with AWS D1.3/D1.3M requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.

b. Locate mechanical fasteners, install according to Shop Drawings, and comply with requirements for spacing, edge distances, and screw penetration.

C. Install temporary bracing and supports to secure trusses and support loads equal to those for which structure was designed. Maintain braces and supports in place, undisturbed, until entire integrated supporting structure has been completed and permanent connections to trusses are secured.

D. Truss Spacing: As indicated on Drawings.

E. Do not alter, cut, or remove truss members or connections of trusses.

3.03 ERECTION TOLERANCES

A. Install cold-formed steel trusses level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet (1:960) and as follows:

1. Space individual trusses no more than plus or minus 1/8 inch (3 mm) from plan location. Cumulative error shall not exceed minimum fastening requirements of sheathing or other finishing materials.

3.04 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:

1. As indicated on the drawings.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Cold-formed metal trusses will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.05 REPAIRS AND PROTECTION

A. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on fabricated and installed cold-formed steel trusses with galvanized repair paint according to ASTM A780/A780M and manufacturer's written instructions.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that cold-formed steel trusses are without damage or deterioration at time of Substantial Completion.

END OF SECTION 05 44 00

SECTION 05 45 00 - ALUMINUM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following aluminum-fabricated items:
   1. Structural shapes and plate.
   2. Pipe handrail and guardrails.
   3. Grating and treads.
   4. Tread plates.
   5. Ladders.
   6. Nuts and bolts.

1.03 REFERENCE STANDARDS:

A. Applicable Standards:
   1. Aluminum Association (AA):
      a. Aluminum Design Manual.
   2. American National Standards Institute (ANSI):
      a. A14.3 - Fixed Ladders - Safety Requirements.
   3. ASTM International (ASTM):
      a. A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. B209 - Aluminum and Aluminum Alloy Sheet and Plate.
      c. B221(B211) - Aluminum and Aluminum Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
      d. B308 - Aluminum Alloy 6061 T6 Standard Structural Profiles.
      e. B429 - Aluminum-Alloy Extruded Structural Pipe and Tube.
      f. B632 - Aluminum-Alloy Rolled Tread Plate.
      g. F436 - Hardened Steel Washers.
      h. F467 - Nonferrous Nuts for General Use.
      i. F468 - Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
      j. F593 - Stainless-Steel Bolts, Hex Cap Screws, and Studs.
      k. F594 - Stainless-Steel Nuts.
   4. American Welding Society (AWS):
      a. D1.2 - Structural Welding Code - Aluminum.

1.04 DEFINITIONS:

A. Handrails: A single pipe supported on a guardrail or brackets from a wall, as on a stairway or ramp, to furnish persons with a handhold in case of tripping.

B. Guardrails and railings: A vertical barrier erected along exposed edges of a floor opening, wall opening, ramp, platform, runway, or stairway to prevent falls of persons. The top member of a guardrail serves as a handrail. The terms handrails, guardrails, and railings may be used interchangeably.

C. Toeboards: A vertical barrier at floor level erected along exposed edges of a floor opening, wall opening, platform, runway, or ramp to prevent falls of materials.

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Include, but not limited to, the following:
   1. Specifications.
   2. Fabrication and erection drawings including sizes, connections, anchorage, size and type of fasteners, and accessories.
   3. Catalog cuts.
   4. Structural computations and metal properties.
   5. Material samples.
   6. Manufacturer's assembly and installation instructions.
   7. Manufacturer's maintenance manual.

1.06 QUALITY ASSURANCE:

A. Guardrails and handrails shall be the product of a company normally engaged in the manufacture of pipe railings.
B. Inspection: Material and workmanship will be subject to inspection in the shop and field.
C. Welder Qualifications:
   1. Welders shall be previously qualified by passing the tests prescribed in the AWS D1.2 Qualification Section and the AA Qualification Standard for Structural Welding of Aluminum, or by passing such other tests as Engineer may accept.
   2. Welders shall have been tested within the past 12 months, and their qualification will be considered as remaining in effect unless the welder has not engaged in a given process of welding for a period exceeding 6 months.
   3. Submit two certified copies of the qualification records as evidence of qualification to the above mentioned codes.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Protect aluminum Work from abuse, staining, or damage during shipment, storage, erection, and installation.
B. Store in a manner to prevent warping of materials.
C. Materials shall be properly packaged to prevent scratching and denting during shipment, storage, and erection. Maintain protective wrapping until Project is completed.

1.08 DESIGN REQUIREMENTS:

A. Guardrails, handrails, and ladders shall be designed and fabricated in strict compliance with the requirements of the 2021 International Building Code.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. Fabricate all aluminum to conform to AA specifications, codes, and standards.
B. Standard tolerances of all aluminum members shall conform to AA Aluminum Design Manual.
C. Fabricate all materials free of blemishes, tool marks, burrs, and other defects.
D. Shop-fabricate insofar as possible.
E. Welding:
   1. Conform to AA Aluminum Design Manual, and AWS D1.2.
   2. All welding shall be performed using inert gas, shielded arc, or resistance welding processes. Welding processes that require welding flux shall not be used.
   3. All welding shall be accomplished using filler Alloy 4043.
   4. Contractor shall perform fabrication inspection of welds in accordance with AWS D1.2 to determine the acceptability of welds. Inspection shall be performed by an AWS

Certified Welding Inspector qualified in accordance with AWS Standard for Qualification and Certification of Welding Inspectors.

5. Joints found to be defective shall be repaired by rewelding.

2.02 STRUCTURAL SHAPES AND PLATE:

A. Conform to ASTM B209 and ASTM B308.
B. Conform to AA Aluminum Standards and Data.
C. Shall be aluminum Alloy 6061 T6 unless otherwise specified.

2.03 NUTS AND BOLTS:

A. Bolts, nuts, and washers shall be AISI Type 304 or Type 316 stainless steel.
B. Bolts shall conform to ASTM F593.
C. Nuts shall conform to ASTM F594.
D. Washers shall conform to ASTM A167 with dimensional tolerances of ASTM F436.

2.04 HANDRAILS AND GUARDRAILS:

A. Acceptable Products/Manufacturers:
   1. Peak to Peak Engineered Railings, Wheat Ridge, CO.
   2. "TUFrail" by Thompson Fabricating, Birmingham, AL.
   3. "Interna-Rail" by The Wagner Companies, Milwaukee, WI.
   4. "Wesrail II" by Moultrie Manufacturing Co., Moultrie, GA.
B. Rails and Posts:
   1. Conform to ASTM B221 or B429.
   2. 1-1/2 inch nominal diameter (1.9 inch o.d.), aluminum Alloy 6105-T5 with clear anodized finish Aluminum Association designation M32-C22-A41 (215-R1). Pipe schedule shall be as required by design but shall be not less than Schedule 40.
   3. Provide linear expansion joints a maximum of 40 ft.-0 inches o.c.
C. Fittings and Accessories:
   1. Floor flanges where indicated.
   2. Wall brackets with 3-inch minimum clearance between handrail and finish wall surface and as indicated for ladder rails.
   3. Fasteners and anchors of stainless steel and of type as required by substrate.
D. Toeboard (Kick Plate):
   1. Toeboard shall conform to OSHA standards. Toeboard shall be a minimum of 4 inches high and shall be an extrusion that attaches to the posts with clamps that will allow for expansion and contraction between posts. Toeboards shall be set 1/4 inch above the walking surface. Toeboards shall be provided on all guardrails where shown on Drawings. Toeboards shall be shipped in stock lengths for field installation.

2.05 LADDERS:

A. Aluminum ladder shall be "TUFLadder" as manufactured by Thompson Fabricating (Birmingham, AL), or approved equal.
B. Rungs shall be designed to provide a non-slip, "Power grip" surface with a 1-inch wide striated top surface and a semi-circular bottom. The straight sides and semi-circular bottom shall have striations at approximately 5/16-inch centers for enhanced gripping. Rungs shall be an aluminum extrusion, Alloy 6063-T6, of sufficient section modulus and moment of inertia to withstand design loads.
C. Side rails shall be 1-1/2-inches Schedule 40 aluminum pipe, Alloy 6105-T5, 6063-T6, or 6061-T6. Pipe shall conform to ASTM B429 or B221.

D. Design and fabricate ladder to meet requirements of OSHA, ANSI A14.3, and applicable building codes.
E. Finish: Pipe for side rails shall have same finish as handrail if ladder is located at an opening in the handrail. Rungs, cage, and brackets shall be "mill" finish.
F. Every ladderway floor opening or platform shall be guarded by standard railing with standard toeboard on all exposed sides (except at the entrance to the opening), with passage through railing provided with a self-closing swinging gate. Self-closing gates shall be as manufactured by FabEnCo, Inc., Houston, TX or approved equal. All hardware shall be stainless steel.
   1. Two-rail systems - Model A82-24.
   2. Three-rail systems - Model XL82-24.
G. Provide “L1E” ladder extension post by Halliday or engineer approved equal at top of interior ladder at hatch location.

2.06 GRATINGS AND TREADS:

A. Grating:
   1. Conform to ASTM B221, aluminum Alloy 6061 or Alloy 6063, mill finish.
   2. Main Bars: 3/16 inch thick (unless otherwise noted) and spaced not more than 1-3/16 inches o.c. Depth as indicated, dovetail slotted to receive cross bars.
   3. Cross Bars: Of depth as required by main bars, spaced not more than 4 inches o.c. Top surface shall be flush with top of main bars.
   4. Configuration of top surface of main bars unless otherwise indicated.
      a. Exterior - Exposed to Weather: Striated.
      b. Interior - Not Exposed to Weather: Striated.
   5. Provide with aluminum "saddle clip"-type fasteners and stainless steel bolts.
B. Treads:
   1. Manufacturer's standard rectangular, with corrugated nosing, aluminum Alloy 6061 T6 or 6063-T6.
   2. Main Bars: As indicated on Drawings.
   3. Crossbars: Spaced not more than 4 inches o.c.
   4. Top Surface of Grating Tread: Striated.
   5. Provide with stainless-steel hardware.
C. Fabrication:
   1. Main bars shall be vertical within a tolerance of 0.10-inch per inch of depth.
   2. Longitudinal bow (before fastening to supports) shall be less than 1/200 of the length.
   3. Transverse bow before fastening to supports shall be less than 3/8 inch in 3 feet.
   4. Crossbars shall not deviate from a straight line perpendicular to the main bars by more than 3/16-inch in 3 feet.
   5. Crossbars shall match crossbars of adjacent sections to form a continuous pattern of straight lines.
   6. Panel width and length tolerances shall be +1/4 inch.
   7. Provide all openings in grating indicated and as required for installation of all piping, wiring, and equipment installed under this Contract.
   8. Band all openings 4 inches and larger with a bar same size as main bearing bar. Weld to each bearing bar with a 3/16-inch fillet weld, 3/4 inch long. Tack weld to all crossbars.
   9. Trim band all locations as follows:
      a. Open end of grating at head of a ladder.
      b. Grating edges that are not perpendicular or parallel to the main bars.
      c. Grating panels with four crossbars or less.
      d. Other locations as indicated.

D. Openings in Grating:
   1. Furnish for other contracts as follows:
      a. Include an allowance in Lump Sum Contract Price for (2) field-fabricated banded openings of 12 inches or less in diameter or rectangular openings of equivalent area.
      b. Include an allowance in Lump Sum Contract Price for (10) shop- fabricated banded openings greater than 12 inches and less than 30 inches in diameter or rectangular openings of equivalent area.
      c. Increase or decrease of quantity of openings required will be adjusted at the Unit Price set forth in the Agreement.
      d. Exact size, location, and final quantities of openings required will be furnished to Contractor during the construction period.

E. Manufacturer:
   1. Gratings and treads shall be as manufactured by one of the following:
      a. Alabama Meals Industries Corporation, Birmingham, AL.
      b. BarnettBates Corporation, Joliet, IL.
      c. Ohio Grating, Canton, OH.
      d. Grating Pacific, Los Alamitos, CA
      e. IKG Industries, Aberdeen, NJ.
      f. Engineer-approved equal.

2.07 TREAD PLATES:

A. Conform to ASTM B632, Alloy 6061-T6, mill finish.
B. Thickness as indicated with surface deformations of the 4 way type.
C. Fasten in place with 1/4-inch countersunk stainless steel screws spaced 24 inches o.c. with a minimum of one screw located at each corner of a panel.

PART 3 - EXECUTION

3.01 GENERAL:

A. Conform to applicable standards of AA.
B. Protect aluminum at contact with other metals, grout, and concrete by a heavy brush coat of alkali-resistant bituminous coating, or a nonporous tape or gasket. Coating is not required for aluminum in contact with stainless-steel bolts. Apply bituminous coating at 15-mil minimum dry film thickness and which shall be one of the following:
   1. Carboline - Bitumastic No. 50.
   2. Tnemec - H.B. Tnemecol 46-465.

3.02 INSTALLATION:

A. Aluminum Handrail and Guardrail:
   1. Space posts a maximum of 6 ft.-0 inches o.c. except where otherwise indicated.
   2. Install posts as indicated on fabrication drawings.
   3. Install toeboards (kick plates) and anchor to each post with clamps and bolts. Allow ¼-inch space between bottom of toeboard and top of floor surface.
   4. Install handrail to walls with brackets spaced not greater than 6 ft.-0 inches o.c., except where otherwise indicated.
      a. Use anchors as indicated on fabrication drawings.
   5. Protect aluminum after cleaning with a clear methacrylate lacquer coating.

B. Grating and Treads:

1. Space fasteners as required to overcome irregularities and maintain grating contact with supports. Minimum anchorage of each panel will be two fasteners at each end and one fastener at each intermediate support.
2. Unless indicated as fixed, fasten grating with clips using stainless-steel bolts.
3. Bolt stair treads to stringers with a minimum of two 3/8-inch stainless-steel bolts at each end of tread.
4. All grating shall be removable unless otherwise indicated.

C. Ladders: Install as indicated. Ladder shall be securely fastened to wall or substrate.

D. Tread Plates: Install as indicated and as specified in PART 2, this Section.

3.03 CLEANING:

A. Clean all aluminum surfaces after installation free of smudges, stains, or other deleterious substances.

END OF SECTION 05 45 00

DIVISION 06 - WOOD AND PLASTICS

SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Wood furring, grounds, nailers, and blocking.

1.03 REFERENCES:

A. American Forest and Paper Association: (Formerly National Forest Products Association).
   1. National Design Specifications for Wood Construction.

B. American Society for Testing and Materials (ASTM):
   1. A153 - Zinc-Coating (Hot-Dip) of Iron and Steel Hardware.
   2. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   3. A563/A563M - Carbon and Alloy Steel Nuts.
   4. A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   5. E96 - Test Methods for Water Vapor Transmission of Materials.

C. American Society of Mechanical Engineers (ASME):
   1. B18.2.1-81 - Square and Hex Bolts and Screws Inch Series.
   2. B18.2.3.8M-81 (R91) - Metric Hex Lag Screws.
   3. B18.6.1-81 - Wood Screws (Inch Series).

D. American Wood Preservers' Association (AWPA):
   1. C2 - Lumber, Timbers, Bridge Ties and Mine Ties, Pressure Treatment.
   2. M4 - Standard for the Care of Preservative-Treated Wood Products.

E. Council of American Building Officials (CABO):
   1. NER-272 - Pneumatic or Mechanically Driven Staples, Nails, P-Nails and Allied Fasteners for Use in all Types of Building Construction.

F. Federal Specifications (FS):
   1. FF-N-105B - Nails, Brads, Staples and Spikes: Wire, Cut and Wrought.

G. International Building Code (IBC).

H. U.S. Department of Commerce, National Institute of Standards and Technology (DOC):
   1. PS 20 - American Softwood Lumber Standard.

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 01 Specification Sections.

B. Product data for the following products:
   1. Wood blocking.
   2. Construction adhesives.

C. Material certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the American Lumber Standards Committee's (ALSC) Board of Review.
   1. Regionally sourced materials within a 500-mile radius
   2. Fire-retardant-treated wood.

D. Wood treatment data as follows, including chemical treatment manufacturer's instructions for handling, storing, installing, and finishing treated materials:
   1. For each type of preservative-treated wood product, include certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained, and compliance with applicable standards.
   2. For waterborne-treated products, include statement that moisture content of treated materials was reduced to levels indicated in this section before shipment to Project site.

E. Fabrication Shop Drawings: Framing layouts and other drawings necessary for proper installation of Work.

1.05 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Keep materials under cover and dry. Protect from weather and contact with damp or wet surfaces. Stack lumber and other panels. Provide for air circulation within and around stacks and under temporary coverings.
   1. For lumber pressure treated with waterborne chemicals, place spacers between each bundle to provide air circulation.

1.07 QUALITY ASSURANCE:

A. Lumber grading and wood species classifications shall conform to PS-20. Identify all lumber by applicable association grade marks. Grade stamp shall contain:
   1. Symbol of grading agency.
   2. Mill number.
   3. Grade of lumber.
   4. Species, species grouping, or combination designation.
   5. Rules under which graded.
   6. Condition of seasoning at time of manufacture.

1.08 WARRANTY

A. The Manufacturer shall warrant that all material shall be free from defects caused by faulty material or workmanship for a minimum period of one (1) year from the date of Substantial Completion, unless otherwise specified.

B. Warranties shall comply with the requirements of Section 01 78 36.

PART 2 - PRODUCTS

2.01 LUMBER, GENERAL:

A. Regional Materials: The following wood materials shall be manufactured within 500 miles of Project Site from materials that have been extracted, harvested, or recovered, as well as manufactured, within 500 miles of Project site:
   1. Dimension lumber.

B. Lumber Standards: Comply with DOC PS 20, and with applicable grading rules of inspection agencies certified by ALSCs Board of Review.

C. Grade Stamps: Provide lumber with each piece factory marked with grade stamp of inspection agency evidencing compliance with grading rule requirements and identifying grading agency, grade, species, moisture content at time of surfacing, and mill.
D. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.
   1. Provide dressed lumber, S4S, unless otherwise indicated.
   2. Provide dry lumber with 19% maximum moisture content at time of dressing for 2-inch nominal (38-mm actual) thickness or less, unless otherwise indicated.

2.02 BOARD LUMBER:
A. Concealed Boards: Where boards will be concealed by other work, provide lumber with 19% maximum moisture content and of following species and grade:
   1. Species and Grade:
      a. Eastern softwoods, No. 3 Common per NELMA rules.
      b. Northern species, No. 3 Common or Standard per NLGA rules.
      c. Mixed southern pine, No. 2 per SPIB rules.
      d. Western woods, Standard per WCLIB rules or No. 3 Common per WWPA rules.
      e. Any species above.

2.03 FIRE-RETARDANT-TREATED MATERIALS:
A. General: Where fire-retardant-treated materials are indicated, materials shall comply with requirements in this article, that are acceptable to authorities having jurisdiction, and with fire-test-response characteristics specified as determined by testing identical products per test method indicated by a qualified testing agency.
B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Products with a flame-spread index of 25 or less when tested according to ASTM E84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.
   1. Treatment shall not promote corrosion of metal fasteners.
   2. Interior Type A: Treated materials shall have a moisture content of 28% or less when tested according to ASTM D3201 at 92% relative humidity. Use where exterior type is not indicated.

2.04 DIMENSION LUMBER:
A. General: Provide dimension lumber of grades indicated according to the ALSC National Grading Rule (NGR) provisions of the inspection agency indicated.

2.05 MISCELLANEOUS LUMBER:
A. General: Provide lumber for support or attachment of other construction, including rooftop equipment curbs and support bases, cant strips, bucks, nailers, blocking, furring, grounds, stripping, and similar members.
B. Fabricate miscellaneous lumber from dimension lumber of sizes indicated and into shapes shown.
C. Moisture Content: 19% maximum for lumber items not specified to receive wood preservative treatment.
D. Grade: For dimension lumber sizes, provide No. 3 or Standard grade lumber per ALSCs NGRs of any species. For board-size lumber, provide No. 3 Common grade per NELMA, NLGA, or

WWPA; No. 2 grade per SPIB; or Standard grade per NLGA, WCLIB or WWPA of any species.

2.06 WOOD-PRESERVATIVE-TREATED MATERIALS:

A. General: Where lumber is indicated as preservative treated or is specified to be treated, comply with applicable requirements of AWPA C2 (lumber). Mark each treated item with the Quality Mark Requirements of an inspection agency approved by ALSCs Board of Review.
   1. Do not use chemicals containing chromium or arsenic.

B. Preservative Treatment by Pressure Process: A WPA U1: Use Category UC2 for interior construction not in contact with ground, Use Category UC3b for exterior construction not in contact with ground, and Use Category UC4a for items in contact with ground.
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium.

C. Kiln-dry lumber after treatment to a maximum moisture content of 19%. Do not use material that is warped.

D. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

E. Application: Treat all rough carpentry unless otherwise indicated.

F. Pressure treat aboveground items with waterborne preservatives to a minimum retention of 0.25 lb/cu. ft. (4.0 kg/cu. m). After treatment, kiln-dry lumber and plywood to a maximum moisture content of 19 and 15%, respectively. Treat indicated items and the following:
   1. Wood cants, nailers, curbs, equipment support bases, blocking, striping, and similar members in connection with roofing, flashing, vapor barriers, and waterproofing.
   2. Wood sleepers, blocking, furring, striping, and similar concealed members in contact with masonry or concrete.
   3. Wood framing members less than 18 inches (460 mm) above grade.

G. Complete fabrication of treated items before treatment, where possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces. Inspect each piece lumber after drying and discard damaged or defective pieces.

2.07 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Wood-Preservative-Treated Materials:
      a. Chemical Specialties, Inc.
      b. Hickson Corp.
      c. Hoover Treated Wood Products, Inc.
      d. Osmose Wood Preserving, Inc.

2.08 FASTENERS:

A. General: Provide fasteners of size and type indicated that comply with requirements specified in this Article for material and manufacture.
   1. Where rough carpentry is exposed to weather, in ground contact, or in area of high relative humidity, provide fasteners with a hot-dip zinc coating per ASTM A153 or of Type 304 stainless steel.

B. Nails, Wire, Brads, and Staples: ASTM F1667.

C. Power-Driven Fasteners: ICC-ES AC70.

D. Wood Screws: ASME B18.6.1.

E. Lag Bolts: ASME B18.2.1. (ASME B18.2.3.8M)

F. Bolts: Steel bolts complying with ASTM A307, Grade A (ASTM F 568, Property Class 4.6); with ASTM A563 (ASTM A563M) hex nuts and, where indicated, flat washers.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Discard units of material with defects that impair quality of rough carpentry and that are too small to use with minimum number of joints or optimum joint arrangement.

B. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted.

C. Fit rough carpentry to other construction; scribe and cope as required for accurate fit. Correlate location of furring, nailers, blocking, grounds, and similar supports to allow attachment of other construction.

D. Apply field treatment complying with AWPA M4 to cut surfaces of preservative-treated lumber.

E. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:

1. CABO NER-272 for power-driven staples, P-nails, and allied fasteners.
2. "Recommended Nailing Schedule" of referenced framing standard and with AFPAs "National Design Specifications for Wood Construction."
3. "Table 2304.9.1 Fastening Schedule" of the 2012 International Building Code.

F. Use hot-dip galvanized or stainless-steel nails where rough carpentry is exposed to weather, in ground contact, roof applications, or in area of high relative humidity.

3.02 WOOD GROUNDS, NAILERS, BLOCKING, AND SLEEPERS:

A. Install wood grounds, nailers, blocking, and sleepers where shown and where required for screeding or attaching other work. Form to shapes shown and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated. Build into masonry during installation of masonry work. Where possible, anchor to formwork before concrete placement.

3.03 NAILER PLATES:

A. Drill and countersink plates at centers required below. Diameter and depth of countersink shall be sufficient to receive bolt heads and washers or nuts and washers without projection beyond the surface of the plates.

B. At roof edges, drill holes for bolts at 4-foot centers and countersink.

3.04 MISCELLANEOUS BLOCKING, FURRING, AND FRAMING:

A. Install as indicated or as required.

3.05 ADJUST AND CLEAN:

A. Adjust and clean all items for proper alignment and as required for installation of finish treatment.

B. Protect all wood materials installed on exterior surfaces with a protective waterproof covering until finish materials have been installed.

END OF SECTION 06 10 00

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 16 00 - BITUMINOUS DAMPPROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:

1. Coal Tar-Epoxy dampproofing for all below grade exterior cast in place concrete walls not containing potable water and for reuse manholes. Refer to structural and civil drawings.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Product data for type of product specified, including data substantiating that materials comply with requirements for dampproofing material specified. Include recommended method of application, recommended primer, number of coats, coverage or thickness, and recommended protection course.

1. Certification by dampproofing manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.04 QUALITY ASSURANCE:

A. Installer Qualifications: Engage an experienced Installer who has complete bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Single-Source Responsibility: Obtain primary dampproofing materials and primers from one source and by a single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.

1.05 PROJECT CONDITIONS

A. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.

B. Weather Limitations: Proceed with dampproofing only when existing and forecasted weather conditions will permit work to be performed according to manufacturer’s recommendations and warranty requirements.

C. Ventilation: Provide adequate ventilation during application of dampproofing in enclosed spaces. Maintain ventilation until dampproofing has thoroughly cured.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Deliver materials in sealed containers or cartons bearing the manufacturer’s label.

B. Protect materials to keep clean, dry, and within manufacturer’s temperature limitations.

1.07 WARRANTY

A. The Manufacturer shall warrant that all material shall be free from defects caused by faulty material or workmanship for a minimum period of one (1) year from the date of Substantial Completion, unless otherwise specified.

B. Warranties shall comply with the requirements of Section 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products of one of the following:
   1. Coal Tar-Epoxy Dampproofing:
      a. Tnemec Tneme-Tar Hi Build Series 46H-413; 16-20 mils DFT.
      b. Or engineer approved equal

2.02 BITUMINOUS DAMPPROOFING:

A. General: Provide products recommended by manufacturer for designated application and suitable for service intended.

B. Cold-Applied, Coal Tar-Epoxy Dampproofing: Roll or spray applied heavy-duty water-resistant epoxy coating made with pitch for protection of concrete from severe chemical fumes and corrosive vapors. Coating shall be suitable for buried or immersion conditions.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean substrate of projections and substances detrimental to Work; comply with recommendations of prime materials manufacturer. Remove oil, grease form release agents, laitance, loose materials, and slick surfaces.

B. Install cant strips and similar accessories as recommended by prime materials manufacturer even though not indicated.

C. Fill voids, seal joints, and apply bond breakers, if any, as recommended by prime materials manufactuer, with particular attention at construction joints.

D. Install separate flashings and corner protection stripping, as recommended by prime materials manufacturer, to precede application of dampproofing. Comply with manufacturer's recommendations. Pay particular attention to requirements at building expansion joints, if any.

E. Surface prep per manufacturer recommendations: including abrasive blasting all surfaces per SSPC-SP13/NACE 6; ICRI CSP 2-4 Surface Preparation of Concrete.

F. Prime substrate as recommended by prime materials manufacturer.

G. Protection of Other Work: Do not allow liquid and mastic compounds to enter and clog drains and conductors. Prevent spillage and migration onto other surfaes of work by masking or otherwise protecting adjoining work.

3.02 INSTALLATION, GENERAL:

A. Comply with manufacturer's recommendations except where more stringent requirements are indicated or specified and where Project conditions require extra precautions to ensure satisfactory performance of work.

B. Apply vertical dampproofing down cast in place concrete walls from finished-grade line to top of footing, extend over top of footing, and down a minimum of 6 inches (150 mm) over outside face of footing. Extend 12 inches (300 mm) onto intersecting walls and footings, but do not extend onto surfaces exposed to view when the Project is completed.

3.03 PROTECTION AND CLEANING:

A. Protect exterior, below-grade dampproofing membrane from damage until backfill is completed. Remove overspray and spilled materials from surfaces not intended to receive dampproofing.

END OF SECTION 07 16 00

SECTION 07 27 26 - FLUID-APPLIED MEMBRANE AIR BARRIERS

PART 1 - GENERAL

1.01 SECTION INCLUDES
- A. Fluid-applied membrane air barriers.

1.02 RELATED REQUIREMENTS
- A. Section 03 30 00 - Concrete.
- B. Section 05 44 00 - Cold-Formed Metal Trusses.
- C. Section 06 10 00 - Rough Carpentry.
- D. Section 07 62 00 - Sheet Metal Flashing and Trim.
- E. Section 07 92 00 – Joint Sealants.

1.03 DEFINITIONS
- A. Air Barrier: Airtight barrier made of material that is virtually air-impermeable but water vapor permeable, both to amount as specified, with seams and joints sealed to adjacent surfaces.

1.04 REFERENCE STANDARDS
- A. ASTM C297/C297M - Standard Test Method for Flatwise Tensile Strength of Sandwich Constructions 2016.
- B. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants 2018.
- C. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers--Tension 2016 (Reapproved 2021).
- D. ASTM D1970/D1970M - Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection 2021.
- E. ASTM D2240 - Standard Test Method for Rubber Property--Durometer Hardness 2015 (Reapproved 2021).
- F. ASTM D2369 - Standard Test Method for Volatile Content of Coatings 2020.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2022a, with Editorial Revision (2023).
- I. ASTM E2178 - Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permeance of Building Materials 2021a.
- J. ICC-ES AC212 - Acceptance Criteria for Water-Resistive Coatings Used as Water-Resistive Barriers over Exterior Sheathing 2015.
- K. ILFI (DEC) - International Living Future Institute ‘Declare’ Program 2017.
- L. NFPA 285 - Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Wall Assemblies Containing Combustible Components 2023.

1.05 ADMINISTRATIVE REQUIREMENTS
- A. Preinstallation Meeting: Convene one week before commencing work of this section.
  1. Require attendance of parties directly affecting work of this section, including the Owner's Representative, Contractor, and Architect.
  2. Contractor to notify Architect at least seven days before this meeting.

1.06 SUBMITTALS

A. Product Data: Provide data on membrane and accessory material types, technical and test data, composition, descriptions and properties, installation instructions, and substrate preparation requirements.
B. Shop Drawings: Provide drawings of special joint conditions.
C. Manufacturer's Installation Instructions: Indicate preparation, installation methods, and storage and handling criteria.
D. Manufacturer's qualification statement.
E. Installer's qualification statement.
F. Testing agency's qualification statement.
G. Executed warranty.
H. VOC Certification: Submit certification that furnished products comply with local regulations controlling use of volatile organic compounds.

1.07 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than five years of documented experience.
B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience.
C. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

1.01 MOCK-UPS

A. Construct air barrier mock-up, 8 feet (2.44 m) long by 8 feet (2.44 m) wide, indicating backup wall, cladding, window, door frame, sill, penetrations, insulation, and flashing.
B. Allow at least 72 hours for inspection and testing of mock-up before proceeding with additional related work.
C. Coordinate construction of mock-up to allow for inspection by Architect and Owner's Representative before start of installation.
D. Locate where directed.
E. Mock-up may remain as part of work.

1.02 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to project site in original packaging with seals unbroken and properly labeled.
B. Store materials in their original undamaged packaging within a clean, dry, and protected location at a temperature above freezing and less than 90 degrees F (32 degrees C).
C. Sequence deliveries to avoid delays and minimize on-site storage.

1.03 FIELD CONDITIONS

A. Ambient Conditions:
    1. Apply primer within temperature range between 40 to 100 degrees F (4 to 38 degrees C).
    2. Apply filler within temperature range between 32 to 110 degrees F (0 to 43 degrees C).
    3. Apply silicone sealant extrusion within temperature range between 40 to 100 degrees F (4 to 38 degrees C).
    4. Apply sealant adhesive within temperature range between 32 to 110 degrees F (0 to 43 degrees C).
B. Maintain substrate temperature and humidity and other conditions affecting performance requirements as recommended by materials manufacturers before, during, and after installation.
C. Perform work only when existing and forecasted weather conditions are within the limits as established by material manufacturer.
D. Proceed with installation only when substrate construction and other preparation work are completed and in acceptable condition for air barrier material.

E. Do not apply to frozen substrate; allow adequate time for substrate to thaw, if freezing conditions exist before application.
F. Ultraviolet (UV) Exposure: Do not expose air barrier materials to sunlight and weather longer than recommended by material manufacturer.

1.04 WARRANTY

A. Manufacturer Warranty: Provide 10-year manufacturer warranty for defective material. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Fluid-Applied Membrane Air Barriers:
1. PROSOCO, Inc: www.prosoco.com/#sle.
a. Location: Lawrence, KS.
b. Phone: (800) 255-4255.
2. Substitutions: Architect approved equal.

2.02 PERFORMANCE REQUIREMENTS

A. Comply with physical and performance requirements as indicated:
1. Provide building envelope with a continuous air- and water-resistive barrier that controls air leakage, avoids condensation in interior wall assembly, and prevents water intrusion.
2. Provide watertight and airtight joints; seal penetrations and paths of water and air infiltration.
3. Provide system that withstands positive and negative combined wind, stack effect, and static pressure in HVAC on building envelope without damage or displacement.
4. Provide system that is airtight and flexible, allowing for relative movement of systems due to thermal and moisture variations.

2.03 FLUID-APPLIED MEMBRANE AIR BARRIERS

A. Applications:
   1. Concrete Walls:
      a. See Section 03 30 00 for concrete.

B. Vapor-Permeable Membrane Air Barrier, Fluid Applied: Prevents air and water leakage in cavity wall, masonry veneer construction, stucco, exterior insulation and finish systems (EIFS), and most other above-grade wall assemblies complying with ICC-ES AC212.
   1. Material: Limestone, water, and acrylic polymer.
   2. Air Permeance: 0.004 cfm/sf (0.02 L/(s sq m)) maximum leakage when tested at 1.57 psf (75 Pa) pressure difference in accordance with ASTM E2178.
   3. Water Vapor Transmission Rate: At least 25 perms (1425 ng/(Pa s sq m)) at 10 mil, 0.010-inch (0.254 mm) thickness, when tested in accordance with ASTM E96/E96M using Water Method, at 73.4 degrees F (23 degrees C).
   4. Tensile Bond: 15 psi (103.4 kPa), minimum, when tested in accordance with ASTM C297/C297M.
   5. Surface Burning Characteristics: Flame spread index of 25 or less, smoke-developed index of 450 or less, Class A when tested in accordance with ASTM E84.
   6. Comply with NFPA 285 requirements for fire propagation characteristics of exterior non-load-bearing wall assembly.
   7. Fastener Sealability: Pass, when tested in accordance with ASTM D1970/D1970M.
   8. VOC Content: Less than 2.4 fl oz/gal (18 g/L).
   9. Products:
      a. PROSOCO, Inc; R-GUARD Spray Wrap MVP (Most Vapor Permeable): www.prosoco.com/#sle.
      b. Substitutions: Architect approved equal.

2.04 ACCESSORIES

A. Sealants, Tapes, and Accessories for Sealing Air Barrier and Adjacent Substrates: As indicated or in compliance with air barrier manufacturer's installation instructions.
B. Thinners and Cleaners: As recommended by material manufacturer.
C. Metal Flashing: See Section 07 62 00.
D. Joint and Seam Filler: Silyl-terminated polymer (STP); single-component, fiber-reinforced gun-grade adhesive and detailing compound with silicone and polyurethane properties.
    1. Color: Pale red.
    2. Water Vapor Transmission Rate: At least 19 perms (1083 ng/(Pa s sq m)) at 20 mil, 0.020-inch (0.508 mm) thickness, when tested in accordance with ASTM E96/E96M.
    3. Tensile Strength: 70 psi (483 kPa), minimum, when tested in accordance with ASTM D412.
    4. Elongation at Break: Greater than 180 percent when tested in accordance with ASTM D412.
    5. Total Solids: 99 percent.
    6. VOC Content: Less than 4 fl oz/gal (30 g/L).
    7. Products:
        a. PROSOCO, Inc; R-GUARD Joint & Seam Filler: www.prosoco.com/#sle.
        b. Substitutions: Architect approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Verify that surfaces and conditions are ready for work in this section.
B. Verify surfaces are sound, clean and free of voids, surface oxidation, dirt, loose aggregate, sharp protrusions, excess mortar, or other contaminants such as grease, oil, and wax that are detrimental to application.
C. Where existing conditions are the responsibility of another installer, notify Architect of unsatisfactory conditions.
D. Do not proceed with this work until unsatisfactory conditions have been corrected.

3.02 PREPARATION

A. Remove projections, protruding fasteners, and loose or foreign matter that might interfere with proper installation.
B. Clean and prime substrate surface to receive adhesives and sealants in accordance with manufacturer's installation instructions.
C. Treat joints in substrate and between dissimilar materials in accordance with manufacturer's installation instructions.
D. Fill or bridge damaged surfaces, voids, or gaps larger than 1 inch (25.4 mm).
E. Fill voids and gaps measuring 1 inch (25.4 mm) or less with liquid-applied fill coat and seam filler as necessary to ensure continuity.
F. Exterior Sheathing:
    1. Ensure that sheathing is properly installed with ends, corners, and edges properly fastened; remove and replace damaged sheathing.
    2. Set mechanical fasteners flush with sheathing; spot overdriven fasteners with liquid-applied fill coat and seam filler.
    3. Seal cut edges of gypsum wallboards exposed in rough openings for windows and doors at corners, as recommended by manufacturer.
    4. Where exterior masonry veneer is being installed, install masonry anchors before installing air barrier over masonry; provide airtight seal around anchors.
G. Masonry and Concrete Substrates:

1. Ensure that masonry head and bed joints are filled and tooled.
2. Mechanically remove loose mortar fins, mortar accumulations and protrusions, and debris.
3. Fill cracks, joints, and gaps with liquid-applied fill coat and seam filler.

3.03 INSTALLATION

A. Install materials in accordance with manufacturer's installation instructions.
B. Air Barriers: Install continuous airtight barrier over surfaces indicated, with seams and joints sealed to adjacent surfaces.
C. Apply sealants and adhesives within recommended temperature range in accordance with manufacturer's installation instructions.
D. Backer Rod: Control sealant depth by installing closed-cell backer rod, with diameter 25 percent greater than joint width; do not puncture backer rod.
E. Fluid-Applied Membranes:
   1. Apply bead or trowel coat of mastic sealant with minimum thickness of 1/4 inch (6 mm) along coating seams, rough cuts, and as recommended by manufacturer.
   2. Use flashing to seal adjacent construction and to bridge joints in coating substrate.
   3. Apply liquid-applied fill coat and filler for seams, joints, cracks, gaps, primed rough edges at gypsum sheathing, and rough openings in accordance with manufacturer’s written instructions.
   4. Rate of Application: Spray apply air barrier to substrate at ratings recommended by manufacturer to provide pinhole-free surface and uniform color.
      a. Concrete Masonry Unit (CMU) Substrate:
         (1) Acrylic-Based Membrane: 30 to 60 sq ft/gal (0.74 to 1.47 sq m/L) per coat; provide at least two coats.
         (2) STP-Based Membrane: 50 to 80 sq ft/gal (1.23 to 1.96 sq m/L) per coat; provide at least two coats.
      b. Exterior Gypsum Board, Oriented Strand Board (OSB), and Plywood Substrate: 50 to 100 sq ft/gal (1.23 to 2.45 sq m/L) per coat; provide additional material for uniform surface where substrate porosity varies.
   5. Cap and seal top edge of fluid-applied air barrier where it comes in contact with roofing system to eliminate water intrusion.
F. Openings and Penetrations in Exterior Air Barriers:
   1. Install flashing over sills, covering entire sill frame member, extending at least 5 inches (125 mm) onto air barrier and at least 6 inches (150 mm) up jambs; mechanically fasten stretched edges.
   2. Apply liquid flashing membrane over surfaces to seal and waterproof rough openings in accordance with manufacturer’s written instructions.
      a. Spread wet product to create an opaque, monolithic flashing membrane that surrounds the rough opening and extends 4 to 6 inches (102 to 152 mm) over face of structural wall or sheathing. Apply additional coats as necessary to provide a void-free and pinhole-free surface.
   3. At openings with frames having nailing flanges, seal head and jamb flanges using a continuous bead of sealant compressed by flange and cover flanges with sealing tape at least 4 inches (100 mm) wide; do not seal sill flange.
   4. At openings with nonflanged frames, seal air barrier to each side of framing at opening using flashing at least 9 inches (230 mm) wide and covering entire depth of framing.
   5. At head of openings, install flashing under air barrier extending at least 2 inches (50 mm) beyond face of jambs; seal air barrier to flashing.
   6. At interior face of openings, seal gap between window and/or door frame, and rough framing, using joint sealant over backer rod.

7. Service and Other Penetrations: Form flashing around penetrating item and seal to air barrier surface.

3.04 PROTECTION

A. Do not leave installed materials exposed to sunlight and weather longer than recommended by manufacturer.

END OF SECTION 07 27 26

SECTION 07 41 13 - METAL ROOF PANELS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following:
B. Factory-formed and field-assembled, standing-seam metal roof panels.
C. Metal soffit panels.
D. Fascia panels.
E. Related Sections include the following:
   1. For field-applied sealants not otherwise specified in this Section: SECTION 07 92 00.

1.02 REFERENCES:

A. American Society for Testing and Materials (ASTM):
B. A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
C. A755/A755M - Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
D. C236 - Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
E. C518 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flowmeter Apparatus.
F. C645 - Nonstructural Steel Framing Members.
G. C665 - Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
H. C920 - Elastomeric Joint Sealants.
I. C991 - Flexible Glass Fiber Insulation for Pre-Engineered Metal Buildings.
J. C1136 - Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
K. C1289 - Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
L. C1311 - Solvent Release Sealants.
M. D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.
N. D4214 - Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
O. E283 - Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
P. E329 - Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
Q. E330 - Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
R. E331 - Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
S. E548 - Guide for General Criteria Used for Evaluating Laboratory Competence.
T. E1514 - Structural Standing Seam Steel Roof Panel Systems.
U. E1592 - Test Method for Structural Performance of Sheet Metal Roof and Siding Systems by Uniform Static Air Pressure Difference.
V. E1646 - Test Method for Water Penetration of Exterior Metal Roof Panel Systems by Uniform Static Air Pressure Difference.
W. E1680 - Test Method for Rate of Air Leakage through Exterior Metal Roof Panel Systems.
X. American Society of Civil Engineers (ASCE):
   1. 7 - Minimum Design Loads for Buildings and Other Structures.
Y. Factory Mutual Global (FMG):

Z. 4471 - Approval Standard, Class I Panel Roofs.
AA. Approval Guide.
BB. National Association of Architectural Metal Manufacturers (NAAMM):
1. Metal Finishes Manual for Architectural and Metal Products.
CC. The North American Insulation Manufacturers Association (NAIMA):
1. 202 - Flexible Fiber Glass Insulation Used in Metal Buildings.
DD. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
1. Architectural Sheet Metal Manual.
EE. The Society for Protective Coatings (SSPC):
1. Paint Specification No. 12: Cold Applied Asphalt Mastic (Extra Thick Film).

1.03 DEFINITIONS:
A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, miscellaneous metal framing, thermal insulation, and accessories necessary for a complete weathertight roofing system.

1.04 PERFORMANCE REQUIREMENTS:
A. General: Provide metal roof panel assemblies that comply with performance requirements specified as determined by testing manufacturers' standard assemblies similar to those indicated for this Project, by a qualified testing and inspecting agency.
B. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft.
C. (0.3 L/s per sq. m) of roof area when tested according to ASTM E1680 OR ASTM E283 at the following test-pressure difference:
D. Test-Pressure Difference: Positive and negative 1.57 lbf/sq. ft. (75 Pa).
E. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. (720 Pa) and the greater of 75% of building live load or 50% of building design positive wind-pressure difference.
F. Negative Preload Test-Pressure Difference: 50% of design wind-uplift-pressure difference.
G. Water Penetration: No water penetration when tested according to ASTM E1646 or ASTM E331 at the following test-pressure difference:
1. Test-Pressure Difference: 20% of positive design wind pressure, but not less than 6.24 lbf/sq. ft. (300 Pa) and not more than 12.0 lbf/sq. ft. (575 Pa).
H. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. (720 Pa) and the greater of 75% of building live load or 50% of building design positive wind-pressure difference.
I. Negative Preload Test-Pressure Difference: 50% of design wind-uplift-pressure difference.
J. FMG Listing: Provide metal roof panels and component materials that comply with requirements in FMG 4471 as part of a panel roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FMG markings.
K. Fire/Windstorm Classification: Class 1A90.
L. Hail Resistance: MH.
M. Structural Performance: Provide metal roof panel assemblies capable of withstanding the effects of gravity loads and stresses within limits and under conditions indicated, based on testing according to ASTM E1592 or ASTM E330.
1. Deflection Limits: Engineer metal roof panel assemblies to withstand design loads with vertical deflections no greater than 1/240 of the span.

N. Seismic Performance: Provide metal roof panel assemblies capable of withstanding the effects of earthquake motions determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."
O. Thermal Movements: Provide metal roof panel assemblies that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
    1. Temperature Change (Range): 120ºF (67ºC), ambient; 180ºF (100ºC), material surfaces.

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 01.
B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal roof panel and accessory.
C. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
    1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches (1:10):
        a. Flashing and trim.
        b. Gutters.
        c. Downspouts.
        d. Soffit panels.
        e. Fascia panels.
    2. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
D. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:
    1. Roof panels and attachments.
E. Samples for Initial Selection: For type of metal roof panel indicated with factory-applied color finishes.
    1. Include similar samples of trim and accessories involving color selection.
F. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
G. Qualification Data: For Installer professional engineer.
H. Material Certificates: For thermal insulation and vapor retarders, signed by manufacturers.
I. Field quality-control inspection reports.
J. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for the following:
K. Metal Roof and Soffit Panels: Include reports for air infiltration, water penetration, thermal performance, and structural performance.
L. Insulation and Vapor Retarders: Include reports for thermal resistance, fire-test-response characteristics, water-vapor transmission, and water absorption.
M. Maintenance Data: For metal roof panels to include in maintenance manuals.
N. Warranties: Special warranties specified in this Section.

1.06 QUALITY ASSURANCE:

A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
B. Installer's responsibilities include fabricating and installing metal roof panel assemblies and providing professional engineering services needed to assume engineering responsibility.
C. Engineering Responsibility: Preparation of data for metal roof panels, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.
D. Testing Agency Qualifications: Qualified according to ASTM E329 for testing indicated, as documented according to ASTM E548.
E. Source Limitations: Obtain each type of metal roof panels through one source from a single manufacturer.
F. Product Options: Drawings indicate size, profiles, and dimensional requirements of metal roof panels and are based on the specific system indicated.
    1. Do not modify intended aesthetic effects, as judged solely by Engineer, except with Engineer's approval. If modifications are proposed, submit comprehensive explanatory data to Engineer for review.
G. Preinstallation Conference: Conduct conference at Project Site to comply with requirements in DIVISION 01.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation. E. Protect foam-plastic insulation as follows:
E. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
F. Protect against ignition at all times. Do not deliver foam-plastic insulation materials to Project site before installation time.
G. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.08 PROJECT CONDITIONS:

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal roof panels to be performed according to manufacturers' written instructions and warranty requirements.
B. Field Measurements: Verify locations of roof framing and roof opening dimensions by field measurements before metal roof panel fabrication and indicate measurements on Shop Drawings.

1.09 WARRANTY:

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal roof panel assemblies that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:

B. Structural failures, including rupturing, cracking, or puncturing.

C. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
   1. Warranty Period: Two years from date of Substantial Completion.

D. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
   1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:

E. Color fading more than 5 Hunter units when tested according to ASTM D2244.

F. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.

G. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   1. Finish Warranty Period: 20 years from date of Substantial Completion.

H. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
   1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 PANEL MATERIALS:

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A755/A755M.
   1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A653/A653M, G90 (Z275) coating designation; structural quality.
   2. Surface: Smooth, flat finish.
   3. Exposed Finishes: Apply the following coil coating, as specified.
      a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
         (1) Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70% polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2604, except as modified below:
      b. Humidity Resistance: 1,000 hours.
      c. Salt Spray Resistance: 1,000 hours.
   4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013-mm).

B. Panel Sealants:
   1. Sealant Tape: Pressure-sensitive, 100% solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2-inch (13-mm) wide and 1/8-inch (3-mm) thick.

2. Joint Sealant: ASTM C920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C1311.

2.02 SUBSTRATE BOARD:

A. 1/2 inch plywood: APA Rated Exterior, Structural 1 made with waterproof glue.
1. Steel/wood fasteners; corrosive resistant, self-tapping, self-drilling; FM Global approved; 12 minimum and sufficient length to penetrate into steel 3/4 inch and wood 1 inch.

2.03 MISCELLANEOUS METAL FRAMING:

A. General: Comply with ASTM C754 for conditions indicated.
1. Steel Sheet Components: Complying with ASTM C645 requirements for metal and with manufacturer's standard corrosion-resistant zinc coating.
B. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power and other properties required to fasten steel members to substrates.

2.04 MISCELLANEOUS MATERIALS:

A. Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating.
B. Fasteners for Roof Panels: Self-drilling or self-tapping 410 stainless or zinc-alloy steel hex washer head, with EPDM or PVC washer under heads of fasteners bearing on weather side of metal roof panels.
C. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws with hex washer head.
D. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
E. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil (0.4-mm) dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

2.05 STANDING-SEAM METAL ROOF PANELS:

A. General: Provide factory-formed metal roof panels designed to be field assembled by lapping and interconnecting raised side edges of adjacent panels with joint type indicated and mechanically attaching panels to supports using concealed clips in side laps. Include clips, cleats, pressure plates, and accessories required for weathertight installation.
1. Steel Panel Systems: Unless more stringent requirements are indicated, comply with ASTM E1514.
B. Vertical-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels: Formed with vertical ribs at panel edges and flat pan between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels and engaging opposite edge of adjacent panels, and mechanically seaming panels together.
1. Manufacturers:
a. Berridge Manufacturing Company.
b. CENTRIA Architectural Systems.
c. MBCI; Div. of NCI Building Systems.
2. Material: Zinc-coated (galvanized) steel sheet, 24 gage.
a. Exterior Finish: Fluoropolymer.
b. Color: As selected by Engineer from manufacturer's full range.
3. Clips: Floating to accommodate thermal movement.

4. Joint Type: As standard with manufacturer.
5. Panel Coverage: 12 inches (305 mm).
6. Panel Height: 1.5 inches (38 mm) minimum.
7. Uplift Rating: UL 90.

2.06 METAL SOFFIT AND FASCIA PANELS:

A. General: Provide factory-formed metal soffit and fascia panels designed to be field assembled by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.

B. Flush-Profile Metal Soffit and Fascia Panels: Perforated soffit and solid fascia panels formed with vertical panel edges and flat pan between panel edges; with flush joint between panels.
   1. Manufacturers:
      a. Berridge Manufacturing Company.
      b. CENTRIA Architectural Systems.
      c. Innovative Metals Company, Inc.
      d. K-Metals Inc.
      e. MBCI; Div. of NCI Building Systems.
      f. Merchant & Evans, Inc.
      g. Metal-Fab Manufacturing, LLC.
      h. Petersen Aluminum Corporation.
      i. Or Architect approved equal.
   2. Material: Same material, finish, and color as metal roof panels.
   3. Soffit Panel Height: 0.875 inch.
   4. Fascia Panel: Full height coverage. No horizontal joints.
   5. Sealant: Factory applied within interlocking joint.

2.07 ACCESSORIES:

A. Roof Panel Accessories: Provide components required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels, unless otherwise indicated.
   1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
   2. Clips: Minimum 0.0625-inch (1.6-mm) thick, stainless-steel panel clips designed to withstand negative-load requirements.
   3. Cleats: Mechanically seamed cleats formed from minimum 0.0250-inch (0.64-mm) thick, stainless-steel or nylon-coated aluminum sheet.
   4. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
   5. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch (25-mm) thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.

B. Flashing and Trim: Formed from same material as roof panels, prepainted with coil coating, minimum 0.018-inch (0.45-mm) thick. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves,

rakes, corners, bases, framed openings, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

C. Gutters: Formed from same material roof panels. Match profile gable trim, complete with end pieces, outlet tubes, and other special pieces as required. Fabricate in minimum 96-inch (2,400-mm) long sections of size and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Furnish gutter supports spaced a maximum of 36 inches (900 mm) o.c., fabricated from same metal as gutters. Provide wire ball strainers of compatible metal at outlets. Finish gutters to match rake trim.

D. Downspouts: Formed from same material as roof panels. Fabricate in 10-foot (3-m) long sections, complete with formed elbows and offsets, and metal thickness according to SMACNA's "Architectural Sheet Metal Manual." Finish downspouts to match gutters.

E. Snow Guards: Prefabricated stainless steel or aluminum units designed to be installed without penetrating roof panel, and complete with predrilled holes, clamps, or hooks for anchoring.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dyna-Guard Snow Retention System by Dynamic Fastener.
      b. Or Architect approved equal.

2.08 FABRICATION:

A. General: Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.

B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.

C. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
   1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
   2. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
   3. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.
   4. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal recommended by metal roof panel manufacturer.
      a. Size: As recommended by SMACNA's "Architectural Sheet Metal Manual" or metal roof panel manufacturer for application but not less than thickness of metal being secured.

2.09 FINISHES, GENERAL:

A. Comply with NAAMMs "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are

acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions with Installer present, for compliance with requirements for installation tolerances, metal roof panel supports, and other conditions affecting performance of work.
   1. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

B. Install soffit panels, fascia, and copings to comply with manufacturer's recommendations.

C. Miscellaneous Framing: Install subpurlins, eave angles, furring, and other miscellaneous roof panel support members and anchorage according to metal roof panel manufacturer's written recommendations.
   1. Soffit Framing: As indicated and required to comply with requirements for assemblies indicated.

3.03 METAL ROOF PANEL INSTALLATION, GENERAL:

A. General: Provide metal roof panels of full length. Anchor metal roof panels and other components of the Work securely in place, with provisions for thermal and structural movement.
   1. Field cutting of metal roof panels by torch is not permitted.
   2. Install panels perpendicular to the metal deck.
   3. Rigidly fasten eave end of metal roof panels and allow ridge end free movement due to thermal expansion and contraction. Predrill panels.
   4. Provide metal closures at rake walls and high and low points or roof.
   5. Flash and seal metal roof panels with weather closures at rakes, and at perimeter of roof.
   6. Fasten with self-tapping screws.
   7. Locate and space fastenings in uniform vertical and horizontal alignment.
   8. Locate panel splices over, but not attached to, structural supports.
   9. Lap metal flashing over metal roof panels at high point and under panel at low point to allow moisture to run over and off the material.

B. Fasteners:
   1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized steel fasteners for surfaces exposed to the interior.

C. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.

D. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers,

and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.

1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.

3.04 SUBSTRATE INSTALLATION:

A. Plywood joints must be true and fitting, allowing for expansion and contraction. Allow 1/8 inch at end and edge joints.

B. Plywood fasteners shall be installed in a uniform grid pattern, with a maximum spacing of 18 inch o.c. between adjacent fasteners. Where fastening to steel studs, fasten to each framing member 6 inches on center.

3.05 FIELD-ASSEMBLED METAL ROOF PANEL INSTALLATION:

A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.

B. Install clips to supports with self-tapping fasteners.

C. Install pressure plates at locations indicated in manufacturer's written installation instructions.

D. Seamed Joint: Crimp standing seams with manufacturer-approved motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.

E. Metal Soffit Panels: Provide metal soffit panels full width of soffits. Install panels perpendicular to support framing.

1. Flash and seal panels with weather closures where metal soffit panels meet walls and at perimeter of all openings.

F. Fascia Panels: Align bottom of panels and fasten with blind rivets, bolts, or self-tapping screws. Flash and seal panels with weather closures where fasciae meet soffits, along lower panel edges, and at perimeter of all openings.

3.06 ACCESSORY INSTALLATION:

A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.

1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.

B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.

2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof,

form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

C. Gutters: Join sections with riveted and soldered or lapped and sealed joints. Attach gutters to eave with gutter hangers spaced not more than 4 feet (1.2 m) o.c. using manufacturer's standard fasteners. Provide end closures and seal watertight with sealant. Provide for thermal expansion.

D. Downspouts: Join sections with 1-1/2-inch (38-mm) telescoping joints. Provide fasteners designed to hold downspouts securely 1-inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 60 inches (1,500 mm) o.c. in between.

1. Provide elbows at base of downspouts to direct water away from building.

3.07 ERECTION TOLERANCES:

A. A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet (6-mm in 6-m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.08 FIELD QUALITY CONTROL:

A. Testing Agency: Contractor will engage a qualified independent testing and inspecting agency to perform inspections and prepare reports.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect completed metal roof panel installation, including accessories. Report results in writing.

C. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.

D. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.09 CLEANING AND PROTECTION:

A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.

B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 07 41 13

SECTION 07 54 23 – THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Adhered thermoplastic polyolefin (TPO) roofing system.
   2. Vapor retarder.
   3. Roof insulation.

B. Related Sections include:
   1. Wood nailers, curbs, and blocking: SECTION 06 10 00 – ROUGH CARPENTRY.
   2. Metal roof penetration flashings, flashings, and counterflashings: SECTION 07 62 00 – SHEET METAL FLASHING AND TRIM.
      a. Required to be submitted with roofing by roofing subcontractor.
   3. Sealants: SECTION 07 92 00 – JOINT SEALANTS.

1.03 REFERENCE STANDARDS:

A. American Society for Testing and Materials (ASTM):
   1. ASTM C140: Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
   2. ASTM C208: Specification for Cellulosic Fiber Insulating Board.
   3. ASTM C552: Specification for Cellular Glass Thermal Insulation.
   4. ASTM C578: Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   5. ASTM C728: Specification for Perlite Thermal Insulation Board.
   6. ASTM C1177/C1177M: Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
   7. ASTM C1278/C1278M: Specification for Fiber-Reinforced Gypsum Panel.
   8. ASTM C1289: Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
   9. ASTM C1396/C1396M: Specification for Gypsum Board.
   10. ASTM D41/D41M: Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing.
   11. ASTM D312: Specification for Asphalt Used in Roofing.
   12. ASTM D448: Classification for Sizes of Aggregate for Road and Bridge Construction.
   13. ASTM D1079: Terminology Relating to Roofing and Waterproofing.
   14. ASTM D1970: Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection.
   15. ASTM D2178: Specification for Asphalt Glass Felt Used in Roofing and Waterproofing.
   16. ASTM D3746: Test Method for Impact Resistance of Bituminous Roofing Systems.
   17. ASTM D4263: Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
   18. ASTM D4272: Test Method for Total Energy Impact of Plastic Films by Dart Drop.
   19. ASTM D4397: Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   20. ASTM D5957: Guide for Flood Testing Horizontal Waterproofing Installations.
   21. ASTM D6152: Specification for SEBS-Modified Mopping Asphalt Used in Roofing.
   22. ASTM D6878: Specification for Thermoplastic Polyolefin Based Sheet Roofing.

23. ASTM E108: Test Methods for Fire Tests of Roof Coverings.
24. ASTM E1980: Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
25. ASTM G152: Practice for Operating Open Flame Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials.
26. ASTM G154: Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
27. ASTM G155: Practice for Operating Xenon Arc Light Apparatus for Exposure of NonMetallicMaterials.

B. American Society of Civil Engineers (ASCE):
1. 7- Minimum Design Loads for Buildings and Other Structures.

C. Factory Mutual Global (FMG):
1. FM Global 4450: Approval Standard for Class 1 Insulated Steel Deck Roofs.
2. FM Global 4470: Approval Standard Class 1 Roof Covers.
3. FM Global Loss Prevention Data Sheet 1-29: Roof Deck Securement and Above-Deck Roof Components.
4. RoofNav.

D. Single-Ply Roofing Institute (SPRI):
1. Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems.

E. National Roofing Contractors Association:
1. The NRCA Roofing and Waterproofing Manual.

F. Underwriters Laboratories Inc.:
1. UL 790: Test Methods for Fire Tests of Roof Coverings.

1.04 DEFINITIONS:

A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" apply to Work of this Section.

B. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," before multiplication by a safety factor.

C. Factored Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," after multiplication by a safety factor.

1.05 PERFORMANCE REQUIREMENTS:

A. General: Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure.
1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D3746 or ASTM D4272.

B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

C. Roofing System Design: Tested by a qualified testing agency to resist the following uplift service level (ASD) pressures:
1. Corner Uplift Pressure: 75 lbf./ft.^{2}.

2. Perimeter Uplift Pressure: 58 lbf./ft.²
3. Field-of-Roof Uplift Pressure: 54 lbf./ft.²

D. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
1. Fire/Windstorm Classification: Class 1A-90.
2. Hail-Resistance Rating: SH.

E. Solar Reflectance Index: Not less than a three-year-aged solar reflectance index of 64 when calculated according to ASTM E1980, based on testing identical products by a qualified testing agency.

F. Energy Performance: Roofing system shall have a three-year-aged solar reflectance of not less than 55 and a three-year-aged emissivity of not less than 0.75 when tested according to CRRC-S100.

G. Exterior Fire-Test Exposure: ASTM E108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

H. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

1.06 SUBMITTALS:

A. Product Data: For each type of product.

B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other Work, including:
1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of roofing, fastening spacings, and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

C. Samples for Verification: For the following products:
1. 12-by-12-inch (300-by-300-mm) square of sheet roofing of color specified, including T-shaped side and end lap seam.
2. Walkway pads or rolls, of color required.

D. Qualification Data: For Installer and manufacturer.

E. Manufacturer Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
1. Submit evidence of compliance with performance requirements.

F. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.

G. Research/Evaluation Reports: For components of membrane roofing system.

H. Field quality control reports.

I. Warranties: Special warranties specified in this Section.

J. Maintenance Data: For roofing system to include in maintenance manuals.

K. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system. Installer has held manufacturer’s installation certificate for a minimum of five years.

L. Inspection Report: Copy of roofing system manufacturer’s inspection report of completed roofing installation.

1.07 QUALITY ASSURANCE:

A. Manufacturer Qualifications: A qualified manufacturer that is FM Global approved for roofing system identical to that used for this Project.

B. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E548.

C. Fire-Test-Response Characteristics: Provide membrane roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E108, for application and roof slopes indicated.
2. Fire-Resistance Ratings: ASTM E119, for fire-resistance-rated roof assemblies of which roofing system is a part.

D. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project Site. Comply with requirements for preinstallation conferences in DIVISION 01. Review methods and procedures related to roof deck construction and roofing system.

E. Source Limitations: Obtain components for membrane roofing system approved by roofing membrane manufacturer.

F. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Deliver roofing materials to Project Site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.09 FIELD CONDITIONS:

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY:

A. Special Warranty: Manufacturer’s standard form, without monetary limitation, in which the manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.

1. Special warranty includes roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of roofing system.

2. Warranty Period: 20 years from date of Substantial Completion.

B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Acceptable Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Basis-of-Design Product: Subject to compliance with requirements, by one of the following:
1. Carlisle SynTec Incorporated.
2. Elevate Building Products.
3. GAF Materials Corporation.
4. Johns Manville.
5. Versico Incorporated.
6. Or Engineer approved equal.

C. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from a manufacturer approved by the membrane roofing manufacturer.

2.02 TPO ROOFING:

A. Fabric-Reinforced Thermoplastic Polyolefin (TPO) Sheet: ASTM D6878, uniform, flexible sheet formed from a thermoplastic polyolefin, internally fabric or scrim-reinforced, and as follows:
1. Membrane thickness: 80 mils, nominal.
2. Exposed Face Color: White.
3. Physical Properties:
   a. Breaking Strength: 464 lbf (2 kN); ASTM D751.
   b. Elongation at Break: 30%; ASTM D751.
   c. Tearing Strength: 65 lbf x 160 lbf (289 N) minimum; ASTM D751, Procedure B.
   d. Puncture Resistance: 380 lbs minimum; FTM 101C, Method 2031.
   e. Brittleness Point: No cracking, Minus 40°F (-40°C); ASTM D2137.
   f. Hydrostatic Resistance: 430 psi; ASTM D751, Method D.
   g. Ozone Resistance: No visible deterioration after being exposed for 168 hours at 104°F (40°C) and an ozone level of 100 pphm (100 mPa); ASTM D1149.
   h. Resistance to Heat Aging: 90% minimum retention of breaking strength, elongation at break, and 60% tearing strength after 168 hours at 240°F (116°C); ASTM D573.
   i. Water Absorption: Less than .7% after 168 hours' immersion at 158°F (70°C); ASTM D471.
   j. Dimensional Change: 0.4% after 6 hours at 158°F (70°C); ASTM D1204.
   k. Heat Aging: 60 weeks, 100%; ASTM D573.

2.03 AUXILIARY ROOFING MATERIALS:

A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.

C. Bonding Adhesive: Manufacturer's standard bonding adhesive for membrane and base flashing.

D. Slip Sheet: Manufacturer's standard of thickness required for application.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.

F. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.

G. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.04 VAPOR RETARDER:

A. Laminated Sheet: Polyethylene laminate, two layers, reinforced with cord grid, with maximum permeance rating of 0.06 perm (3.5 ng/Pa by s by m^2).

1. Provide SA Vapor Retarder products with minimum following requirements:
   a. Adhesive: Manufacturer’s standard lap adhesive, FM Global approved for vapor-retarder application.
   b. Minimum 31-mil (0.76-mm) total thickness.
   c. Cold applied.
   d. With slip-resisting surface and release paper backing.
   e. Provide primer when recommended by vapor-retarder manufacturer.
2. Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.

2.05 ROOF INSULATION:

A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.

B. Polyisocyanurate Board Insulation: ASTM C1289, Type II, Class 1, Grade 3, felt or glass-fiber mat facer on both major surfaces.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers:
2. Basis-of-Design Product: Subject to compliance with requirements by one of the following:
   a. Carlisle SynTec Incorporated.
   b. Firestone Building Products.
   c. GAF Materials Corporation.
   d. Hunter Panels.
   e. Insulfoam LLC; a Carlisle company.
   f. Johns Manville.
   g. Or Engineer approved equal.

C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.

D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
E. Minimum R-value as indicated on the drawings.

2.06 INSULATION ACCESSORIES:
A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
D. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate, 5/8 inch (16 mm) thick, factory primed.
1. Products: Subject to compliance with requirements, provide the following available products that may be incorporated into the Work, but are not limited to, the following:
a. Georgia-Pacific Corporation; Dens Deck Prime.
b. Or Engineer approved equal.

2.07 WALKWAYS:
A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads, approximately 3/16 inch (5 mm) thick and by/or acceptable to roofing system manufacturer.
1. Size: 30 by 30 inches (760 by 760 mm). Manufacture pads to dimensional tolerances of ±1/16 inch (1.6 mm) in length, height, and thickness.
2. Color: To match selected roofing color.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates, areas, and conditions with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D4263.
5. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:
A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

3.03 ROOFING INSTALLATION, GENERAL:

A. Install roofing system according to roofing system manufacturer's written instructions.

B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.04 SUBSTRATE BOARD INSTALLATION:

A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.

1. Fasten substrate board to top flanges of steel deck according to recommendations in FM Global's "RoofNav" and FM Global Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification.
2. Fasten substrate board to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.05 VAPOR-RETARDER INSTALLATION:

A. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 inches (90 mm) and 6 inches (150 mm), respectively. Seal laps by rolling. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.06 INSULATION INSTALLATION:

A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.

B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.

C. Install tapered insulation under area of roofing to conform to slopes indicated.

D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (68 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.

1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.

E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.

F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.

1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

G. Adhered Insulation: Install each layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.

1. Fasten first layer of insulation according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.

2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
3. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

H. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.
1. Fasten cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
2. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

I. Install slip sheet over cover board and immediately beneath roofing.

3.07 ADHERED ROOFING INSTALLATION:

A. Adhere roofing over area to receive roofing according to roofing system manufacturer's written instructions. Unroll roofing and allow to relax before retaining.
B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
C. Accurately align roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
D. Bonding Adhesive: Apply to substrate and underside of roofing at rate required by manufacturer, and allow to partially dry before installing roofing. Do not apply to splice area of roofing.
E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
F. Apply roofing with side laps shingled with slope of roof deck where possible.
G. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roofing and sheet flashings according to manufacturer's written instructions, to ensure a watertight seam installation.
1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.

H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.08 BASE FLASHING INSTALLATION:

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.09 WALKWAY INSTALLATION:

A. Flexible Walkways: Install walkway products in locations indicated. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.10 FIELD QUALITY CONTROL:

A. Inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components. Furnish reports to Architect.
   1. Localize water test at flashings, seams, and penetrations.
   2. Repair leaks, repeat water tests, and make further repairs until roofing and flashing installations are watertight.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

C. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional Work complies with specified requirements.

3.11 PROTECTING AND CLEANING:

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.

B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.12 ROOFING INSTALLER'S WARRANTY:

A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("Work") on the following project:
   1. Owner: <Insert name of Owner>.
   2. Address: <Insert address>.
   3. Building Name/Type: <Insert information>.
   4. Address: <Insert address>.
   5. Area of Work: <Insert information>.
   6. Acceptance Date: _____.
   7. Warranty Period: <Insert time>.
   8. Expiration Date: _____.

B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said Work as are necessary to correct faulty and defective Work and as are necessary to maintain said Work in a watertight condition.

D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to Work and other parts of the building, and to building contents, caused by:
   a. Lightning;
   b. Peak gust wind speed exceeding 120mph;
   c. Fire;
   d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
   e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the Work;
   f. Vapor condensation on bottom of roofing; and
   g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When Work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to Work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of Work.
4. During Warranty Period, if Owner allows alteration of Work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other Work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect Work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said Work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate Work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects Work covered by this Warranty.
6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect Work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said Work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original Work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.
   1. Authorized Signature: _____.
   2. Name: _____.
   3. Title: _____.

END OF SECTION 07 54 23

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes sheet metal flashing and trim in the following categories:
   1. Roof-drainage systems.
   2. Exposed trim and coping.

B. Related Work Specified Elsewhere:
   1. Through-wall flashing and other integral masonry flashings specified as part of masonry work: DIVISION 04.
   2. Set-on-type curbs, equipment supports, roof hatches, vents, and other manufactured roof accessory units: DIVISION 07.
   3. Elastomeric sealants: SECTION 07 92 00.
   4. Flashing and roofing accessories installed integral with roofing membrane as part of roofing-system work: DIVISION 07.

1.02 REFERENCES:

A. Aluminum Association (AA):
   1. Designation System for Aluminum Finishes, 7th ed.

B. American Architectural Manufacturers Association (AAMA):
   1. 606.2 - Integral Color Anodic Finishes for Architectural Aluminum.

C. American Society for Testing and Materials (ASTM):
   1. A653/A653M - Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. A755/A755M - Steel Sheet, Metallic-Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
   3. B32 - Solder Metal.
   4. B209/209M - Aluminum and Aluminum-Alloy Sheet and Plate.
   5. B221/B221M - Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
   6. D4397 - Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   7. D4586 - Asphalt Roof Cement, Asbestos-Free.

D. Federal Specifications (FS):
   1. UU-B-790a - Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent, and Fire Resistant).

E. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):
   1. Architectural Sheet Metal Manual.

F. Society for Protective Coatings (SSPC):
   1. Paint 12 - Cold-Applied Asphaltic Mastic (Extra Thick Film).

1.03 PERFORMANCE REQUIREMENTS:

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

1.04 SUBMITTALS:

A. Submit in accordance with DIVISION 01.

B. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.

C. Shop Drawings of each item specified showing layout, profiles, methods of joining, and anchorage details.

D. Samples of sheet metal flashing, trim, and accessory items, in the specified finish. Where finish involves normal color and texture variations, include Sample sets composed of 2 or more units showing the full range of variations expected.
   1. 8-inch- (200-mm-) square Samples of specified sheet materials to be exposed as finished surfaces.
   2. 12-inch (300-mm-) long Samples of factory-fabricated products exposed as finished Work. Provide complete with specified factory finish.

1.05 QUALITY ASSURANCE:
A. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.06 PROJECT CONDITIONS:
A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Provide for leakproof weather resistance, durability of Work, and protection of materials and finishes.

1.07 WARRANTY
A. The Manufacturer shall warrant that all material shall be free from defects caused by faulty material or workmanship for a minimum period of two (2) years from the date of Substantial Completion, unless otherwise specified.
B. Warranties shall comply with the requirements of Section 01 78 36.

PART 2 - PRODUCTS

2.01 METALS:
A. Aluminum: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated and with not less than the strength and durability of alloy and temper designated below:
   1. Factory-Painted Aluminum Sheet: ASTM B209 (ASTM B209M), 3003-H14, with a minimum thickness of 0.040 inch (1.0 mm), unless otherwise indicated or specified.
B. Galvanized Steel Sheet: ASTM A653 (ASTM A653M), hot-dip galvanized steel sheet with 0.20% copper, mill phosphatized where indicated for painting; not less than 0.0396 inch (1.0 mm) thick, unless otherwise indicated or specified.

2.02 SHEET METAL FLASHING AND FABRICATIONS:
A. Sheet Metal Fabrications:
   1. General: Fabricate sheet metal items in thickness or weight needed to comply with performance requirements but not less than that listed below for each application and metal.
   2. Downspouts: Fabricate from the following material:
      a. Aluminum: 0.024 inch (0.6 mm) thick.
   3. Conductor Heads: Fabricate from the following material:
      a. Aluminum: 0.0320 inch (0.8 mm) thick.
   4. Scuppers: Fabricate from the following material:
      a. Aluminum: 0.0320 inch (0.8 mm) thick.
   5. Sill flashing: Fabricate from the following material:
      a. Aluminum: 0.0320 inch (0.8 mm) thick.

B. Miscellaneous Materials and Accessories:
   1. Fasteners: Same metal as sheet metal flashing or other noncorrosive metal as recommended by sheet metal manufacturer. Match finish of exposed heads with material being fastened.
   2. Asphalt Mastic: SSPC-Paint 12, solvent-type asphalt mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil (0.4-mm) dry film thickness per coat.
   3. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.
   4. Elastomeric Sealant: Generic type recommended by sheet metal manufacturer and fabricator of components being sealed and complying with requirements for joint sealants as specified in SECTION 07 92 00.
   5. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior and interior nonmoving joints, including riveted joints.
   6. Adhesives: Type recommended by flashing sheet metal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheet metal.
   7. Paper Slip Sheet: 5-lb/square (0.244 kg/sq. m) red rosin, sized building paper conforming to FS UU-B-790, Type I, Style 1b.
   8. Polyethylene Underlayment: ASTM D4397, minimum 6-mil- (0.15-mm-) thick black polyethylene film, resistant to decay when tested according to ASTM E154.
   9. Metal Accessories: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching or compatible with material being installed; noncorrosive; size and thickness required for performance.
   10. Roofing Cement: ASTM D4586, Type I, asbestos free, asphalt based.
   11. Downspout Boot: Provide a cast iron downspout boot at bottom of downspouts where indicated, refer to architectural drawings. Reference manufacturer instructions for installation requirements.
      a. Acceptable Manufacturers:
         (1) J.R. Hoe
         (2) NEI, Inc.
         (3) Or Architect approved equal.

C. Fabrication, General:
   1. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.
   2. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
   3. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.
   4. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.
   5. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
   6. Expansion Provisions: Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently

weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

7. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
8. Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with asphalt mastic or other permanent separation as recommended by manufacturer.
9. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.
10. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
    a. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.03 PREFORMED METAL FABRICATIONS:

A. Aluminum Coping System:
1. Cap shall be 0.063-gage aluminum formed to dimensions indicated, fluoropolymer coating, color as selected from manufacturer's standard. Provide in minimum 10'-0" lengths as much as possible to keep joints to a minimum.
2. Provide drainage system at joints with concealed joint covers or splice plates, coping chair, and galvanized steel cleats or anchor plates.
3. Provide with adhesive or anchors for anchoring system to top of wall surface and in accordance with manufacturer's system.
4. Manufacturers:
    a. W. P. Hickman Company - Permasnap Coping.
    b. MM Systems Corporation - Snap-Lok Coping I.
    c. Metal-Era - Perma-Tite.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions under which sheet metal flashing and trim are to be installed and verify that Work may properly commence. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Unless otherwise indicated, install sheet metal flashing and trim to comply with performance requirements, manufacturer's installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Anchor units of Work securely in place providing for thermal expansion of metal units; conceal fasteners where possible and set units true to line and level. Install Work with laps, joints, and seams that will be permanently watertight and weatherproof.
B. Install exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
C. Roof-Edge Flashings: Secure metal flashings at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

D. Expansion Provisions: Provide thermal expansion of exposed sheet metal Work. Space movement joints at maximum of 10 feet (3 m) with no joints allowed within 24 inches (610 mm) of corner or intersection. Where lapped or bayonet-type expansion provisions in Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with mastic sealant (concealed within joints).

E. Sealed Joints: Form nonexpansion, but movable, joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant. Use joint adhesive for nonmoving joints specified not to be soldered.

F. Seams: Fabricate nonmoving seams in sheet metal with flat-lock seams. Tin edges to be seamed, form seams, and solder.

G. Seams: Fabricate nonmoving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.

H. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces, at locations of contact, with asphalt mastic or other permanent separation as recommended by manufacturer.
   1. Underlayment: Where stainless steel or aluminum directly on cementitious or wood substrates, install a slip sheet of red-rosin paper and a course of polyethylene underlayment.
   2. Bed flanges of Work in a thick coat of roofing cement where required for waterproof performance.

I. Roof-Drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation.

J. Equipment Support Flashing: Coordinate equipment support flashing installation with roofing and equipment installation. Weld or seal flashing to equipment support member.

3.03 CLEANING AND PROTECTION:

A. Clean exposed metal surfaces, removing substances that might cause corrosion of metal or deterioration of finishes.

B. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering.

END OF SECTION 07 62 00

SECTION 07 72 00 - ROOF ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

A. Roof curbs.
B. Roof hatch mounted guardrails.
C. Roof hatches.
D. Ladder safety post device.

1.02 REFERENCE STANDARDS

A. Applicable Standards:
   1. Factory Mutual (FM).
   2. Underwriters Laboratories (UL).
   3. American Society of Testing and Materials (ASTM).
B. 29 CFR 1910.23 - Ladders current edition.
C. 29 CFR 1910.29 - Fall Protection Systems and Falling Object Protection - Criteria and Practices Current Edition.
D. 29 CFR 1926.502 - Fall protection systems criteria and practices Current Edition.
E. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
F. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.

1.03 SUBMITTALS

A. Submit as specified in DIVISION 01.
B. Include, but not limited to, the following:
   1. Product data and specifications, rough-in diagram, details, fabrication and erection details, and drawings.
   2. Coordination drawings for items interfacing with units. Indicate dimensions of items and locations of items provided under this Section, together with relationships and method of attachment to adjacent construction.
      a. Operation and maintenance data.
C. Warranty Documentation:
   1. Submit manufacturer warranty.
   2. Ensure that forms have been completed in Owner's name and registered with manufacturer.
   3. Submit documentation that roof accessories are acceptable to roofing manufacturer, and do not limit the roofing warranty.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Handle and store units to prevent racking, warping, or other damage.
B. Store products in manufacturer's unopened packaging until ready for installation.
C. Store products under cover and elevated above grade.

1.05 WARRANTY

A. The Manufacturer shall warrant that all material shall be free from defects caused by faulty material or workmanship for a minimum period of one (1) year from the date of Substantial Completion, unless otherwise specified.
B. Warranties shall comply with the requirements of Division 01.

C. Manufacturer Warranty: Provide 1 year manufacturer warranty for all accessories. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.01 ROOF HATCH MOUNTED GUARDRAILS:

A. Non-Penetrating Rooftop Mounted Guardrails:
   1. Provide top and mid railings that comply with 29 CFR 1910.29.
   2. Structural Load: 200 lb (90.7 kg), minimum, in any direction with components in compliance with 29 CFR 1926.502.
   3. Height: 42 inches (1067 mm), minimum.
   4. Railings: 1-5/8 inches (41.3 mm) minimum outside diameter, hot-rolled, welded tubing, free of sharp edges and snag points.
   5. FRP material molded-in, high visibility, safety yellow color treated with UV inhibitor.
   6. Steel Surface Finish: Hot-dip zinc galvanized, with color of safety yellow.

2.02 ROOF HATCHES:

A. Roof Hatch Manufacturers:
   1. Bilco Company; Type TB (various types and special size): www.bilco.com/#sle.
   2. Nystrom, Inc; www.nystrom.com/#sle.
   3. Or Engineer approved equal.

B. Frames and Curbs: One-piece curb and frame with integral cap flashing to receive roof flashings; extended bottom flange to suit mounting.
   1. Insulation: Manufacturer's standard; 1 inch (25 mm) rigid glass fiber, located on outside face of curb. Provide with cover liner.
   2. Curb Height: 12 inches (305 mm) from finished surface of roof, minimum.

2.03 ROOF STAIRWAY HATCH:

1. Furnish and install Single Lead Roof Access Hatch Type L-50TB With Guardrails and Swing Gate mounted to Hatch by the Bilco Company where indicated on drawings. The roof hatch shall be single leaf and pre-assembled from the manufacturer. See Drawings for dimensions.

B. Performance characteristics:
   1. Cover shall be reinforced to support a minimum live load of 40 psf (195 kg/m^2) with a maximum deflection of 1/150th of the span or 20 psf (97 kg/m^2) wind uplift.
   2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
   3. Operation of the cover shall not be affected by temperature. Entire hatch shall be weathertight with fully welded corner joints on cover and curb.

C. Cover: Shall be 11 gauge aluminum with a 3” beaded flange with formed reinforcing members. Cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.

D. Cover insulation: Shall be fiberglass of 1” thickness, fully covered and protected by a metal liner, 18 gauge aluminum.

E. Curb: 12” in height, 11 gauge aluminum. The curb shall be formed with a 3-1/2” flange with a 7/16” holes provided for securing to the concrete. The curb shall be equipped with an integral metal capflashing of the same gauge and material as the curb, fully welded at the corners with the Bil-Clip flashing system or approved equal.

F. Curb insulation: Shall be rigid, high density fiberboard of 1” thickness on outside of curb.

G. Lifting mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire

arc of opening and closing. The upper tube shall be the outer tube to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.

H. Railing: Hatch shall include a handrail matching the rise and tread of the access stair. Handrail shall align with permanent handrail of access stair. Handrail must clear first step.

I. Hardware:
   1. Heavy pintle hinges shall be provided
   2. Cover shall be equipped with an enclosed two point spring latch with interior and exterior turn handles
   3. Roof hatch shall be equipped with interior and exterior padlock hasps.
   4. The latch strike shall be a stamped component bolted to the curb assembly.
   5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a 1” (25mm) diameter red vinyl grip handle to permit easy release for closing.
   6. All hardware shall be Type 316 Stainless Steel.
   7. Cover hardware shall be bolted into heavy gauge channel reinforcing welded to the underside of the cover and concealed within the insulation space.
   8. Finishes: Factory finish shall be or mill finish aluminum.

J. Prefabricated units, single-leaf, complete with curbs, mounting flanges, insulation, weather seal, gaskets, hardware and accessories, and integral cap flashing. Weld corner joints for weathertightness. Units shall be designed for 40 psf external loading and 20 psf internal loading pressure. Fabricate for ladder access.

K. Metal: Aluminum-mill finish cover and curb. Metal gauges for curb and cover shall be as required by size of unit.

L. Safety Railing System: Roof hatch safety rail system mounted directly to curb without penetration of roofing system.

M. Fasteners: Same metal as metal being fastened or other noncorrosive metal as recommended by scuttle manufacturer. Match finish of exposed fasteners with finish of material being fastened.
   1. Railing Size: As indicated on drawings.

N. Size(s): 3 ft-0 inches by 3 ft-0 inches with 18-inch curb. (Where roof slope exceeds 1/4 inch per foot, fabricate curbs with height tapered to match slope and to result in level installation of top of unit.)
   1. Railing: Comply with 29 CFR 1910.23 for ladder safety, with a safety factor of two.
   2. Self-Closing Gate: Comply with 29 CFR 1910.29 for safe egress and fall protection through hatch opening.
   3. Posts and Rails: Fiberglass reinforced polymer tubing. Pultruded and fire retardant. High visibility, safety yellow color treated with UV inhibitor.
   4. Gate: Same material as railing; automatic closing with latch.
   5. Finish: Manufacturer's standard; molded in integral safety yellow.
   6. Gate Hinges and Post Guides: ASTM B221 (ASTM B221M), 6063 alloy, T5 temper aluminum.
   7. Mounting Brackets: Attached to cap flashing of roof hatch. Hot dipped galvanized steel, 1/4 inch (6.4 mm) thick, minimum.
   8. Products:

O. Hardware: Steel, zinc coated and chromate sealed, unless otherwise indicated or required by manufacturer.
   1. Lifting Mechanisms: Compression or torsion spring operator with shock absorbers that automatically opens upon release of latch; capable of lifting covers despite 10 psf (475 kPa) load.
   2. Hinges: Heavy duty pintle type.
   3. Hold open arm with vinyl-coated handle for manual release.
   4. Latch: Upon closing, engage latch automatically and reset manual release.

5. Manual Release: Pull handle on interior.
6. Locking: Padlock hasp on interior.
7. Basis of Design Manufacturer: Bilco Co. - Bil-Guard Hatch Rail System.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.
B. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.02 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using methods recommended by manufacturer for achieving acceptable results for applicable substrate under project conditions.

3.03 INSTALLATION:

A. Coordinate installation with roof deck construction, roof insulation, and roofing system to ensure that each element of the Work performs properly and that combined elements are waterproof and weathertight. Anchor units securely to support structural substrates, adequate to withstand lateral and thermal stresses, as well as inward and outward loading pressures.
B. Separate metal surfaces from dissimilar metals, wood, and cementitious substrates as required to prevent corrosive action. Separate with a thick coating of bituminous compound or other separation as recommended by the roof manufacturer.
C. Bed flanges in mastic or compound which is compatible with roofing and flashing to form a seal.
D. Safety Post Device:
   1. Install device on rungs at top of fixed ladder in scuttles and heat-smoke vents to provide for safe assistance in getting in and out of unit.
   2. Install device securely to rungs with components and fasteners so that devices operate properly and without interference of proper scuttle or vent operation.
   3. Install per manufacturer's directions.
E. Hatch Rail System:
   1. Attach to cap flashing of roof hatch per manufacturer's installation instructions not penetrating the roof material.
   2. Install device with components and fasteners so that devices operate properly and without interference of proper scuttle or vent operation.
F. Install in accordance with manufacturer's instructions, in manner that maintains roofing system weather-tight integrity.

3.04 FIELD QUALITY CONTROL, ADJUSTMENT, AND CLEANING:

A. Test and adjust units as required for proper operation. Lubricate joints and hardware.
B. Clean surfaces as required to prevent deterioration and uneven weathering.
C. Touch up any damaged coatings with coating equivalent to that used in fabrication. Prepare surfaces as required prior to touch-up.

3.05 CLEANING

A. Clean installed work to like-new condition.

3.06 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Date of Substantial Completion.

END OF SECTION 07 72 00

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes sealants and related materials for application in the joint locations specified in PART 2, this Section.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. C920 - Elastomeric Joint Sealants.
      b. C1193 - Guide for Use of Joint Sealants.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.
B. Includes, but not limited to, the following for each type of sealant or associated material required:
   1. Product data and Specifications, including instructions for joint preparation and sealer application.
   2. Color charts.

1.04 QUALITY ASSURANCE:

A. Manufacturer of sealants shall have a minimum of five years of successful experience in the production of types of sealants required.
B. Sealant installer shall be certified by the sealant manufacturer as having the necessary experience and equipment to install the materials properly.
C. Obtain joint sealant materials from a single manufacturer for each different product required.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver all materials in original sealed containers or bundles with labels and inscriptions legible and intact, and informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.
B. Store all materials in areas suitable to prevent deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.06 PROJECT CONDITIONS:

A. Environmental Conditions:
   1. Do not proceed with installation of joint sealers under the following conditions:
      a. When ambient and substrate temperature conditions are outside the limits permitted by joint sealer manufacturer or below 40°F (4.4°C).
      b. When joint substrates are wet due to rain, frost, condensation, or other causes.
B. Joint Width Conditions: Do not proceed with installation of joint sealers where joint widths are more or less than allowed by joint sealer manufacturer for application indicated.
C. Joint Substrate Conditions: Do not proceed with installation of joint sealers until contaminants capable of interfering with their adhesion are removed from joint substrates.
D. Proceed with application only when forecasted weather conditions are favorable for proper cure and development of bond strength.

1.07 WARRANTY

A. The Manufacturer shall warrant that all material shall be free from defects caused by faulty material or workmanship for a minimum period of two (2) years from the date of Substantial Completion, unless otherwise specified.

B. Warranties shall comply with the requirments of Section 01 78 36.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Manufacturer listed under each type of material is to establish minimum quality and specific type. Equivalent products of manufacturers listed below will be acceptable subject to suitability for intended condition.

B. Sealants and Caulking:

1. BASF Corporation.
2. Dow Corning Corp.
3. General Electric.
4. Pecora Corporation.
5. Sika Chemical Corp.
6. Sonneborn Building Products.
7. Tremco Manufacturing Company.
8. W. R. Meadows, Inc.

C. Sealant Backer Rod (Closed-Cell):

1. Bostik Construction Products Div.
2. Sonneborn Building Products - Sonofoam.
3. W. R. Meadows - Sealtight Backer Rod or Cera-Rod.

2.02 GENERAL:

A. Before purchase of each specified sealant, investigate its compatibility with the joint surfaces, joint fillers, and other materials in the joint system. Select materials for compatibility with joint surfaces and other indicated exposures, and, except as otherwise indicated, select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated.

B. Provide colors as selected by Engineer's Consultant from manufacturer's standard colors.

2.03 ELASTOMERIC SEALANTS:

A. Sealants conforming to equivalent Federal Specifications will be acceptable.

B. One-Component Urethane Sealant - Use NT:

1. Conform to ASTM C920, Type S, Grade NS, Class 35. Use classification as required by locations stated below.
2. Manufacturers:
   a. Pecora Corp. - Dynatrol I.
   b. Tremco - Dymonic.
   c. Basf – Masterseal NP1
3. Use in the following locations:
   a. Exterior and interior joints around perimeter door, louvers and frames.
   b. Exterior and interior joints at penetration of walls, decks, and floors by piping, conduit, and other services or equipment except fire-rated penetrations.
   c. Veneer Joints (VJ).

d. Roof flashing materials as indicated.
e. Roof flashing reglets and retainers.
f. Miscellaneous locations as indicated.
g. Miscellaneous locations as required (but not indicated).

2.04 MISCELLANEOUS MATERIALS:

A. Joint Cleaner: Type as recommended by the sealant manufacturer for the joint surfaces to be cleaned, which is not harmful to substrates and adjacent surfaces and which does not leave oily residues or have detrimental effect on sealant adhesion or in-service performance.

B. Joint Primer/Sealer: Type as recommended by the sealant manufacturer for the joint surfaces to be primed or sealed.

C. Bond-Breaker Tape:
1. Polyethylene tape or other plastic tape as recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint, where such adhesion would result in sealant failure.
2. Provide self-adhesive tape where applicable.

D. Sealant Backer Rod:
1. Compressible rod stock, preformed, resilient, nonwaxing, nonextruding strips of flexible, nongassing plastic foam, nonabsorbent to water and gas, and of size, shape and density, sealant depth, and that otherwise contributes to optimum sealant performance.
2. Rod shall be of size that will compress 25% in joint width and shape to control joint depth, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side and provide a highly compressible backer to minimize the possibility of sealant extrusion when joint is compressed.

PART 3 - EXECUTION

3.01 JOINT SURFACE PREPARATION:

A. Joint Cleaning:
1. Clean joint surfaces immediately before application of sealant.
2. Remove all foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust, paints (except for permanent protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealers, oil, grease, waterproofing water repellents, water, surface dirt, and frost.
3. Clean concrete, masonry, and similar porous joint surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers. Remove loose particles remaining from above operations by vacuuming or blowing out joints with oil-free compressed air.
4. Clean metal and other nonporous surfaces with chemical cleaners or other means which are not harmful to substrates and do not leave residues capable of interfering with adhesion of joint sealers.
5. Remove laitance and form-release agents from concrete.

B. Joint Priming: Prime joint substrates as required by joint sealant manufacturer. Confine primers to areas of joint sealer bond; do not allow spillage or migration onto adjoining surfaces.

C. Surface Protection: Use where required to prevent contact of sealant with adjoining surfaces which would otherwise be permanently stained or damaged by such contact or by cleaning

methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.02 APPLICATION:

A. Conform to sealant manufacturer's printed instructions except where more stringent requirements apply.
   1. For sealant installation, comply with ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

B. Install joint-filler units at depth or position in joint to coordinate with other Work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint fillers. Do not stretch, twist, puncture, or tear joint fillers. Remove absorbent joint fillers which have become wet prior to sealant installation and replace with dry materials.

C. Install sealant backer rod for sealants except where indicated to be omitted.

D. Install bond-breaker tape between sealants and joint fillers, compression seals, or back of joints where adhesion of sealant to back of joints would result in sealant failure.

E. Install sealants by proven installation techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration and providing uniform, cross-sectional shapes and depths relative to joint widths, which allow optimum sealant-movement capability.

F. Install sealants to depths as indicated or, if not indicated, as recommended by sealant manufacturer within the following limitations:
   1. For normal moving joints sealed with elastomeric sealants, but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2 inch deep nor less than 1/4 inch deep.

G. Unless indicated otherwise, provide a slightly concave surface conforming to ASTM C1193. (Provide recessed or flush configuration where indicated.)

H. Do not allow sealants or compounds to overflow from confines of joint or spill onto adjoining surfaces. Clean the adjoining surfaces to eliminate evidence of spillage without damage to adjoining surfaces or finishes.

I. Immediately after sealant installation and prior to time skimming or curing begins, tool nonsag sealants to form smooth uniform beads of configuration indicated to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Do not use tooling agent which would discolor sealants or adjacent surfaces or are not approved by sealant manufacturer. Remove excess sealant from surfaces adjacent to joint.

3.03 CURE AND PROTECTION:

A. Cure sealants in compliance with manufacturer's printed instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability. Cure and protect sealants in a manner which will minimize increases in modulus of elasticity and other accelerated aging effects. Replace or restore sealants which are damaged or deteriorated during construction period. Repaired areas shall be indistinguishable from original Work.

3.04 FIELD QUALITY CONTROL:

A. After nominal cure of exterior joint sealants which are exposed to weather, test for water leaks as follows:
   1. Flood joint exposure with water directed from a 3/4-inch garden hose and connected to water system with 25-psi minimum static water pressure.

2. Hold hose perpendicular to wall face, 2'-0" from joint, and move stream of water along joint at approximate rate of 20 feet per minute.
3. Test approximately 5% of total joint system in locations which are typical of every joint condition, and which can be inspected easily for leakage on opposite face.
4. Perform tests in presence of Engineer's Consultant.

B. Repair sealant installation at leaks or, if leakage is excessive, replace sealant installation as required. Do not perform repair or replacement work until joints are dry.

END OF SECTION 07 92 00

DIVISION 8 - OPENINGS

SECTION 08 11 00 - STEEL DOORS AND FRAMES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes steel doors and frames for interior use.

B. Related Work Specified Elsewhere:

1. For building anchors into and grouting frames in masonry construction: DIVISION 04.
2. For door hardware and weatherstripping: SECTION 08 70 00.
3. For field painting primed frames: DIVISION 09.

C. Supplier shall review and understand the American Iron and Steel (AIS) Requirements. Iron and steel products must be produced in the United States in a manner that complies with the AIS Requirement and certifications of such production must be provided to the Design-Builder prior to shipment.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):

1. A115 Series - A Collection of A115.1-A115.17, Specifications for Steel Door and Frame Preparation for Hardware.

B. American National Standards Institute/Steel Door Institute (ANSI/SDI):

1. 100 - Recommended Specifications for Standard Steel Doors and Frames.

C. American Society for Testing and Materials (ASTM):

1. A153 - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. A525/A525M - General Requirements for Steel Sheet, Zinc Coated (Galvanized) by the Hot-Dip Process.
3. A526/A526M - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
4. A642/A642M - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Drawing Quality, Special Killed.
5. A780 - Practice for Repair of Damaged Hot-Dip Galvanized Coatings.
6. C236 - Test Method for Steady-State Thermal Performance of Building Assemblies by Means of a Guarded Hot Box.
7. C578 - Rigid, Cellular Polystyrene Thermal Insulation.
8. C591 - Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation.
9. C976 - Test Method for Thermal Performance of Building Assemblies by Means of a Calibrated Hot Box.

D. Department of Defense (DOD):

1. P-21035A (SH) - Paint, High Zinc Dust Content, Galvanizing Repair.

E. Door and Hardware Institute (DHI):

1. Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames.

F. Federal Specifications (FS):

1. TT-P-641G(1) - Primer Coating, Zinc Dust Zinc Oxide (for Galvanized Surfaces).

G. National Association of Architectural Metal Manufacturers (NAAMM):

1. Metal Finishes Manual for Architectural and Metal Products.

H. Steel Door Institute (SDI):

1. 105 - Recommended Erection Instructions for Steel Frames.
2. 107 - Hardware on Steel Doors (Reinforcement-Application).
3. 108 - Recommended Selection and Usage Guide for Standard Steel Doors.

4. 111 Series: 111A-111F - Recommended Details, Steel Doors and Frames.
5. 112 - Galvanized Standard Steel Doors and Frames.
6. 117 - Manufacturing Tolerances Standard Steel Doors and Frames.

I. Steel Structures Painting Council (SSPC):
1. PA 1 - Paint Application Specification No. 1.
2. Paint 20 - Paint Specification No. 20 Zinc-Rich Primers (Type I, "Inorganic," and Type II, "Organic").

1.03 SUBMITTALS:

A. Product Data for each type of door and frame specified, including details of construction, materials, dimensions, hardware preparation, core, profiles, and finishes.

B. Shop Drawings showing fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of door and frame hardware and reinforcements, and details of joints and connections. Show anchorage and accessory items.

C. Door Schedule: Submit schedule of doors and frames using same reference numbers for details and openings as those on Contract Drawings.
1. Indicate coordination of glazing frames and stops with glass and glazing requirements.

D. Certificates and Affidavits: Furnish prior to shipment. Include the following:
1. American Iron and Steel (AIS) Certifications.
a. If Supplier is unable to meet AIS requirements, Supplier shall disclose this information to Design Builder in their proposal.

1.04 QUALITY ASSURANCE:

A. Provide doors and frames complying with ANSI/SDI 100 and as specified.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver doors and frames cardboard-wrapped or crated to provide protection during transit and job storage. Provide additional protection to prevent damage to finish of factory-finished doors and frames.

B. Inspect doors and frames on delivery for damage. Minor damages may be repaired provided refinished items match new work and are acceptable to Engineer's Consultant; otherwise, remove and replace damaged items as directed.

C. Store doors and frames at building site under cover. Place units on minimum 4-inch-(100-mm-) high wood blocking. Avoid using nonvented plastic or canvas shelters that could create a humidity chamber. If cardboard wrappers on doors become wet, remove cartons immediately. Provide minimum 1/4-inch (6-mm) spaces between stacked doors to promote air circulation.

1.06 WARRANTY:

A. Supplier shall warrant that all equipment shall be free of defects caused by faulty material or workmanship for a minimum period of two (2) years from date of Substantial Completion for the entire project, unless otherwise specified.

B. See procurement documents for full requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Steel Doors and Frames:
      a. Ceco Door Products.
      b. Curries Co.
      c. Kewanee Corp.
      d. Steelcraft.
      e. Or Engineer approved equal.

2.02 MATERIALS:

A. Galvanized Steel Sheets: Zinc-coated carbon steel complying with ASTM A526 (ASTM A526M), commercial quality, or ASTM A642 (ASTM A642M), drawing quality, hot-dip galvanized according to ASTM A525, with A60 or G60 (ASTM A525M, with Z180 or ZF180) coating designation, mill phosphatized.

B. Supports and Anchors: Fabricated from not less than 0.0478-inch- (1.2-mm-) thick steel sheet; 0.0516-inch- (1.3-mm-) thick galvanized steel where used with galvanized steel frames.

C. Inserts, Bolts, and Fasteners: Manufacturer's standard units. Where items are to be built into exterior walls, hot-dip galvanize complying with ASTM A153, Class C or D as applicable.

2.03 DOORS:

A. Personnel Doors: Prepare and reinforce doors and frames to receive factory- and field-applied hardware according to ANSI/DHI A115 Series. Comply with the following:
   1. Steel Doors: 1-3/4 inches (44 mm) thick; Weld 0.0598-inch (1.5-mm) thick, inverted zinc-coated (galvanized) steel channels to face sheets at top and bottom of door.
      a. Exterior Doors fabricated from 18 guage-thick 0.0516-inch, zinc-coated (galvanized) steel face sheets; of styles indicated.
      b. Core:
         (1) Core: Meeting the required u-value in section 2.05-1-a below.
   2. Anchors and Accessories: Manufacturer's standard units, galvanized according to ASTM A123.
   3. Fabrication: Fabricate doors and frames to be rigid; neat in appearance; and free from defects, warp, or buckle. Provide continuous welds on exposed joints; grind, dress, and make welds smooth, flush, and invisible.

2.04 FRAMES:

A. Provide metal frames for doors according to ANSI/SDI 100, and of types and styles as shown on Drawings and schedules. Conceal fastenings, unless otherwise indicated. Fabricate frames of minimum 16-gauge-thick galvanized steel sheet.
   1. Fabricate frames with mitered or coped corners, continuously welded construction. All welds ground smooth and primed.

B. Steel Frames: Fabricate 2-inch (50-mm) wide face frames from 16 guage-thick (.0635) zinc-coated (galvanized) steel sheet.
      a. Type: Factory welded.

C. Transom Panels and removable mullions: Construct same as adjacent doors and frames.

D. Match finish of frames, mullions and transoms to doors.

2.05 FABRICATION:

A. Fabricate steel door and frame units to be rigid, neat in appearance, and free from defects, warp, or buckle. Where practical, fit and assemble units in manufacturer's plant. Clearly identify work that cannot be permanently factory assembled before shipment, to assure proper assembly at Project site. Comply with ANSI/SDI 100 requirements.
   1. Internal Construction: One of the following manufacturer's standard core materials according to SDI standards:
      a. Rigid polyurethane for exterior doors conforming to ASTM C591. Minimum U-factor: 0.37.
      b. Unitized steel grid.
      c. Vertical steel stiffeners.
      d. Rigid mineral fiber with internal sound deadener on inside of face sheets.
   2. Clearances: Not more than 1/8 inch (3.2 mm) at jambs and heads, except not more than 1/4 inch (6.4 mm) between pairs of doors. Not more than 3/4 inch (19 mm) at bottom.

B. Fabricate exposed faces of doors and panels, including stiles and rails of nonflush units, from only cold-rolled steel sheet.

C. Tolerances: Comply with SDI 117 "Manufacturing Tolerances Standard Steel Doors and Frames."

D. Fabricate concealed stiffeners, reinforcement, edge channels, and moldings from either cold- or hot-rolled steel sheet.

E. Galvanized Steel Doors, Panels, and Frames: For the following locations, fabricate doors, panels, and frames from galvanized steel sheet according to SDI 112. Close top and bottom edges of doors flush as an integral part of door construction or by addition of minimum 0.0635-inch- (1.6-mm-) thick galvanized steel channels, with channel webs placed even with top and bottom edges. Seal joints in top edges of doors against water penetration.
   1. At exterior locations.

F. Exposed Fasteners: Unless otherwise indicated, provide countersunk flat or oval heads for exposed screws and bolts.

G. Hardware Preparation: Prepare doors and frames to receive mortised and concealed hardware according to final door hardware schedule and templates provided by hardware supplier. Comply with applicable requirements of SDI 107 and ANSI A115 Series specifications for door and frame preparation for hardware.

H. Reinforce doors and frames to receive surface-applied hardware. Drilling and tapping for surface-applied hardware may be done at Project site.

I. Locate hardware as indicated on Shop Drawings or, if not indicated, according to the Door and Hardware Institute's (DHI) "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2.06 FINISHES, GENERAL:

A. Comply with NAAMM's "Metal Finishes Manual" for recommendations relative to applying and designating finishes.

B. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for steel sheet finishes.

C. Apply primers and organic finishes to doors and frames after fabrication.

D. Prime finishes on all doors and frames shall meet the ASTM humidity, salt spray, impact and file adhesion test as required by ANSI A224.1.

2.07 GALVANIZED STEEL SHEET FINISHES:

A. Surface Preparation: Clean surfaces with nonpetroleum solvent so that surfaces are free of oil or other contaminants. After cleaning, apply a conversion coating of the type suited to the organic coating applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A780.
   1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in galvanized steel, with dry film containing not less than 94% zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint 20.

B. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply air-dried primer specified below immediately after cleaning and pretreatment.
   1. Shop Primer: Zinc-dust, zinc-oxide primer paint complying with performance requirements of FS TT-P-641, Type II.

C. Field Finish Coats: Refer to SECTION 09 90 00.

PART 3 - EXECUTION

3.01 DOOR INSTALLATION:

A. General: Comply with manufacturer's written instructions for installing doors, hardware, operators, and other door components. Coordinate installation with wall flashings and other components. Seal perimeter of each door frame with elastomeric sealant used for panels.

B. Personnel Doors and Frames: Comply with provisions of SDI 105, unless otherwise indicated. Install doors and frames straight, level, and plumb. Securely anchor frames to building structure. Set units with maximum 1/8-inch (3-mm) clearance between door and frame at jambs and head and maximum 3/4-inch (19-mm) clearance between door and floor.

C. Hardware: Mount units at heights indicated in DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   1. Install surface-mounted items after finishes have been completed on substrates involved.
   2. Set units level, plumb, and true to line and location. Adjust and reinforce substrate as necessary for proper installation and operation.
   3. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.
   4. Set thresholds for exterior doors in full bed of butyl-rubber or polyisobutylene mastic sealant complying with requirements specified in SECTION 07 92 00 - JOINT SEALANTS.

3.02 ADJUSTING AND CLEANING:

A. Prime Coat Touchup: Immediately after erection, sand smooth any rusted or damaged areas of prime coat and apply touchup of compatible air-drying primer.

B. Protection Removal: Immediately before final inspection, remove protective wrappings from doors and frames.

C. Doors: After completing installation, lubricate, test, and adjust doors to operate easily, free from warp, twist, or distortion.

D. Hardware: Adjust and check each operating item of hardware to ensure proper operation and function. Replace units that cannot be adjusted to operate freely and smoothly.
   1. Where door hardware is installed more than one month before acceptance or occupancy, make final check and adjustment of hardware items during the week before acceptance or occupancy. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.

END OF SECTION 08 11 00

SECTION 08 31 13 – ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section includes access doors and frames for floors.

1.03 REFERENCED STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. ASTM International:

1. ASTM A 36/A 36M - Specification for Carbon Structural Steel.
2. ASTM A 153/A 153M - Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A 653/A 653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM A 666 - Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM A 879/A 879M - Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
6. ASTM A 1008/A 1008M - Specifications for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
7. ASTM B 209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
8. ASTM B 209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate [Metric].
9. ASTM B 221 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
10. ASTM B 221M - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes [Metric].
11. ASTM F 2329 - Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

C. National Association of Architectural Metal Manufacturers (NAAMM):

1. Metal Finishes Manual for Architectural and Metal Products.

D. National Fire Protection Association (NFPA):

1. NFPA 80 - Fire Doors and Other Opening Protectives.
2. NFPA 252 - Standard Method of Fire Tests of Door Assemblies.

E. Underwriters Laboratories Inc. (UL):

1. UL 10B - Fire Tests of Door Assemblies.

1.04 SUBMITTALS:

A. Product Data and Shop Drawings: For each type of product.

B. Product Schedule: For access doors and frames.

PART 2 - PRODUCTS

2.01 ACCESS DOORS AND FRAMES:

A. Aluminum Flush Access Doors:
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Bilco Floor Access Doors or comparable product by one of the following:
      a. Halliday Products, Inc.
      b. The Bilco Company, Inc.
      c. Acudor Products, Inc.
      d. Cendrex Inc.
      e. Lane-Aire Manufacturing Corp.
      f. Metropolitan Door Industries Corp.
      g. MIFAB, Inc.
      h. Williams Bros. Corporation of America (The).
      i. Other manufacturer as approved by Engineer.
   2. Description: Face of door flush with frame, with exposed flange and concealed hinge.
   3. Locations: See Drawings.
   4. Door Size: See Drawings.
   5. Aluminum Sheet for Door: Manufacturer's standard thickness requirements, with clear anodized-aluminum finish.
   6. Frame Material: Manufacturer's standard thickness requirements, with aluminum mill finish.
   7. Latch and Lock: Cam latch, key operated.
   8. Safety Grating: Provide fall protection safety grating at all hatch types. Grating panel shall meet the requirements of OSHA standard 29 CFRI 926.502(c) and be equipped with a hold open device to lock the grating panel(s) in the open position.
      a. Material: Aluminum, powder-coat finish
      b. Color: Safety Yellow.
      c. Hardware: Stainless steel.

2.02 MATERIALS:

A. Aluminum Extrusions: ASTM B221 (ASTM B221M), Alloy 6063.
B. Aluminum Sheet: ASTM B209 (ASTM B209M), alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated.
C. Frame Anchors: Same material as door face.
D. Inserts, Bolts, and Anchor Fasteners: Hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329.

2.03 FABRICATION:

A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
B. Metal Surfaces: For metal surfaces exposed to view in the completed work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
C. Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish mounting holes, attachment devices and fasteners of type required to secure access doors to types of supports indicated.
D. Latch and Lock Hardware:

1. Quantity: Furnish number of latches and locks required to hold doors tightly closed.
2. Keys: Furnish two keys per lock and key all locks alike.

E. Aluminum: After fabrication, apply manufacturer's standard protective coating on aluminum that will come in contact with concrete.

2.04 FLOOR ACCESS HATCH (CHANNEL FRAME W/ DRAINAGE):

1. Furnish and install Type W-R access hatch by Halliday or approved equal where indicated on drawings. The roof hatch shall be single leaf and pre-assembled from the manufacturer. See Process Drawings for dimensions.

B. Performance characteristics:
1. Cover: Shall be reinforced to support a 300 psf live load with a maximum deflection of 1/150th of the span.
2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
3. Operation of the cover shall not be affected by temperature.
4. Entire door, including all hardware components, shall be highly corrosion resistant.

C. Cover: Shall be 1/4” (6mm) aluminum diamond pattern.

D. Frame: Channel frame shall be 1/4" extruded aluminum frame with continuous anchor flange with accommodation for drainage coupling.

E. Hinges: Door shall open to 90 degrees and automatically lock with 316 stainless steel hold-open arm with an aluminum release handle.

F. Drain Coupling: Provide a 1-1/2” (38mm) drain coupling located in the corner of the channel frame.

G. Lock Type: Cam lock.

H. Hardware:
1. Hinges: Heavy forged Type 316 stainless steel hinges, each having a minimum 1/4” (6mm) diameter Type 316 stainless steel pin, shall be provided and shall pivot so the covers do not protrude into the channel frame.
2. Cover shall be equipped with a hold open arm which automatically locks each cover in the open position.
3. Cover shall be fitted with the required number and size of compression spring operators. Springs and spring tubes shall be Type 316 stainless steel.
4. Hardware: Shall be Type 316 stainless steel throughout.

I. Finishes: Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame.

2.05 FLOOR ACCESS HATCH (WATERTIGHT, H-20 RATED):

1. Furnish and install Type F1H Flush Mount Floodtight H-20 hatch by Halliday or approved equal where indicated on Drawings. The roof hatch shall be single leaf and pre-assembled from the manufacturer. See Process Drawings for dimensions.

B. Performance characteristics:
1. Cover: Shall be reinforced to support a H-20 load rating with a maximum deflection of 1/150th of the span.
2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
3. Operation of the cover shall not be affected by temperature.
4. Entire door, including all hardware components, shall be highly corrosion resistant.

C. Cover: Shall be 1/4” (6mm) aluminum diamond pattern.

D. Frame: Frame shall be 1/4" extruded aluminum frame incorporating a continuous concrete anchor.
E. Hinges: Door shall open to 90 degrees and automatically lock with 316 stainless steel hold-open arm with an aluminum release handle.
F. Drain Coupling: Provide a 1-1/2" (38mm) drain coupling located in the corner of the channel frame.
G. Lock Type: Cam lock.
H. Hardware:
    1. Hinges: Heavy forged Type 316 stainless steel hinges, each having a minimum 1/4" (6mm) diameter Type 316 stainless steel pin, shall be provided and shall pivot so the covers do not protrude into the channel frame.
    2. Cover shall be equipped with a hold open arm which automatically locks each cover in the open position.
    3. Cover shall be fitted with the required number and size of compression spring operators. Springs and spring tubes shall be Type 316 stainless steel.
    4. Hardware: Shall be Type 316 stainless steel throughout.
I. Finishes: Factory finish shall be mill finish aluminum with bituminous coating applied to the exterior of the frame.

2.06 FINISHES:
A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Examine substrates for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:
A. Comply with manufacturer's written instructions for installing access doors and frames.

3.03 ADJUSTING:
A. Adjust doors and hardware, after installation, for proper operation.

END OF SECTION 08 31 13

SECTION 08 33 23 – OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 SECTION INCLUDES:

A. Exterior insulated coiling doors.

1.02 REFERENCE STANDARDS:

A. American Architectural Manufacturers Association (AAMA):
   1. 607.1 - Voluntary Guide Specification and Inspection Methods for Clean Anodic Finishes for Architectural Aluminum.
B. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
C. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
D. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications 2022b.
E. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2022.
F. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
G. ASTM B209/B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2021a.
H. ASTM B221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes 2021.
I. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric) 2021.
J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2023.
K. NAAMM AMP 500-06 - Metal Finishes Manual 2006.
L. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
M. NEMA ICS 1 - Industrial Control and Systems General Requirements 2022.
N. NEMA ICS 2 - Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts 2008 (Reaffirmed 2020).
O. NEMA ICS 6 - Industrial Control and Systems: Enclosures 1993 (Reaffirmed 2016).
P. NEMA MG 1 - Motors and Generators 2021.

1.03 DEFINITIONS:

A. Operation Cycle: One complete cycle of a door begins with the door in the closed position. The door is then moved to the open position and back to the closed position.

1.04 PERFORMANCE REQUIREMENTS:

A. Structural Performance: Provide overhead coiling doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
   1. Wind Load: Uniform service level (ASD) pressure (velocity pressure) of 28 lbf/sq. ft., acting inward and outward.
B. Operation-Cycle Requirements:
   1. Design overhead coiling door components and operator to operate for not less than 20,000 cycles.

1.05 SUBMITTALS:

A. Reference Division 1 Specifications for submittal procedures.
B. Product Data: Provide general construction, and component connections and details Include details of construction relative to materials, dimensions of individual components, profiles, and finishes. Provide roughing-in diagrams, operating instructions, and maintenance information.
   1. Setting drawings, templates, and installation instructions for built-in or embedded anchor devices.
   2. Summary of forces and loads on walls and jambs.
C. Shop Drawings: Indicate pertinent dimensioning, anchorage methods, hardware locations, and installation details. For special components and installations not dimensioned or detailed in manufacturer's data sheets.
D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified requirements.
E. Samples: Please submit a hard copy color chart or chip showing full range of colors available for units with factory-applied finished.
F. Manufacturer's Installation Instructions: Indicate installation sequence and procedures, adjustment and alignment procedures.
G. Manufacturer's qualification statement.
H. Installer's qualification statement.
I. Maintenance Data: Indicate lubrication requirements and frequency, periodic adjustments required, and cleaning.

1.06 QUALITY ASSURANCE:

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years of documented experience.
B. Installer Qualifications: Company specializing in performing work of type specified and with at least three years documented experience.
C. Source Limitations: Obtain overhead coiling doors through one source from a single manufacturer.
   1. Obtain operators and controls from the overhead coiling door manufacturer.

1.07 DESIGN REQUIREMENTS:

A. Design and construct doors to withstand a combined wind-loading positive and negative pressure of +28 psf and -28 psf to operate satisfactorily under these conditions.

1.08 WARRANTY:

A. See Division 01 for warranty requirements.
B. Manufacturer Warranty: Provide five-year manufacturer warranty for three-ply multifilament polyester fabric curtain. Complete forms in Owner's name and register with manufacturer.
C. Manufacturer Warranty: Provide 2-year manufacturer warranty for roller shaft counterbalance assembly. Complete forms in Owner's name and register with manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Overhead Coiling Doors: Subject to compliance with requirements, provide products by one of the following:
   1. Cornell Iron Works, Inc.
   2. Overhead Door Corporation:
      a. Basis of Design: Stormtite 625

3. Raynor Garage Doors
4. The Cookson Company
5. Wayne-Dalton, a Division of Overhead Door Corporation

2.02 COILING DOORS:

A. Exterior Coiling Doors: Steel slat curtain.
   1. Capable of withstanding positive and negative wind loads of 28 psf (1341 Pa) without undue deflection or damage to components, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated.
   2. Single Thickness Slats: Manufacturer's standard.
   3. Insulation: Fill slat with (Min. U-value of 0.31) rigid cellular polystyrene or polyurethane-foam-type thermal insulation complying with maximum flame-spread and smoke-developed indices of 75 and 450, respectively, according to ASTM E84. Enclose insulation completely within metal slat face.
   4. Finish: Factory painted, color to be standard gray.
   5. Guide, Angles: Galvanized steel.
   6. Hood Enclosure: Manufacturer's standard; powder coated steel.
   7. Manual hand chain lift operation.
   8. Mounting: As indicated on drawings.
   9. Locking Devices: Slide bolt on inside.

2.03 HOODS AND ACCESSORIES:

A. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head and act as weatherseal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface-mounted hoods and fascia for any portion of between-jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
   1. Shape:
      a. Round.

B. Weatherseals: Provide replaceable, adjustable, continuous, compressible weather-stripping gaskets fitted to bottom and at top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch (3-mm) thick, replaceable, continuous sheet secured to inside of curtain coil hood.
   1. Provide manual operators with bottom weather seal.
   2. In addition, provide replaceable, adjustable, continuous, flexible, 1/8-inch (3-mm) thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weathertight installation.

C. Slide Bolt: Fabricate with side locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

2.04 MATERIALS AND COMPONENTS:

A. Metal Curtain Construction: Interlocking slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of material thickness recommended by door manufacturer for performance, size, and type of door indicated, and as follows:
   1. Slat Ends: Each slat fitted with end locks to act as wearing surface in guides and to prevent lateral movement.
      a. Malleable-iron castings galvanized after fabrication, secured to curtain slats with galvanized rivets, or high-strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.

2. Windlocks: Malleable-iron castings secured to curtain slats with galvanized rivets or high-strength nylon, as required to comply with wind load.
3. Curtain Bottom for Slat Curtains: Fitted with 2 angles suit type of curtain slats to provide reinforcement and positive contact in closed position, each not less than 1-1/2 by 1-1/2 by 1/8 inch (38 by 38 by 3mm) thick, either galvanized or stainless-steel or aluminum extrusions to suit type of curtain slats.
4. Weatherstripping for Exterior Doors: Moisture and rot proof, resilient type, located at jamb edges, bottom of curtain, and where curtain enters hood enclosure of exterior doors.
    a. Provide replaceable, adjustable, continuous, compressible weather-stripping gaskets fitted at top of exterior doors, unless otherwise indicated. At door head, use 1/8-inch (3-mm) thick, replaceable, continuous sheet secured to inside of curtain coil hood.
    b. Provide motor-operated doors with combination bottom weatherseal and sensor edge.
    c. In addition, provide replaceable, adjustable, continuous, flexible, 1/8-inch (3-mm) thick seals of flexible vinyl, rubber, or neoprene at door jambs for a weathertight installation.
5. Steel Slats: Minimum thickness, 24 gauge; ASTM A653/A653M galvanized steel sheet.

B. Guide Construction: Continuous, of profile to retain door in place with snap-on trim, mounting brackets of same metal.

C. Guides - Angle: ASTM A36/A36M metal angles, size as indicated. Fabricate curtain jamb guides of steel angles, or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly, and to withstand loading. Slot bold holes for guide adjustment. Provide removable stops on guides to prevent overtravel of curtain and a continuous bar for holding windlocks.
1. Build up units with not less than 3/16-inch (5-mm) thick, hot-dip galvanized in compliance with ASTM A36 (ASTM A36M), and ASTM A123/A123M.

D. Hood Enclosure and Trim: Internally reinforced to maintain rigidity and shape.

E. Lock Hardware:
1. Slide Bolt: Provide on single-jamb side, extending into slot in guides, with padlock on one side.
2. Manual Chain Lift: Provide padlockable chain keeper on guide.

F. Slide Bolt: Fabricate with side locking bolts to engage through slots in tracks for locking by padlock, located on both left and right jamb sides, operable from coil side.

G. Roller Shaft Counterbalance: Steel pipe and helical steel spring system, capable of producing torque sufficient to ensure smooth operation of curtain from any position and capable of holding position at mid-travel; with adjustable spring tension; requiring 25 lb (10 kg) nominal force to operate.

2.05 COUNTERBALANCING MECHANISM:

A. General: Counterbalance doors by means of adjustable-tension steel helical torsion spring, mounted around a steel shaft and contained in a spring barrel connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.

B. Counterbalance Barrel: Fabricate spring barrel of hot-formed, structural-quality, welded or seamless carbon-steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 in./ft. (2.5 mm/m) of span under full load.

C. Provide spring balance of one or more oil-tempered, heat-treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast-steel barrel plugs to secure ends of springs to barrel and shaft.
D. Fabricate torsion rod for counterbalance shaft of cold-rolled steel, sized to hold fixed spring ends and carry torsional load.
E. Brackets: Provide mounting brackets of manufacturer's standard design, either cast-iron or cold-rolled steel plate with bell-mouth guide groove for curtain.

2.06 FINISHES, GENERAL:

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
B. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 MANUAL DOOR OPERATORS:

A. Chain-Hoist Operator: Provide manual chain-hoist operator consisting of endless steel handchain, chain pocket wheel and guard, and gear-reduction unit with a maximum 35-lbf (155-N) effort for door operation. Provide alloy steel hand chain with chain holder secured to operator guide.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that adjacent construction is suitable for door installation.
B. Verify that door opening is plumb, header is level, and dimensions are correct.
C. Notify Architect of any unacceptable conditions or varying dimensions.
D. Commencement of installation indicates acceptance of substrate and door opening conditions.

3.02 INSTALLATION:

A. General: Install door and operating equipment complete with necessary hardware, jamb, and head mold strips, anchors, inserts, hangers, and equipment supports according to Shop Drawings, in accordance with manufacturer's instructions, and as specified.
B. Install fire-rated doors in accordance with NFPA 80.
C. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
D. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
E. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
F. Install enclosure and perimeter trim.

3.03 TOLERANCES:

A. Maintain dimensional tolerances and alignment with adjacent work.
B. Maximum Variation From Plumb: 1/16 inch (1.6 mm).
C. Maximum Variation From Level: 1/16 inch (1.6 mm).
D. Longitudinal or Diagonal Warp: Plus or minus 1/8 inch per 10 feet (3.2 mm per 3 m) straight edge.

3.04 ADJUSTING:

A. Adjust operating assemblies for smooth and noiseless operation.
B. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion and fitting weathertight for entire perimeter.

3.05 CLEANING:

A. Clean door and surrounding walls and floors after installation.
B. Clean installed components.
C. Remove labels and visible markings.

END OF SECTION 08 33 23

SECTION 08 70 00 - FINISH HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes hardware for the proper installation, operation, and control of doors.

1.03 REFERENCES:

A. Applicable Standards:
   1. American National Standards Institute (ANSI):
      a. A115 Series - Door and Frame Preparation.
      b. A156 Series - Hardware.
   2. Builders Hardware Manufacturers Association (BHMA):
      a. 1301 - Materials and Finishes.
   3. Door and Hardware Institute (DHI):
      a. Keying - Procedures, Systems and Nomenclature.
      b. Architectural Hardware Scheduling Sequence and Schedule Format.
      c. Abbreviations and Symbols.
      d. Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames.
      e. Recommended Procedure for Processing Hardware Schedules and Templates.
      f. Recommended Locations for Builder's Hardware for Standard Steel Doors and Frames.
   4. Underwriters Laboratories (UL):
      a. Building Materials Directory.
      b. 305 - Panic Hardware.

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Includes, but not limited to, the following:
   1. Product data includes manufacturers' technical product data for each item of door hardware, installation instructions, maintenance of operating parts and finish, and other information necessary to show compliance with requirements.
   2. Final hardware schedule coordinated with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
      a. Final Hardware Schedule Content: Based on hardware indicated, organize schedule into "hardware sets" indicating complete designations of every item required for each door or opening. Include the following information:
         (1) Type, style, function, size, and finish of each hardware item.
         (2) Name and manufacturer of each item.
         (3) Fastenings and other pertinent information.
         (4) Location of each hardware set cross referenced to indications on drawings both on floor plans and in door and frame schedule.
         (5) Explanation of all abbreviations, symbols, and codes contained in schedule.
         (6) Mounting locations for hardware.
         (7) Door and frame sizes and materials.
         (8) Keying information.

b. Keying Schedule: Submit separate detailed schedule indicating clearly how the Engineer's final instructions on keying of locks has been fulfilled.
c. Templates for doors, frames, and other work specified to be factory prepared for the installation of door hardware. Check shop drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.05 QUALITY ASSURANCE:

A. Supplier Qualifications: A recognized architectural door hardware supplier, with warehousing facilities in the Project's vicinity, that has a record of successful in-service performance for supplying door hardware similar in quantity, type, and quality to that indicated for this Project and that employs an experienced architectural hardware consultant (AHC) who is available to Engineer and Contractor for consultation at reasonable times during the course of the Work.
   1. Require supplier to meet with Engineer to finalize keying requirements and to obtain final instructions in writing.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Tag each item or package separately with identification related to final hardware schedule and include basic installation instructions with each item or package.
B. Packaging of door hardware is responsibility of supplier. As material is received by hardware supplier from various manufacturers, sort and repackage in containers clearly marked with appropriate hardware set number to match set numbers of approved hardware schedule. Two or more identical sets may be packed in same container.
C. Inventory door hardware jointly with representatives of hardware supplier and hardware installer until each is satisfied that count is correct.
D. Deliver individually packaged door hardware items promptly to place of installation (Project Site).
E. Provide secure lock-up for door hardware delivered to the project, but not yet installed. Control handling and installation of hardware items that are not immediately replaceable so that completion of the work will not be delayed by hardware losses both before and after installation.

1.07 COORDINATION:

A. Coordinate hardware with other Work.
B. Furnish templates and other detail matter as required to each fabricator of doors and frames, and to other Work to be prepared for the installation of hardware.
C. Where Modifications to this Specification are required due to unanticipated conditions, make recommendations of alternative procedures to the Engineer for his consideration and approval.

1.08 MAINTENANCE:

A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Engineer's continued adjustment, maintenance, and removal and replacement of door hardware.

1.09 WARRANTY

A. The Manufacturer shall warrant that all finish hardware shall be free from defects caused by faulty material or workmanship for a minimum period of one (1) year from the date of Substantial Completion, unless otherwise specified.
B. Warranties shall comply with the requirments of Section 01 78 36.

PART 2 - PRODUCTS

2.01 ACCEPTABLE PRODUCTS: ITEMS OF HARDWARE ARE SPECIFIED IN DOOR SCHEDULE, WITH REFERENCE TO THE LISTING GIVEN IN THIS PART - PRODUCT REQUIREMENTS.

2.02 PRODUCT REQUIREMENTS:

A. Hardware shall meet the respective applicable standards specified in PART 1, this Section.
B. Provide hardware complete with all fasteners, anchors, instructions, layout templates, and any specialized tools as required for satisfactory installation and adjustment.
C. Provide manufacturer's standard products meeting the design intent of this Specification, free of imperfections affecting appearance or serviceability.
D. Hardware is specified in PART 2 – Section 2.03 – HARDWARE SCHEDULE, this Section, by type and function category, each of which has been selected as that best meeting the application. Acceptable products are given for each category in the hardware sets below.

2.03 HARDWARE SCHEDULE: REFER TO THE DOOR SCHEDULE ON THE DRAWINGS TO ASCERTAIN HANDS, AND SIZES.

SET #1

Doors 105, 205 *(Reuse Pump Station Walk Door, Potable Pump Station Walk Doors)*
PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW NRP (4 EA. LEAF AT DOORS OVER 7'6" HEIGHT)	630	IVE
1	EA	PANIC HARDWARE	98-L-17	630	VON
1	EA	RIM CYLINDER	20-022	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A	AL	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

NOTE: INSTALL WEATHERSTRIP AT FRAME HEAD FIRST, THEN INSTALL CLOSER PA BRACKET ON WEATHERSTRIP.

SET #2

Doors 102, 202 *(Potable Electrical Room Double Door, Reuse Electrical Room Double Door)*

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
6	EA	HINGE	5BB1HW NRP (4 EA. LEAF AT DOORS OVER 7'6" HEIGHT)	630	IVE
1	EA	PANIC HARDWARE	9827-EO	630	VON
1	EA	PANIC HARDWARE	9827-L-17	630	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	FSIC CORE	23-030	626	SCH
2	EA	SURFACE CLOSER	4111 SCUSH SRI	689	LCN
2	EA	KICK PLATE	8400 10" X 1" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A	AL	ZER
1	EA	GASKETING	328AA-S (HEAD & JAMBS)	AA	ZER
1	EA	ASTRAGAL SET	8195AA	AA	ZER
2	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER

SET #3

Doors 101, 201 *(Reuse Pump Station Walk Doors)*

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW NRP (4 EA. LEAF AT DOORS OVER 7'6" HEIGHT)	630	IVE
1	EA	POWER TRANSFER	EPT10 CON	689	VON
1	EA	ELEC PANIC HARDWARE	RX-LC-QEL-98-L-17-CON 24 VDC	630	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	FSIC CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4111 SCUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
1	EA	RAIN DRIP	142A	AL	ZER
1	EA	GASKETING	429AA-S	AA	ZER
1	EA	DOOR SWEEP	8197AA	AA	ZER
1	EA	THRESHOLD	65A-223	A	ZER
2	EA	WIRE HARNESS	CON X LENGTH REQ'D		SCH
1	EA	DOOR CONTACT	679-05 HM/WD AS REQ'D	WHT	SCE
1	EA	LOW VOLTAGE LOCK POWER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	CARD READER	BY SECURITY SYSTEM INTEGRATOR		
1	EA	WIRING DIAGRAM	BY SECURITY SYSTEM INTEGRATOR		

DOOR NORMALLY CLOSED AND LOCKED. PASSAGE THROUGH DOOR REQUIRES VALID CARD PRESENTATION TO WALL MOUNT CARD READER, MOMENTARILY RETRACTING DEVICE LATCH. INSIDE PUSH PAD ALWAYS FREE EGRESS.

SET #4

Doors 103, 203 *(Potable Electrical Room Single Door, Reuse Electrical Room Single Door)*

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW (4 EA. LEAF AT DOORS OVER 7'6" HEIGHT)	630	IVE
1	EA	PANIC HARDWARE	98-L-17	630	VON
1	EA	RIM CYLINDER	20-057 ICX	626	SCH
1	EA	FSIC CORE	23-030	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

SET #5

Doors 104, 204 *(Potable Control Room Single Door, Reuse Control Room Single Door)*

PROVIDE EACH SGL DOOR(S) WITH THE FOLLOWING:

QTY		DESCRIPTION	CATALOG NUMBER	FINISH	MFR
3	EA	HINGE	5BB1HW (4 EA. LEAF AT DOORS OVER 7'6" HEIGHT)	630	IVE
1	EA	PASSAGE SET	ND10S SPA	626	SCH
1	EA	SURFACE CLOSER	4111 CUSH SRI	689	LCN
1	EA	KICK PLATE	8400 10" X 2" LDW B-CS	630	IVE
3	EA	SILENCER	SR64	GRY	IVE

SET #6

Doors 100, 200 *(Overhead Coiling Doors)*

Mfr. = MANUFACTURER
SCH = Schlage
LCN = LCN
IVE = Ives
VON = Von Duprin
ZER = Zero
GLY = Glynn Johnson

Or Engineer approved equal.

2.04 KEYING:

A. Keying requirements shall be determined by consultation with the Owner.
B. Tag and identify keys.
C. Provide three keys for each lock or cylinder.
D. Key to existing master key system.
E. Provide construction master keys for all exterior doors.

2.05 MATERIALS AND FABRICATION:

A. Manufacturer's Name Plate: Do not use manufacturers' products that have manufacturer's name or trade name displayed in a visible location.
   1. Manufacturer's identification will be permitted on rim of lock cylinders only.
B. Base Metals: Product hardware units of basic metal using manufacturer's standard metal alloy, composition, temper, and hardness, but in no case of lesser quality than specified for applicable hardware units by applicable ANSI/BHMA A156 series standards for each type of hardware item and with ANSI/BHMA A156.18 for finish designations indicated. Do not furnish "optional" materials or forming methods except as otherwise specified.
C. Fasteners: Provide hardware manufactured to conform to published templates, generally prepared for machine screw installation. Do not provide hardware that has been prepared for self-tapping sheet metal screws, except as specifically indicated or specified.
D. Furnish screws for installation with each hardware item. Provide Phillips flat-head screws except as otherwise indicated. Finish exposed screws to match hardware finish.
E. Provide concealed fasteners for hardware units that are exposed when door is closed except to the extent no standard units of type specified are available with concealed fasteners. Do not use thru-bolts for installation where bolt head or nut on opposite face is exposed in other work unless their use is the only means of reinforcing the work adequately to fasten the hardware securely. Where thru-bolts are used as a means of reinforcing the work, provide sleeves for each thru-bolt or use hex screw fasteners.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Check all frames and doors for proper hardware cutouts and reinforcements.
B. Except as specified otherwise, install articles of hardware after finishes have been completed on the substrate. Note all requirements for coordination with protective coating applications.
C. Install hardware at such a time in the Project schedule to minimize the possibility of damage from the activity of other trades prior to acceptance.
D. Check the installation requirements of doors the hardware is to be installed on.

3.02 INSTALLATION:

A. Mount articles of hardware at locations and in the manner prescribed in the respective DHI standards specified in PART 1, this Section, unless otherwise specified.
B. Install each hardware item in compliance with the manufacturer's instructions and recommendations. Where cutting and fitting is required to install hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation or application of surface protection with finishing work specified in the DIVISION 09 Sections. Do not install surface-mounted items until finishes have been completed on the substrates involved.
C. Set units level, plumb, and true to line and location. Adjust and reinforce the attachment substrate as necessary for proper installation and operation.

D. All field preparations, such as drilling, cutting, tapping, and countersinking shall be accurately executed to assure precise fitting and adjustment.
E. Use fasteners of correct size and type with anchoring devices as required by construction conditions, suited to the nature of the attachment substrate, and the duty performance required.
F. In the course of installation, avoid damage to hardware mechanisms, finishes, and surrounding surfaces; smearing of paints, sealants, and lubricants onto surfaces not intended to receive them; and the admission of foreign matter into chassis and cases of units and their associated preparations.
G. Seal weather-protection components attached to the exterior sides of doors and frames in place with clear silicone caulk in such a manner as to ensure a continuously filled seam throughout the joinery.
H. Cut and fit weather stripping accurately to affect the greatest possible continuity of the contact element. Where hardware-compatible extrusions are specified "do not cut," adjust templating of soffit-mounted hardware to suit the extrusion thickness and mount all such items on the extrusions.
I. Protection plates shall be installed on visual centers of closed doors. Bottom edges of all such plates shall be flush with bottoms of doors or shall meet top edges of surface-applied door sweeps where they are specified.
J. At exterior doors, obtain satisfactory operation of the installation, then apply a thin layer of clear silicone caulk under hinge leaves, both door and frame. Remove excess caulk after torquing fasteners.
K. Adjust door closers immediately upon installation. Adjust in exact conformance with manufacturer's printed instructions. Back-check shall be advanced to reduce shock at dead stop. Latching speed shall be set to assure unassisted positive latching. Readjustment of closers may be required prior to acceptance as directed by the Engineer. Adjust hold open device so door closes with normal use. Hold open device to be engaged only when extra push to the door is applied.
L. Degrees of swing of doors are given for closers where exact dimensioning, of the installation to achieve the indicated angles, is required.

3.03 ADJUSTMENT AND CLEANING:

A. Check and adjust each operating item of hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate freely and smoothly or as intended for the application made.
    1. Where door hardware is installed more than one month prior to acceptance or occupancy return to the installation during the week prior to acceptance or occupancy and make final check and adjustment of all hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors. Adjust door control devices to compensate for final operation of heating and ventilating equipment.
    2. Checking and adjustment shall be performed by a certified Architectural Hardware Consultant to ensure proper operation and function of each unit.
B. Lubricate units only as recommended by their manufacturers.
C. Remove excess sealants, lubricants, and any other foreign substances, and protect all installations from subsequent damage.
D. Clean units just prior to final acceptance, with only materials and procedures recommended by their manufacturers.
E. Maintain the sheets of instruction, layout templates, and any supplementary literature regarding hardware in a readable condition. Transmit to the Engineer all such matter together with all spare parts, specialized tools, and other accessories supplied with the hardware. Also, transmit

to the Engineer a copy of the approved hardware schedule. Notify the Engineer in writing that such transmittal has occurred.

F. Instruct Owner's maintenance personnel in the proper adjustment and maintenance of door hardware and finishes. Instructions shall be performed by a certified Architectural Hardware Consultant or a qualified representative of the manufacturer.

END OF SECTION 08 70 00

SECTION 08 80 00 – GLASS AND GLAZING

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes glass and glazing for the following items:
   1. Door and window glass.

1.02 REFERENCES:

A. Applicable Standards:
   1. American National Standards Institute, Inc. (ANSI):
      a. Z97.1 - Performance Specifications and Method of Test for Safety Glazing Material Used in Buildings.
   2. American Society for Testing and Materials (ASTM):
      a. C509 - Cellular Elastomeric Preformed Gasket and Sealing Material.
      b. C542 - Lock-Strip Gaskets.
      c. C716 - Installing Lock-Strip Gaskets and Infill Glazing Materials.
      d. C864 - Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
      e. C920 - Elastomeric Joint Sealants.
      f. C1036 - Flat Glass.
      g. C1048 - Heat Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
      h. C1172 – Laminated Glass.
      i. E1300 - Practice for Determining the Minimum Thickness and Type of Glass Required to Resist a Specified Load.
      j. E2190 - Insulating Glass Unit Performance and Evaluation.
   3. Code of Federal Regulations (CFR):
      a. 40 CFR 59, Subpart D - National Volatile Organic Compound Emissions Standard for Architectural Coatings.
   4. Consumer Product Safety Commission (CPSC):
      a. 16 CFR 1201 - Safety Standard for Architectural Glazing Materials.
   5. Flat Glass Marketing Association (FGMA):
      a. Glazing Manual.
   6. National Fire Protection Association (NFPA):
      a. 80 - Fire Doors and Windows.
      b. 252 - Fire Tests of Door Assemblies.
      c. 257 - Fire Test for Window and Glass Block Assemblies.

1.03 DEFINITIONS:

A. Manufacturer is used in this Section to refer to a firm that produces primary glass or fabricated glass as defined in the referenced glazing standard.

B. Deterioration of Insulating Glass: Failure of the hermetic seal under normal use due to causes other than glass breakage and improper practices for maintaining, and cleaning insulating glass. Evidence of failure is the obstruction of vision by dust, moisture, or film on the interior surfaces of glass. Improper practices for maintaining and cleaning glass do not comply with the manufacturer's directions.

1.04 SYSTEM PERFORMANCE REQUIREMENTS:

A. General: Provide glazing systems that are produced, fabricated, and installed to withstand normal thermal movement, wind loading, and impact loading (where applicable), without failure including loss or glass breakage attributable to the following: Defective manufacture, fabrication, and installation; failure of sealants or gaskets to remain watertight and airtight;

deterioration of glazing materials; and other defects in construction. Comply with ASTM E1300.

B. Glass Design: Glass thicknesses specified or indicated on Drawings are minimum. Confirm glass thicknesses by analyzing Project loads and in-service conditions.

C. Normal thermal movement results from the following maximum change (range) in ambient and surface temperatures acting on glass-framing members and glazing components. Base engineering calculation on materials' actual surface temperatures due to both solar heat gain and nighttime sky heat loss.

1. Temperature Change (Range): 120°F, ambient; 180°F, material surfaces.

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Include, but not limited to, the following:

1. Product Data: Technical data for each glazing material and fabricated glass product required, including installation and maintenance instructions.
2. Certificates: Product certificates from respective manufacturers attesting that glass and glazing materials furnished comply with requirements. Separate certification will not be required for glazing materials bearing manufacturer's permanent labels designating type and thickness of glass, provided labels represent a quality control program involving a recognized certification agency or independent testing agency acceptable to authorities having jurisdiction.
3. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1.06 QUALITY ASSURANCE:

A. Glazing Standards: Comply with recommendations of Flat Glass Marketing Association (FGMA) "Glazing Manual" and "Sealant Manual" except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this Section or other referenced standards.

B. Safety Glazing Standard: Where safety glass is indicated or required by authorities having jurisdiction, provide type of products indicated which comply with ANSI Z97.1 and testing requirements of 16 CFR Part 1201 for Category II materials.

C. Fire-Resistive Glazing Products for Door Assemblies: Assemblies complying with NFPA 80 that are labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for fire ratings indicated, based on testing according to NFPA 252.

D. Fire-Resistance Rated Glass for Window Assemblies: Assemblies complying with NFPA 80 that are labeled and listed by UL or other testing and inspecting agency acceptable to authorities having jurisdiction for fire ratings indicated, based on testing according to NFPA 257.

E. Insulating Glass Certification Program: Provide insulating glass units permanently marked either on spacers or at least one component pane of units with appropriate certification label of inspecting and testing agency.

F. Glazier Qualifications: Engage an experienced glazier who has completed glazing similar in material, design, and extent to that indicated for Project with a record of successful in-service performance.

G. Single-Source Responsibility for Glass: To ensure consistent quality of appearance and performance, provide materials produced by a single manufacturer or fabricator for each kind and condition of glass and glazing accessory indicated or specified.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Protect glass and glazing materials during delivery, storage, and handling to comply with manufacturer's directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, temperature changes, direct exposure to sun, and from other causes.

B. Where insulating glass units will be exposed to substantial altitude changes, comply with insulating glass fabricator's recommendations for venting and sealing to avoid hermetic seal ruptures.

1.08 PROJECT CONDITIONS:

A. Do not proceed with glazing when ambient and substrate temperature conditions are outside the limits permitted by glazing material manufacturer or when joint substrates are wet due to rain, frost, condensation, or other causes.

B. Install liquid sealants at ambient and substrate temperatures above 40°F.

1.09 WARRANTY:

A. General: Warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

B. Manufacturer's Warranty on Insulating Glass: Submit written warranty signed by manufacturer of insulating glass agreeing to furnish replacements for insulating glass units that deteriorate as defined in "Definitions" article, f.o.b. point of manufacture, freight allowed Project Site, within specified warranty period indicated below. Warranty covers only deterioration due to normal conditions of use and not to handling, installing, protecting, and maintaining practices contrary to glass manufacturer's published instructions.

1. Warranty Period: Manufacturer's standard but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Primary and Heat-Treated Glass Products:

1. Cardinal IG.
2. Guardian Industries Corp.
3. Manko Window Systems.
4. Viracon.
5. Vitro Architectural Glass.

B. Preformed Gaskets:

1. D. S. Brown Co.
2. Tremco, Inc.

C. Glazing Sealants and Tapes:

1. Bostik Construction Products Inc.
2. Dow Corning Corp.
3. W. R. Meadows, Inc.
4. Pecora Corp.
5. Sonneborn Building Products.
6. Tremco, Inc.

2.02 GLASS PRODUCTS, GENERAL:

A. Primary Glass Standard: Provide primary glass which complies with ASTM C1036 requirements, including those indicated by reference to type, class, quality, and if applicable, form, finish, mesh, and pattern.

B. Heat-Treated Glass Standard: Provide heat-treated glass which complies with ASTM C1048 requirements, including those indicated by reference to kind, condition, type, quality, class, and if applicable, form, finish, and pattern.

C. Sizes: Fabricate glass to sizes required for glazing openings indicated with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses specified or indicated, or if not otherwise indicated, as recommended by glass manufacturer for application indicated.

2.03 SEALED INSULATING GLASS UNITS:

A. General: Preassembled units consisting of organically sealed panes of glass enclosing a hermetically sealed dehydrated air space and complying with ASTM E774 for performance classification indicated as well as with other requirements specified for glass characteristics, air space, sealing system, sealant, spacer material, corner design, and desiccant.

B. Sealant-Edged Insulating Glass:

1. Low-E outboard lites being PPG Solargray Solarban or engineer approved equal.
2. Fabricate units with a permanent hermetically sealed, dry air, or gas-filled space. Provide an edge seal consisting of twin primary sealant beads of polyisobutylene; positioned and retained by a tubular aluminum or galvanized steel spacer-bar frame with soldered/welded sealed corners and filled with desiccant with breather ports into sealed space; with secondary edge seals of silicone polysulfide or hot melt butyl completely encapsulating outer face of spacer bar and sealed to the opposing sheets of glass.
3. Performance Characteristics: Visible light transmittance of 15, exterior light reflectance of 10%, interior light reflectance of 38%, winter nighttime U-value of 0.38 (fixed fenestration) and 0.77 (entrance doors), solar heat gain coefficient of 0.40, and light-to-solar gain of 0.60.

2.04 LAMINATED GLASS

1. Laminated Glass ASTM C1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
    a. Exterior Door Glass Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.
        (1) Overall Insulating Glass Thickness 1-1/16”.
        (2) Outboard lite: 1/4” tempered tinted with low-E coating.
        (3) Air Space: 7/16”.
        (4) Inboard lite: 3/16” Laminated Sheet: .060” Clear PVB and 2 sheets of 3/32” Clear Heat-Strengthened Glass.
        (5) Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
        (6) Interlayer Color: Clear unless otherwise indicated.
        (7) Basis of Design: Vitro Architectural Solargray Solarban insulated glass unit, or engineer approved equal.
    b. Interior Window Glass Construction (between similarly conditioned spaces): Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.

(1) Nominal ¼" laminated safety glass with two sheets of 3/32" Clear Heat Stregthened Glass and a 0.60 PVB inner layer.

2. Unit shall be warranted for 10 years.
3. Basis of Design: Vitro Architectural Glass clear insulated glass unit, or engineer approved equal.

2.05 ELASTOMERIC GLAZING SEALANTS AND PREFORMED GLAZING TAPES:

A. General:
1. Compatibility: Select glazing sealants and tapes of proven compatibility with other materials with which they will come into contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of installation and service, as demonstrated by testing and field experience.
2. Suitability: Comply with recommendations of sealant and glass manufacturers for selection of glazing sealants and tapes which have performance characteristics suitable for applications indicated and conditions at time of installation.
3. Elastomeric Sealant Standard: Provide chemically-curing elastomeric sealant of base polymer which complies with ASTM C920 requirements, including those for type, grade, class, and uses.
4. Colors: Provide color of exposed sealants as selected by Engineer/Architect from manufacturer's standard colors.
5. VOC Content: For sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 MISCELLANEOUS GLAZING MATERIALS:

A. Provide materials with proven record of compatibility with surfaces contacted in installation.
B. Cleaners, Primers, and Sealers: Type recommended by sealant or gasket manufacturer.
C. Setting Blocks: Neoprene, EPDM, or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.
D. Spacers: Neoprene, EPDM, or silicone blocks or continuous extrusions as required for compatibility with glazing sealant of size, shape, and hardness recommended by glass and sealant manufacturers for application indicated.
E. Edge Blocks: Neoprene, EPDM, or silicone blocks as required for compatibility with glazing sealant, of size and hardness required to limit lateral movement (side-walking) of glass.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Examine framing and glazing channel surfaces for compliance with manufacturing and installation tolerances, including those for size, squareness, offsets at corners, face or edge clearances, presence and functioning of weep system, for effective sealing of joinery, and conditions under which glazing is to be performed.
B. Clean sash and glazing channel, or other framing members to receive glass immediately before glazing.
C. Remove any coatings not firmly bonded to the substrate, moisture, frost, oil, grease, dust, dirt, and all foreign substances. Remove lacquer from metal surfaces where elastomeric sealants are specified for use.

3.02 PERFORMANCE REQUIREMENTS:

A. Watertight and airtight installation of each piece of glass is required, except as otherwise specified or indicated. Each installation must withstand normal temperature changes, wind loading, and impact loading (for operating sash and doors) without failure including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials, and other defects in the Work.

3.03 SEALANT GLAZING - WET:

A. Cut glass accurately to size from measurements taken at the building and follow glass bite requirements recommended by the glass manufacturer.

B. Conform to FGMA Glazing Manual, combined printed recommendations of glass manufacturers, glazing sealants, gaskets, and other glazing materials except as otherwise indicated or specified.

C. Protect glass from edge damage during handling and installation; use a rolling block in rotating glass units to prevent damage to glass corners. Do not impact glass with metal framing. Use suction cups to shift glass units within openings; do not raise or drift glass with a pry bar. Rotate glass with flares or bevels along one horizontal edge which would occur in vicinity of setting blocks so that these are located at top of opening.

D. Remove from Project and dispose of glass units with edge damage or other imperfections of kind that, when installed, weaken glass, and impair performance and appearance.

E. Apply primer or sealer to joint surfaces wherever required by glazing material manufacturer.

F. Install setting blocks of proper size in sill rabbet, located to comply with referenced glazing standard unless otherwise required by glass manufacturer. Set blocks in thin course of sealant which is acceptable for heel bead use.

G. Provide spacers inside and out, of correct size and spacing to preserve required face clearances, for glass sizes larger than 50 united inches, except where gaskets or glazing tapes with continuous spacer rods are used for glazing. Provide 1/8-inch minimum bite of spacers on glass and use thickness equal to sealant width. With sealant tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking to comply with requirements of referenced glazing standard, except where otherwise required by glass unit manufacturer.

I. Set units of glass in each series with uniformity of pattern, draw, bow, and similar characteristics.

J. Provide compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep systems and from adhering to joint back surface as well as to control depth of sealant for optimum performance.

K. Force sealants into glazing channels to eliminate voids and to ensure complete "wetting" or bond of sealant to glass and channel surfaces.

L. Tool exposed surfaces of sealants to provide a substantial "wash" away from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, to eliminate dirt and moisture pockets.

3.04 CURE, PROTECTION, AND CLEANING:

A. Cure glazing sealants and compounds in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength, and surface durability.

B. Protect glass, glazing sealants, and compounds during construction period so that they will be without deterioration or damage (other than normal weathering) at time of completion.

C. Take precautions required to prevent glass damage resulting from the alkaline wash from green concrete surfaces, runoff from noncoated metals, and similar sources of possible discoloration or damage.
D. Protect glass from breakage immediately upon installation, by attachment of crossed streamers to framing held away from glass. Do not apply markers directly on surfaces of glass.
E. Remove and replace glass which is broken, chipped, cracked, abraded, or damaged in other ways during glass installation and the continuing construction period, including pieces damaged through natural causes, accidents, and vandalism.
F. Wash both faces of glass. Remove all dirt, stains, labels, and other foreign substances. Comply with glass manufacturer's instructions.

END OF SECTION 08 80 00

DIVISION 09 - FINISHES

SECTION 09 90 00 – PROTECTIVE COATINGS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes coating of exterior and interior surfaces throughout the Project and which are listed in PART 2, with systems specified on "coating system" sheets at the end of this Section.

B. Coating systems include surface preparation, prime coat (first coat), finish coats (second and third coats), inspection, cleaning, and touch-up of surfaces and equipment. Shop preparation, prime coat, and finish coats to be shop-applied, may be specified elsewhere or referenced to this Section so that a complete system is specified and coordinated.

1. Where surface preparation and first (prime) coat are specified in other Sections to be shop-applied, such as for structural steel, hollow metal doors or equipment, only the touch-up and finish coats are a part of field painting. Surface preparation is the required degree of preparation prior to application of first (prime) coat regardless if done in shop or field.
2. If materials are provided without shop primer such as miscellaneous steel or sheet metal, then surface preparation, first, second, and third coats are a part of field painting.

1.02 RELATED REQUIREMENTS:

A. Shop Painting and Coatings: All applicable Divisions.

B. Factory Prefinished Items: All applicable Divisions.

1.03 REFERENCE STANDARDS:

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. A13.1 - Scheme for the Identification of Piping Systems.
   b. Z53.1 - Safety Color Code for Marking Physical Hazards.
2. American Society for Testing and Materials (ASTM):
   a. D4259 - Abrading Concrete.
3. Society for Protective Coatings (SSPC) Surface Preparation Specifications:
   a. SP1 - Solvent Cleaning: Removes oil, grease, soil, drawing and cutting compounds, and other soluble contaminants.
   b. SP2 - Hand Tool Cleaning: Remove loose material. Not intended to remove adherent mill scale, rust, and paint.
   c. SP3 - Power Tool Cleaning: Removes loose material. Not intended to remove all scale or rust.
   d. SP5 - White Metal Blast Cleaning: Removes all scale, rust, foreign matter. Leaves surface gray-white uniform metallic color.
   e. SP6 - Commercial Blast Cleaning: Two-thirds of every nine square inches free of all visible residues; remainder only light discoloration.
   f. SP10 - Near-White Blast Cleaning: At least 95% of every nine square inches shall be free of all visible residues.
   g. SP11 - Power Tool Cleaning to Bare Metal.
   h. SP13 – Surface Preparation of Concrete.

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Includes, but not limited to, the following:
   1. Schedule of products and paint systems to be used. Schedule shall include the following information:
      a. Surfaces for system to be applied.
      b. Surface preparation method and degree of cleanliness.
      c. Product manufacturer, name, and number.
      d. Method of application.
      e. Dry film mil thickness per coat of coating to be applied.
   2. Color charts for selection and acceptance.
   3. Technical and material safety data sheets.
   4. Certification(s) by coating manufacturer(s) that all coatings are suitable for service intended as stated on each coating system sheet. If manufacturer has an equivalent product as that specified, and it is suitable for the intended purpose, Contractor shall submit the recommended product for approval at no increase in cost, and state reasons for substitution.
   5. Contractor shall certify in writing to the Engineer/Architect that applicators have previously applied all the systems in this Specification and have the ability and equipment to prepare the surfaces and apply the coatings correctly.

C. Submittals for industrial maintenance coatings shall be prepared by, or have assistance in preparation of, a corrosion engineer or industrial coatings technical representative of the coating manufacturer.

1.05 QUALITY ASSURANCE:

A. Include on label of container:
   1. Manufacturer's name, product name, and number.
   2. Type of paint and generic name.
   3. Color name and number.
   4. Storage and temperature limits.
   5. Mixing and application instructions, including requirements for precautions which must be taken.
   6. Drying, recoat, or curing time.

B. A coating report shall be completed daily by Contractor at each phase of the coating system starting with surface preparation. These shall be submitted on the form attached at end of this Section.

C. In the event a problem occurs with coating system, surface preparation, or application, Contractor shall require coating applicator and coating manufacturer's technical representative to promptly investigate the problem and submit results to Engineer/Architect.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Delivery of Materials:
   1. Deliver in sealed containers with labels and information legible and intact. Containers shall also have correct labels with required information.

1.07 REGULATORY REQUIREMENTS:

A. In addition to requirements specified elsewhere for environmental protection, provide coating materials that conform to the restrictions of the U.S. EPA and the local and regional jurisdictions. Notify Engineer/Architect of any coating specified herein that fails to conform to the requirements for the location of the Project or location of application.

B. Lead Content: Use only coatings that are totally lead free.

C. Chromate Content: Do not use coatings containing zinc-chromate or strontium chromate.
D. Asbestos Content: Materials shall not contain asbestos.
E. Mercury Content: Materials shall not contain mercury or mercury compounds.

1.08 WARRANTY
A. The Manufacturer shall warrant that all protective coatings shall be free from defects caused by faulty material or workmanship for a minimum period of two (2) years from the date of Substantial Completion, unless otherwise specified.
B. Warranties shall comply with the requirements of Section 01 78 36.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:
A. Proprietary names and product numbers are specified in most systems for material identification from these manufacturers:
1. Ameron Protective Coatings Systems Group, PPG.
2. Carboline Company, Inc.
3. Tnemec Company, Inc.
4. Sherwin-Williams.

2.02 GENERAL:
A. Materials furnished for each coating system must be compatible to the substrate.
B. When unprimed surfaces are to be coated, entire coating system shall be by the same coating manufacturer to assure compatibility of coatings.
C. When shop-painted surfaces are to be coated, ascertain whether finish materials will be compatible with shop coating. Inform Engineer/Architect of any unsuitable substrate or coating conditions.

2.03 COATING SYSTEMS:
A. Specified on the "Protective Coating System" sheets at the end of this Section.

2.04 SURFACES TO BE COATED:
A. System A-5:
1. Item: Steel Bollards and exterior exposed carbon steel
a. Reference: DIVISION 05, Architectural, Civil and Structural Drawings
b. Location: As indicated
B. System B-4:
1. Item: New Galvanized Steel, Including: Veneer Lintels, Double Tee Support Angles, and Ladder
a. Reference: DIVISION 05, Architectural and Structural Drawings
b. Location: As indicated
C. System D-1:
1. Item: Process equipment and pipe submerged in water, including: pump/motor interiors.
2. Reference: DIVISION 33
3. Location: As indicated
D. System E-1:
1. Item: New Iron and Steel Process Piping, Valves, Motors, Pipe Supports, Drains, Air Lines & Related Accessories. Interior Exposure, & Exterior Surfaces.

a. Reference: DIVISION 22, 33, 41 & 46
b. Location: As indicated

2. Item: Misc. Non-galvanized Steel Interior Exposure, including interior structural steel:
   a. Reference: DIVISION 05 & drawings
   b. Location: As indicated
3. Item: Steel Hangers & Supports for Mechanical Equipment and Piping. Interior Exposure:
   a. Reference: DIVISION 05 & Mechanical Drawings
   b. Location: As indicated

E. System F-3:
1. Item: Interior CMU walls
   a. Reference: Architectural Drawings
   b. Location: As indicated

F. Item: Exterior masonry sealer
1. Product: Prosoco Block Guard and Graffiti Control 9 @ 30-100sq.ft. per gallon

G. Item: Manhole concrete interiors
1. Reference: Civil and Structural drawings
2. Location: As indicated
3. Provide the following Tnemec system or approved Sherwin Williams or Carboline equal meeting the design criteria listed below:
   a. Coating system:
      (1) Surface Preparation: Power wash with a minimum of 5,000 PSI to create an ICRI-CSP 5
      (2) Tnemec Series 456 @ minimum 125 mils D.F.T

2.05 .SURFACES NOT TO BE COATED:

A. Do not field coat any of the following items unless specifically noted otherwise.
1. Copper, stainless steel, aluminum, FRP fabrications, Conduit, PVC piping.

2.06 COLOR CODING OF PIPING AND PHYSICAL HAZARDS:

A. Color Coding of Piping: Exterior and interior by color coding entire pipe.
1. General:
   a. Coat piping with solid colors as specified below for entire length of pipe in exposed finished and unfinished areas. Exclude areas in pipe chases and furred areas.
   b. Coat all other piping in colors matching adjacent surfaces. If adjacent area is unfinished, paint in color determined by Engineer/Architect.
   c. Identify piping with legend and arrows as specified below. Apply after completion of finish coating.
2. Color Scheme:

Description	Color	Notes
Potable	Dark Blue	Ref Mechanical/Process Drawings.
Raw or Recycled	Olive Green	Ref Process Drawings.
Drain	Dark Gray	Ref Mechanical Drawings.
All others	Light Gray	Ref Process Drawings.

3. Location of Legends and Arrows:
   a. Place on piping near connections to Equipment, adjacent to valves or fittings, on both sides of walls penetrated, and at intervals not to exceed 50 feet (15 meters).

b. Place arrows adjacent to or below legends depending upon visibility. Place arrows in direction of flow. For dual-flow piping, indicate both directions.
c. Locate legends to be visible from normal line of vision above floor level. Legend locations subject to approval of Engineer/Architect.

4. Letter Size:
a. Block-style letters, all capitals, conforming to ANSI A13.1.

B. Color Coding of Piping: Exterior and interior by color band.
1. General:
a. Coat piping in colors as selected by Engineer/Architect for entire length of pipe in exposed finished and unfinished areas. Exclude areas above suspended ceilings except for band and legend, in pipe chases and furred areas.
b. After completion of finish coating, identify piping with band, legend, and arrow as specified below.

C. Pipe Labeling:
1. Location of Legends and Arrows:
a. Color band, legends, and arrows on piping near connections to Equipment, adjacent to valves or fittings, on both sides of walls penetrated, and at intervals not to exceed 50 feet (15 meters).
b. Place arrows adjacent to or below legends depending upon visibility. Place arrows in direction of flow. For dual-flow piping, indicate both directions.
c. Locate legends to be visible from normal line of vision above floor level. Legend locations subject to approval of Engineer/Architect.
2. Letter and Band Size:
a. Block-style letters, all capitals, conforming to ANSI A13.1, and as follows. Band full circumference of pipe.

Outside Diameter of Pipe or Covering	Width of Banding	Size of Letters and Arrows
Less than 3/4" (19 mm)	6" (150 mm)	Approved metal tag or band
3/4" to 1-1/4" (19 mm to 32 mm)	8" (200 mm)	1/2" (13 mm)
1-1/2" to 2" (38 mm to 50 mm)	10" (250 mm)	3/4" (19 mm)
2-1/2" to 6" (64 mm to 150 mm)	12" (300 mm)	1-1/4" (32 mm)
8" to 10" (200 mm to 250 mm)	24" (600 mm)	2-1/2" (64 mm)
Over 10" (250 mm)	32" (800 mm)	3-1/2" (89 mm)

D. Color Coding Physical Hazards: Exterior and interior.
1. General:
a. Paint areas indicated to identify physical hazard areas as required by ANSI Z53.1.
b. All colors shall conform to Federal Safety Color Code requirements.

PART 3 - EXECUTION

3.01 SURFACE PREPARATION:

A. Prepare surfaces for each coating system conforming to SSPC or ASTM surface preparation specifications listed.
1. If grease or oils are present, SSPC-SP1 shall precede any other method specified for metal substrates.
2. Remove surface irregularities such as weld spatter, burrs, or sharp edges prior to specified surface preparation.

B. Depth of profile will be as specified or as recommended by the manufacturer for each system, but in no instance shall it exceed one-third of the total dry film thickness of complete system.
C. Prepare only those areas which will receive the first coat of the system on the same day.
   1. On steel substrates, apply coating before rust bloom forms.

3.02 APPLICATION:
A. Apply coatings in accordance with coating manufacturer's recommendations.
B. Use properly designed brushes, rollers, and spray equipment for all applications.
C. On unprimed surfaces apply first coat of the system the same day as surface preparation.
D. Dry film thickness of each system shall meet the minimum specified. Maximum dry film thickness shall not exceed the minimum more than 20% or coating manufacturer's requirements if less. Where a dry film thickness range is specified, the range shall not be less than or exceeded.
E. Shop and field painting shall remain 3 inches (75mm) away from unprepared surface of any substrate such as areas to be welded or bolted.
F. Environmental Conditions:
   1. Atmospheric temperature must be 50°F (10°C) or higher during application, unless otherwise approved by coating manufacturer. Do not apply coatings when inclement weather or freezing temperature may occur within coating recoat cure times.
   2. Wind velocities for exterior applications shall be at a minimum to prevent overspray or fallout and not greater than coating manufacturer's limits.
   3. Relative humidity must be less than 85%. The ambient temperature and the temperature of the surface to be painted must be at least 5°F (2.8°C) above the dew point.
   4. Provide adequate ventilation in all areas of application to ensure that at no time does the content of air exceed the Threshold Limit Value given on the manufacturer's Material Safety Data Sheets for the specific coatings being applied.
G. Recoat Time: In the event a coating, such as an epoxy, has exceeded its recoat time limit, prepare the applied coating in accordance with manufacturer's recommendations.
H. Protection:
   1. Cover or otherwise protect surfaces not to be painted. Remove protective materials when appropriate.
   2. Mask, remove, or otherwise protect finish hardware, machined surfaces, grilles, lighting fixtures, and prefinished units as necessary.
   3. Provide cover or shields to prevent surface preparation media and coatings from entering orifices in electrical or mechanical Equipment. Where ventilation systems must be kept in operation at time of surface preparation, take precautions to shield intakes and exhausts to prevent the materials from entering system or being dispersed.
   4. Provide signs to indicate fresh paint areas.
   5. Provide daily cleanup of both storage and working areas and removal of all paint refuse, trash, rags, and thinners. Dispose of leftover containers, thinners, rags, brushes, and rollers which cannot be reused in accordance with applicable regulations.
   6. Do not remove or paint over Equipment data plates, code stamps on piping, or UL fire-rating labels.

3.03 INSPECTION:
A. Contractor shall provide and use a wet film gauges to check each application approximately every 15 minutes in order to immediately correct film thickness under or over that specified.
B. Contractor shall provide and use a dry film gauge to check each coat mil (mm) thickness when dry, and the total system mil (mm) thickness when completed.

C. Use holiday or pinhole detector on systems over metal substrates to detect and correct voids when indicated on system sheet.
D. Check air temperature and temperature of the substrate at regular intervals to be certain surface is 5ºF (2.8ºC) or more above the dew point.

3.04 CLEANING AND REPAIRS:

A. Remove spilled, dripped, or splattered paint from surfaces.
B. Touch up and restore damaged finishes to original condition. This includes surface preparation and application of coatings specified.
C. Provide remainder of open paint cans to owner for touch ups.

END OF SECTION 09 90 00

BURNS McDONNELL	PROTECTIVE COATING SYSTEM **System: A-5**

SERVICE:	Steel - Moderate to Severe Exposure (Nonimmersion)
Surface Preparation:	Shop: SSPC-SP6 and profile depth 1.5 to 2.5 mils (38 to 63 microns). Field: SSPC-SP2/3. Clean and dry.
First Coat:	High solids polyamine or polyamide epoxy with minimum 67% solids by volume. Apply at 5.0 to 7.0 mils (125 to 175 microns) dry film thickness.
Second Coat:	High solids aliphatic acrylic polyurethane gloss enamel with minimum 52% solids by volume. Apply at 3.0 to 5.0 mils (75 to 125 microns) film thickness.
System Total:	Minimum 8.0 mils (200 microns) dry film thickness.
Volatile Organic Content:	Maximum 2.8 lb/gal (340 g/L)

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COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
PPG	Amerlock 2 or 400	Same as first coat	Amercoat 450 H
Carboline	Carboguard 890	Same as first coat	Carbothane 134 HG
Tnemec	Hi-Build Epoxoline II, Series N69	Same as first coat	Endura-Shield II, Series 1074
Sherwin-Williams	Macropoxy 646 B58-600/B58V600	Same as first coat	HS Polyurethane B65-300 Series

BURNS McDONNELL	PROTECTIVE COATING SYSTEM **System: B-4**

SERVICE:	Nonferrous & Galvanized Metal — Moderate to Severe Exposure Exterior or Interior (Including Galvanized Handrail)
Surface Preparation:	Shop or field first coat: Remove oil or soap film with neutral detergent or emulsion cleaner.
First Coat:	Pretreat and/or allow to weather as recommended by coating manufacturer.
Second Coat:	High build polyamide or polyamidoamine epoxy with minimum 65% solids by volume. Apply at 4.0 - 6.0 mils (100 -150 microns) dry film thickness.
Third Coat:	High solids aliphatic acrylic polyurethane gloss enamel with minimum 60% solids by volume. Apply at 2.0 – 3.0 mils (50 – 75 microns) dry film thickness.
System Total:	Minimum 6.0 mils (150 microns) dry film thickness in addition to galvanizing.
Volatile Organic Content:	Maximum 2.8 lb/gal (340 g/L).

COATING MANUFACTURER	PRODUCT DESIGNATION			
	FIRST COAT	**TOUCH UP**	**SECOND COAT**	**THIRD COAT**
PPG	See above		Amercoat 385	Amercoat 450 H
Carboline	See above		Carboguard 893 SG	Carbothane 134 HG
Sherwin-Williams	See above		Macropoxy 646 B58-600 Series	HS Polyurethane B65-300 Series
Tnemec	See above		F.C. Typoxy Series 27	Endura-Shield II 1074

BURNS McDONNELL	PROTECTIVE COATING SYSTEM System: D-1

SERVICE: Steel: Potable Water Immersion, Normal Service, Interior of Tank.

Surface Preparation: Shop or Field First Coat: SSPC-SP10 and profile depth of 1.5 to 2.5 mils (38 to 63 microns).
Field Touch-Up (of Shop-applied first coat): Same as for first coat.

First Coat: High solids epoxy phenalkamine coating with minimum 82% solids by volume and be for use with potable water that is NSF 61 product certified including Standard 600. Apply at 12.0 to 18.0 mils (305 to 457 microns) dry film thickness.

Second Coat: None.

System Total: Minimum 12.0 mils (305 microns) dry film thickness. Check for voids with holiday or pinhole detector.

COATING MANUFACTURER	PRODUCT DESIGNATION		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
Tnemec	Epoxoline, Series 21	Same as first coat	

BURNS McDONNELL	**PROTECTIVE COATING SYSTEM** **System: E-1**

SERVICE: Steel & Iron – Nonpotable Liquid Immersion, Normal to Severe Exposure. Interior of Tank or Basin. Exterior of Steel, Piping, or Equipment in Tank or Basin.

Surface Preparation: Shop or Field First Coat: SSPC-SP10 and profile depth of 1.5 to 2.5 mils (38 to 63 microns).
Field Touch-Up (of Shop-applied first coat): Same as for First Coat.

First Coat: High solids amine, polyamidoamine, or polyamide epoxy coating with minimum 67% solids by volume. Apply at 5.0 to 7.0 mils (125 to 175 microns) dry film thickness.

Second Coat: Same as first coat.

System Total: Minimum 10.0 mils (250 microns) dry film thickness. Check for voids with holiday or pinhole detector.

Volatile Organic Content: Maximum 2.8 lb/gal (340 g/L).

COATING MANUFACTURER	**PRODUCT DESIGNATION**		
	FIRST COAT	**TOUCH UP**	**SECOND COAT**
PPG	Amerlock 2 or 400	Same as first coat	Same as first coat
Carboline	Carboguard 890	Same as first coat	Same as first coat
Sherwin-Williams	Macropoxy 646 FC B58W610/B58V600	Same as first coat	Same as first coat
Tnemec	Hi-Build Epoxoline II Series N69	Same as first coat	Same as first coat

BURNS McDONNELL	**PROTECTIVE COATING SYSTEM** **System: F-3**

SERVICE: Concrete, Concrete Masonry Units (CMU) –Severe Exposure (Nonimmersion) Interior

Surface Preparation: Concrete: ASTM D4258. Fill pits in concrete with patching compound as recommended by coating manufacturer.
CMU: ASTM D4261, clean and dry.

First Coat: Concrete: High solids epoxy with minimum 67% solids by volume. Apply at 5.0 to 8.0 mils (0.127 to 0.203 mm) dry film thickness.
CMU: High solids epoxy block filler with minimum 60% solids by volume. Apply at 10.0 to 20.0 mils (0.254 to 0.508 mm) dry film thickness and as required to fill pores.

Second Coat: Concrete & CMU: High solids epoxy with minimum 67% solids by volume. Apply at 5.0 to 8.0 mils (0.127 to 0.203 mm) dry film thickness. Semi gloss or gloss finish.

System Total: Concrete: Minimum 10.0 mils (0.254 mm) dry film thickness.
CMU: Minimum 15.0 mils (0.381mm) dry film thickness.

Volatile Organic Content: Maximum 3.5 lb./gal (425 g/L).

COATING MANUFACTURER	**PRODUCT DESIGNATION**	
	FIRST COAT	**SECOND COAT**
Concrete		
Carboline	Carboguard 890	Carboguard 890
Sherwin-Williams	Macropoxy HS B58W400 Series	Macropoxy HS B58W 400 Series
Tnemec	Hi-Build Epoxoline II Series N69	Hi-Build Epoxoline II Series N69
CMU		
Carboline	Sanitile 600	Carboguard 890
Sherwin-Williams	Kem CatiCoat HS B42W400	Macropoxy HS B58W 400 Series
Tnemec	Epoxy Block Filler WB 1254	Hi-Build Epoxoline II Series N69

DIVISION 10 - SPECIALTIES

SECTION 10 14 01 - SIGNAGE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following:
   1. Interior melamine plastic-laminate room signs.
   2. Cast metal letters and numbers.
   3. Cast metal plaque.

1.02 REFERENCES:

A. Applicable Standards:
   1. Aluminum Association (AA).
   2. American Architectural Manufacturers Association (AAMA):
      a. AAMA 603.8 - Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
   3. American Society for Testing and Materials (ASTM):
      a. A167 - Stainless and Heat-Resisting Chromium-Nickel Steel, Plate, Sheet, and Strip.
      b. B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
      c. B221 - Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      d. B584 - Copper Alloy Sand Castings for General Applications.
      e. D790 - Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
      f. D1003 - Test Method for Haze and Luminous Transmittance of Transparent Plastics.
   4. American National Standards Institute (ANSI):
      a. A117.1 - Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People.
   5. National Association of Architectural Metal Manufacturers (NAAMM).
   6. Underwriters Laboratories Inc. (UL).
   7. Americans with Disabilities Act (AD).
      a. Accessibility Guidelines (AG).

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.
B. Includes, but not limited to, the following:
   1. Product data.
   2. Specifications.
   3. Letter layout, fabrication, and erection details. Show anchorages and accessory items.
   4. Color chips or chart for color and finish selection.
   5. Samples of each color and finish selected.
   6. Full-size spacing templates for individual building-mounted letters and numbers.

1.04 QUALITY ASSURANCE:

A. Uniformity of Manufacturer: For each sign form and graphic image process indicated, furnish products of a single manufacturer.
B. UL Compliance: Provide lighting fixtures and electrical components which are UL-labeled and listed.

1.05 DELIVERY, HANDLING, AND STORAGE:

A. Store off the floor in clean, dry area as packaged by manufacturer.
B. Protect all items from staining and damage.
C. Adequately support all items to prevent warping during storage.

PART 2 - PRODUCTS

2.01 INTERIOR MELAMINE PLASTIC-LAMINATE ROOM SIGNS: RAISED COPY TYPE

A. Plaque material shall consist of melamine plastic laminate 1/8" thick, with contrasting cover color and rated non-static, fire retardant, and self-extinguishing.
B. Raised copy - 1/32" from sign face place and carved or blasted into laminate. Tactile characters/symbols shall be accompanied by Grade 2 braille.
C. Word/number signs shall be 5/8" high lettering on 2" plate with length as required by legend.
D. Letters to be Standard uppercase.
E. Sign border to be 3/8" wide, 1/32" raised, with 1/8" inside radius.
F. Letters and numbers shall be centered on sign. Grade 2 Braille shall be placed directly below last line of letters or numbers, except for room number signs, where they shall be placed directly behind the last number.
G. Word and picture signs shall have the equivalent verbal and braille description placed directly below the picture in raised copy. Picture signs shall be approximately 8" x 8" size.
H. Finish and color combination as selected by Engineer from manufacturer's standards.
I. Mounting system shall be with vinyl tape.
J. Manufacturers:
    1. Best Manufacturing Sign Systems.
    2. Or Engineer approved equal.
K. Word Signs Location
    1. To be mounted 5’ above finished floor, and 6” away from the frame of the door on the latch side of the door.
    2. Potably electrical room – 102
        a. Potable Pump Station side of door 103
    3. Potable control room – 103
        a. Potable Pump Station side of door 104
    4. Reuse electrical room – 202
        a. Reuse Pump Station side of door 203
    5. Reuse control room – 203
        a. Reuse pump station side of door 204

2.02 CAST METAL LETTERS:

A. 3/8” thick medium bronze anodized aluminum
B. Produce characters with smooth, flat faces, sharp corners; and free from pits, scale, sand holes, or other defects.
C. Style: Helvetica Medium as approved by Architect from manufacturer's full assortment of styles.
D. Aluminum Finish: Baked enamel with 5-year guarantee against defects and workmanship.
E. Fabricate for 1/2-inch projected mounting and provide with all fasteners as required for mounting to substrate indicated.
F. Size: Height(s) as indicated on Drawings with manufacturer's standard depth and stroke width.
G. Manufacturers:
    1. Andco Industries Corp.

2. A.R.K. Ramos.
3. Gemini, Inc.
4. Mathews International Corp.
5. Metal Arts, Inc.
6. The Southwell Co.

H. Legend: Reference structural details.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:
1. Install all items level and plumb and at height indicated, with sign surfaces free from distortion or other defects of appearance.
2. Attach all items securely to mounting surface and conform to manufacturer's instructions, unless otherwise indicated.

B. Plastic-Laminate Signs: Mount as indicated on the Drawings.
1. Vinyl Tape Mounting: Use double-sided foam tape to mount signs to smooth, nonporous surfaces. Do not use for vinyl-covered or rough surfaces.
2. Screw Mounting: Use appropriate anchors, screws, and sleeves as required for substrate to be secured to.
3. Bracket-Mounted Units: Use manufacturer's standard brackets, fittings, and hardware for mounting signs which project at right angles from walls and ceilings. Attach brackets and fittings securely to ceilings or walls with concealed fasteners and anchoring devices to comply with manufacturer's directions.
4. Install signs approximately 5'-0" above floor and adjacent to the door entering the room indicated on the sign.
5. Install equipment plates to be readily visible and as determined by Engineer.

C. Signs:
1. Erect plumb and rigid.

D. Cast and Fabricated Metal Letters:
1. Mount letters and numbers using standard fastening methods recommended by manufacturer for letter form, type of mounting, wall construction, and condition of exposure.
2. For projected mounting, mount letters at projection distance from wall surface indicated or specified.
3. Mount in location indicated.

E. Cast Metal Plaque:
1. Install on wall as required by specified mounting system.
2. For concealed mounting, thread studs inserted into tapped lugs on back of plaque and set in predrilled holes filled with quick-setting cement.
3. For face mounting, use exposed fasteners with rosettes attached through face of plaque into wall surface.
4. Mount approximately 5'-0" above floor to centerline of plaque, and in location indicated or as determined by Engineer.

3.02 CLEANING AND PROTECTION:

A. Clean all sign surfaces after installation in accordance with manufacturer's instructions.
B. Touch up any scratched surfaces to match original finish.
C. Repair or replace damaged items as required by Engineer.

SECTION 10 14 01 - SIGNAGE: CONTINUED

END OF SECTION 10 14 01

SECTION 10 44 00 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following:
   1. Portable fire extinguishers.
   2. Fire-protection accessories.

1.02 REFERENCES:

A. American Architectural Manufacturers Association (AAMA):
   1. 603.8 - Voluntary Performance Requirements and Test Procedures for Pigmented Organic Coatings on Extruded Aluminum.
   2. 606.1 - Voluntary Guide Specifications and Inspection Methods for Integrate Color Anodic Finishes for Architectural Aluminum.
   3. 607.1 - Voluntary Guide Specification and Inspection Methods for Clear Anodic Finishes for Architectural Aluminum.
   4. 608.1 - Voluntary Guide Specification and Inspection Methods for Electrolytically Deposited Color Anodic Finishes for Architectural Aluminum.
B. International Fire Code.
C. National Association of Architectural Metal Manufacturers (NAAMM):
   1. Metal Finishes Manual for Architectural and Metal Products.
D. National Fire Protection Association (NFPA):
   1. 10 - Standard for Portable Fire Extinguishers.
E. Underwriter's Laboratory (UL):
   1. Fire Protection Equipment Directory.

1.03 SUBMITTALS:

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire-protection specialties.
   1. Fire Extinguishers: Include rating and classification.
B. Iron and Steel products must be produced in the United States and certifications of such production must be provided to the Owner prior to shipment.

1.04 QUALITY ASSURANCE:

A. Source Limitations: Obtain fire extinguishers through one source from a single manufacturer.
B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Standard for Portable Fire Extinguishers."
C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
   1. Provide extinguishers listed and labeled by FM.
   2. Provide UL listed or FM approved fire extinguishers.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Portable Fire Extinguishers:
      a. Amerex Corporation.
      b. Ansul Incorporated.

c. Badger; div. of Figgie Fire Protection Systems.
d. Buckeye Fire Equipment Company.
e. Fire-End & Croker Corporation.
f. General Fire Extinguisher Corporation.
g. J.L. Industries, Inc.
h. Kidde: Walter Kidde, The Fire Extinguisher Co.
i. Larsen's Manufacturing Company.
j. Modern Metal Products; div. of Technico.
k. Moon/American, Inc.
l. Pem All; div. of Pem Systems, Inc.
m. Potter-Roemer; div. of Smith Industries, Inc.
n. Samson Products, Inc.
o. Watrous; div. of American Specialties, Inc.

2.02 PORTABLE FIRE EXTINGUISHERS:

A. General: Provide fire extinguishers of type, size, and capacity for each cabinet and other locations indicated.
B. FE-1: Multipurpose Dry-Chemical Type Extinguisher:
1. UL or FM-rated 2-A:10:B:C, 10-lb. (4.5-kg) nominal capacity, in enameled-steel container.
C. FE-2: Clean Agent Type Extinguisher:
1. UL or FM-rated 5-B:C, 10-lb. (4.5-kg) nominal capacity, in enameled-steel container.

2.03 ACCESSORIES:

A. Mounting Brackets: Manufacturer's standard steel, designed to secure extinguisher, of sizes required for types and capacities of extinguishers indicated, with plated or baked-enamel finish.
1. Provide brackets for extinguishers.
B. Identification: Provide lettering to comply with authorities having jurisdiction for letter style, color, size, spacing, and location. Locate as indicated by Engineer/Architect.
1. Identify bracket-mounted extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to wall surface.
2. Provide single or double sided wall signage similar to SETON #21999 OR #22001.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine fire extinguishers for proper charging and tagging.
1. Remove and replace damaged, defective, or undercharged units.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Comply with manufacturer's written instructions for installing fire-protection specialties.
B. Install in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.
1. Fasten mounting brackets to structure, square and plumb.
2. Mount wall signage above each fire extinguisher with clear maximum vision.
3. Provide service tag on extinguisher after field inspection.

3.03 ADJUSTING, CLEANING, AND PROTECTION:

A. Provide final protection and maintain conditions that ensure that fire extinguishers are without damage or deterioration.

END OF SECTION 10 44 00

SECTION 10 44 50 - IDENTIFICATION OF PIPING AND VALVES WITH MARKERS AND TAGS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the identification of piping with pipe markers and valves with tags.

1.02 REFERENCES:

A. American National Standards Institute (ANSI):
   1. A13.1 - Scheme for the Identification of Piping Systems.

1.03 SUBMITTALS:

A. Submit required documents for information or approval as described in SECTION 01 33 00-SUBMITTALS.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. W. H. Brady Company.
B. Seton Company.

2.02 IDENTIFICATION OF PIPING AND VALVES:

A. Materials for Pipe Markers: Based upon W. H. Brady Company pressure-sensitive type markers.
   1. Brady B-500 vinyl for general purpose use, with specified legend.
   2. Banding Tape: Brady self-sticking banding tape of material same as markers, solid colors, 2 -inch width.
   3. Arrows: Same material as worded markers.

B. Valve Tags:
   1. Valve Tags: Valve supplier shall provide phenolic plastic ID tags stamped with valve number for all valves. Tag shall be as specified below. Tag shall be easily removable and shall be mounted so as not to interfere with normal valve operations. Valve number shall be as identified in the valve schedule.
      a. Materials and Fabrication Tagging:
         (1) Supplier shall provide project specific tagging to identify Equipment supplied by the tag number as identified on the Project Piping and Instrumentation Diagrams (P&IDs). At a minimum, tags will include tag number, item description, and P&ID number.
            (a) Phenolic plastic tags shall be furnished for field instrumentation, process valves, and other small decives that a plant operator is not likely to have any direct interface with.
            (b) Phenolic plastic tags shall be permanently attached to the Equipment with stainless steel pan-head screws, rivets, or drive screws. Stainless steel wire or chains amy only be used with Purchaser’s approval.
            (c) Equipment tags shall be minimum of 1-1/4 inch by 2-1/2 inches and include the device identification number.
            (d) Lettering shall be electro/laser etched or engraved , with text at least 3/16 inch in height. Text shall be sized as large as possible within the size constraints of the tag.

(e) Separate nameplates are not required for pressure indicators. They may be provided instead with nameplate information, as described above, permanently engraved on the faces. Face engraving text size and layout shall be readable without magnification.

2. Vault or Pit Installed Valves:
   a. In addition to valve tag, provide a cast bronze floor plate to be anchored into the top concrete slab of pit or valve adjacent to the floor box or floor stand. Plate shall be minimum of 4”x3”x3/16”. Valve number shall be engraved in plate with minimum letter height of 1 ½”. Plate will be anchored into concrete using threaded lugs with split stud anchor or other suitable anchoring device by others. Valve number shall be as identified in the valve schedule.

C. Sizing of Pipe Markers, Arrows, and Bands:
   1. Conform to ANSI A13.1 as a minimum for legend letter size and length of color field based upon outside diameter of pipe or covering, if applicable.
   2. Size of arrows and band width shall be coordinated with pipe marker and letter size, and also be based upon outside diameter of pipe or covering, if applicable.

D. Pipe Legend and Color Coding:
   1. Basic color identification and labeling shall conform to ANSI A13.1.
   2. Legend designation shall be in black or white letters with appropriate background color. Wrap band full circumference of pipe at each end of legend. Provide arrows with single or double head to indicate direction of flow.

2.03 PIPE COATING IDENTIFICATION COLORS:

A. Coat and label pipes with colors specified in Table 1 and as approved by the Engineer. Band and Label all above grade pipe as specified in 2.02 and according to ANSI A13.1.

Table 1. Pipe Summary Table

Location	Coating Color	Lettering Color
Finished Water	Dark Blue	White
Reuse Water	Purple	White

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean area of surface to receive label or other pressure-sensitive item free of oil, grease, dust, dirt, or other substances which would affect adhesion.

B. On painted surface, install label only after coating system is complete and dry.

3.02 LOCATIONS:

A. Piping Labels:

1. Use proper label type suitable for exterior location as applicable.
2. Locate labels and banding on piping near connections to equipment, adjacent to valves or fittings, on both sides of walls penetrated, and at intervals not to exceed 50 feet. Band both ends of labels around circumference of pipes so that banding ends overlap.
3. For piping with arrows, indicate direction of flow. Place arrows adjacent to or below labels, depending upon visibility.
4. For piping with cold weather insulation, placement of labels shall be on the oustide of the insluation jackets.
5. Locate legends and arrows to be visible from normal line of vision above floor or grade level.
6. Replace labels and banding which do not adhere properly.

B. Tags:

1. Install in applicable locations.
2. Attach securely to unit so as not to be easily removed.
3. Locate tags to be visible from normal line of vision above floor or grade level.

END OF SECTION 10 44 50

SECTION 12 35 53 - LABORATORY CASEWORK AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes laboratory countertops, sinks, related accessories, and service fixtures normally furnished by laboratory furniture manufacturer. Service fixtures are to be supplied and installed as part of Work of this Section, including internal piping and wiring up to designated point of supply connection, as indicated on Drawings. Supply connections are specified in DIVISIONS 23 and 26, respectively.

B. Related Work Specified Elsewhere:

1. Lab cabinetry and sink as scheduled on drawings.

1.03 REFERENCES:

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
    a. A366 - Steel, Carbon, Cold-Rolled Sheet, Commercial Quality.
    b. C1036 - Specification for Flat Glass.
    c. D543 - Resistance of Plastics to Chemical Reagents.
    d. D695 - Compressive Properties of Rigid Plastics.
    e. D785 - Rockwell Hardness of Plastics.
    f. D790 - Flexural Properties of Plastics.
2. American Iron and Steel Institute (AISI).

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Includes, but not limited to, the following:

1. Product data, including Specifications and installation instructions for each type of laboratory furniture unit and accessory.
2. Include certification that applied finish complies with specified chemical- and physical-resistance requirements.
3. Shop Drawings for laboratory furniture showing plans, elevations, ends, cross sections, service spaces, and location and type of service fixtures with lines thereto. Include details and location of anchorages and fitting to floors, walls, and base. Include layout of units with surrounding walls, doors, windows, and other building components.
4. Samples: Color charts or chips for color selection of laboratory furniture, tops, and accessories. Submit 6-inch by 6-inch Samples of selected finishes, including top material.

1.05 QUALITY ASSURANCE:

A. Single-Source Responsibility: Provide laboratory casework with tops, sinks, and service fixtures, manufactured or furnished by same laboratory furniture company for single responsibility.

B. Catalog Standards:

1. Manufacturer's catalog numbers are indicated on Drawings for convenience in identifying certain laboratory cabinet work. Unless modified by notation on the Drawings or

otherwise specified, the catalog description for the indicated number constitutes the requirements for each such cabinet.

2. The use of catalog numbers and the specific requirements set forth on Drawings and in Specifications are not intended to preclude the use of any other acceptable manufacturer's product or procedure which may be equivalent, but are given for the purpose of establishing a standard of design and quality for materials, construction, and workmanship.

C. Supervision: Manufacturer or manufacturer's authorized agent shall install and supervise installation of laboratory furniture and equipment.

1.06 STORAGE AND HANDLING:

A. Protect finished surfaces from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.

1.07 WARRANTY

A. The Manufacturer shall warrant that all lab casework and accessories shall be free from defects caused by faulty material or workmanship for a minimum period of one (1) year from the date of Substantial Completion, unless otherwise specified.

B. Warranties shall comply with the requirements of Section 01 78 36.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Duralab Equipment Corporation.

B. Kewaunee Scientific Corporation.

1. Zack Sutton
   (913) 432-3363
   Zack@innovlab.com
   www.innovlab.com

C. Mott Manufacturing Ltd.

2.02 CASEWORK, GENERAL:

A. Casework Product Standard: Comply with SEFA 8 M, "Laboratory Grade Metal Casework."

B. System Structural Performance: Laboratory casework and support framing system shall withstand the effects of the following gravity loads and stresses without permanent deformation, excessive deflection, or binding of drawers and doors:

1. Support Framing System: 600 lb./ft. (900 kg/m).
2. Suspended Base Cabinets (Internal Load): 160 lb./ft. (240 kg/m).
3. Work Surfaces (Including Tops of Suspended Base Cabinets): 160 lb./ft. (240 kg/m).
4. Wall Cabinets (Upper Cabinets): 160 lb./ft. (240 kg/m).
5. Shelves: 40 lb./sq. ft. (200 kg/sq. m).

2.03 METAL CABINET MATERIALS:

A. Metal: Cold-rolled, commercial steel (CS) sheet, complying with ASTM A1008/A1008M; matte finish; suitable for exposed applications.

B. Nominal Metal Thickness:

1. Sides, Ends, Fixed Backs, Bottoms, Tops, Soffits, and Items Not Otherwise Indicated: 0.048 inch (1.21 mm). Except for flammable liquid storage cabinets, bottoms may be 0.036 inch (0.91 mm) if reinforced.

2. Back Panels, Doors, Drawer Fronts and Bodies, and Shelves: 0.036 inch (0.91 mm) except 0.048 inch (1.21 mm) for back panels and doors of flammable liquid storage cabinets and for unreinforced shelves more than 36 inches (900 mm) long.
3. Intermediate Horizontal Rails, Table Aprons and Cross Rails, Center Posts, and Top Gussets: 0.060 inch (1.52 mm).
4. Drawer Runners, Sink Supports, and Hinge Reinforcements: 0.075 inch (1.90 mm).
5. Leveling and Corner Gussets: 0.105 inch (2.66 mm).

2.04 METAL CABINET FINISH:

A. General: Prepare, treat, and finish welded assemblies after assembling. Prepare, treat, and finish components that are to be assembled with mechanical fasteners before assembling. Prepare, treat, and finish concealed surfaces same as exposed surfaces.
B. Preparation: After assembly, clean surfaces of mill scale, rust, oil, and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it.
C. Chemical-Resistant Finish: Immediately after cleaning and pretreating, apply laboratory casework manufacturer's standard two-coat, chemical-resistant, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils (0.05 mm).
   1. Chemical and Physical Resistance of Finish System: Finish complies with acceptance levels of cabinet surface finish tests in SEFA 8 M. Acceptance level for chemical spot test shall be no more than four Level 3 conditions.
   2. Colors for Metal Laboratory Casework Finish: As selected by Architect from manufacturer's full range.

2.05 HARDWARE:

A. General: Provide laboratory casework manufacturer's standard, commercial-quality, heavy-duty hardware complying with requirements indicated for each type.
B. Hinges: Stainless-steel, five-knuckle hinges complying with BHMA A156.9, Grade 1, with antifriction bearings and rounded tips. Provide two for doors 48 inches (1200 mm) high or less and three for doors more than 48 inches (1200 mm) high.
C. Hinged Door and Drawer Pulls: Stainless-steel back-mounted pulls. Provide two pulls for drawers more than 24 inches (600 mm) wide.
   1. Design: As selected from manufacturer's full range.
   2. Overall Size: As selected from manufacturer's full range.

2.06 FABRICATION:

A. Tops, Sinks, and Related Components:
   1. Fabricate with smooth, clean, exposed tops and edges, in uniform plane, free of defects. Make exposed edges and corners uniformly rounded.
   2. Furnish tops in maximum practicable lengths.

2.07 TOPS, SINKS, AND RELATED COMPONENTS:

A. General:
   1. Furnish the following items and materials specified:
      a. Table tops, box curbs, backsplashes.
      b. Sinks.
   2. Maintain top thickness with tolerance not exceeding ±1/32 inch. Provide front and end overhang of 1 inch over base cabinets except where cabinet abuts wall, formed with

continuous drip groove under surface 1/2 inch from edge. Provide 1/4-inch radius along exposed top edge and at exposed corners.

3. Sink Outlets: Reference SECTION 22 42 16.13 – COMMERCIAL LAVATORIES and plumbing drawings for bottom drain connection and strainer, fabricated of same material as sink wherever possible, or as otherwise acceptable to Engineer/Architect.
4. Overflows: Furnish for sinks, except cup sinks, of standard beehive or open-top type with separate strainer. Height 2 inches less than sink depth. Of same material as sink.

B. Material: Cast epoxy resin.
1. May be 1 inch thick in lieu of 1-1/4 inch.
2. Factory-molded tops of modified epoxy-resin formulation, uniform mixture throughout full thickness. Color, nonglaring black.
3. Physical Properties:
   a. Flexural Strength (ASTM D790): 4,000 psi.
   b. Compressive Strength (ASTM D695): 14,000 psi.
   c. Hardness, Rockwell M (ASTM D785): 197.
   d. Water Absorption in 24 Hours: 0.05% by weight.
   e. Heat Distortion Point: 400ºF.
4. Chemical Resistance: Test of following reagents in standard laboratory concentrations, in accordance with ASTM D543, entirely unaffected or slight dulling of finish. Chemical resistance shall be from glacial acetic acid, hydrochloric acid, nitric acid, phosphoric acid, sulfuric acid, chromic acid, ammonium hydroxide, calcium hypochlorite, sodium hydroxide, acetone, amyl acetate, aqua regia, benzene, butyl alcohol, ethyl acetate, ethyl alcohol, ethyl ether, formaldehyde, hydrogen peroxide, methyl alcohol, methyl ethyl ketone, kerosene, phenol, silver nitrate, trichlorethylene, xylene, and zinc chloride.
5. Workmanship: Cast surfaces very smooth, with factory cutouts for sinks and drip grooves. Plain butt-type joints assembled with epoxy adhesive and prefitted, concealed metal spline.
6. Products:
   a. Provide cast epoxy-resin units as manufactured by one of the following:
      (1) Fisher-Hamilton - Modified Epoxy Resin.
      (2) Kewaunee - Kemresin.
      (3) Or engineer approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas, with Installer present, for compliance with requirements for installation tolerances, location of reinforcements, and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF CABINETS:

A. Comply with installation requirements in SEFA 2.3. Install level, plumb, and true; shim as required, using concealed shims. Where laboratory casework abuts other finished work, apply filler strips and scribe for accurate fit, with fasteners concealed where practical. Do not exceed the following tolerances:
1. Variation of Tops of Base Cabinets from Level: 1/16 inch in 10 feet (1.5 mm in 3 m).
2. Variation of Bottoms of Upper Cabinets from Level: 1/8 inch in 10 feet (3 mm in 3 m).
3. Variation of Faces of Cabinets from a True Plane: 1/8 inch in 10 feet (3 mm in 3 m).
4. Variation of Adjacent Surfaces from a True Plane (Lippage): 1/32 inch (0.8 mm).

5. Variation in Alignment of Adjacent Door and Drawer Edges: 1/16 inch (1.5 mm).

B. Utility-Space Framing: Secure to floor with two fasteners at each frame. Fasten to partition framing, wood blocking, or metal reinforcements in partitions and to base cabinets.

C. Base Cabinets: Fasten cabinets to utility-space framing, partition framing, wood blocking, or reinforcements in partitions, with fasteners spaced not more than 16 inches (400 mm) o.c. Bolt adjacent cabinets together with joints flush, tight, and uniform.
   1. Where base cabinets are installed away from walls, fasten to floor at toe space at not more than 24 inches (600 mm) o.c. and at sides of cabinets with not less than two fasteners per side.

D. Wall Cabinets: Fasten to hanging strips, masonry, partition framing, blocking, or reinforcements in partitions. Fasten each cabinet through back, near top, at not less than 16 inches (400 mm) o.c.

E. Install hardware uniformly and precisely. Set hinges snug and flat in mortises.

F. Adjust laboratory casework and hardware so doors and drawers align and operate smoothly without warp or bind and contact points meet accurately. Lubricate operating hardware as recommended by manufacturer.

3.03 INSTALLATION OF COUNTER TOPS:

A. Tops:
   1. Comply with installation requirements in SEFA 2.3. Abut top and edge surfaces in one true plane with flush hairline joints and with internal supports placed to prevent deflection. Locate joints only where indicated on Shop Drawings.
   2. Where practicable, make field jointing in same manner as factory jointing using dowels, splines, adhesives, and fasteners recommended by manufacturer. Locate field joints as shown on accepted Shop Drawings, so that there is no Job Site processing of top and edge surfaces.
   3. Abut top and edge surfaces in one true plane with internal supports placed to prevent any deflection. Provide flush hairline joints in top units.
   4. Provide all holes and cutouts as required for mechanical and electrical service fixtures.
   5. Where necessary to penetrate tops with fasteners, countersink heads approximately 1/8 inch and plug hole flush with material equal in chemical resistance, color, hardness, and texture to top surface.
   6. After installation, carefully dress joints smooth, remove any surface scratches, clean and polish entire surface.
   7. Provide scribe mouldings for closures at junctures of top, curb, and splash with walls as recommended by manufacturer for materials involved. Use chemical-resistant, permanently elastic sealing compound where recommended by manufacturer.
   8. Secure epoxy countertops to cabinets with epoxy cement, applied at each corner and along perimeter edges at not more than 48 inches (1200 mm) o.c.

B. Sinks:
   1. Comply with installation requirements in SEFA 2.3.
   2. Underside Installation: Use manufacturer's recommended adjustable support system for table-type and cabinet-type installations.
      a. Set top edge of sink unit in sink and countertop manufacturers' recommended chemical-resistant sealing compound or adhesive, and firmly secure to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement. Remove excess sealant or adhesive while still wet and finish joint for neat appearance.

3. Set top edge of sink unit firmly pressed to countertop, set in manufacturer's recommended chemical-resistant sealing compound to produce a tight and fully leakproof joint. Adjust sink and securely support to prevent movement.

C. Hardware: Adjust hardware so that doors and drawers operate properly and smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer. Replace any missing or damaged hardware to match existing.

D. Service Fixtures: Install mechanical and electrical service fixtures securely to curb, top, or where indicated. Install to uniform appearance and ease of operation. Adjust to operate properly.

3.04 CLEANING AND PROTECTION:

A. Repair or remove and replace defective work with new equipment or material.

B. Clean finished surfaces, touch up as required, and remove or refinish damaged or soiled areas as acceptable to the Engineer/Architect.

C. Protect laboratory furniture from damage by the Work of other trades until acceptance of the Work.

END OF SECTION 12 35 53

DIVISION 13 – SPECIAL CONSTRUCTION

SECTION 13 08 41 – WATER STORAGE TANK CLEANING, DISINFECTION AND TESTING

PART 1 - GENERAL

1.01 SUMMARY:

A. This section will govern the cleaning and testing of the tank. All appurtenant operations involving cleaning, disinfection and testing shall be done in strict conformance with the drawings and other terms and conditions of the Contract. All standard specifications made a portion of these Specifications by reference shall be the latest edition and revision thereof.

B. It is the intent of this Specification to be in conformance with AWWA C652 and all local, State, and Federal standards. In the event a conflict occurs between this Specification and AWWA C652 and/or the local, State, or Federal regulation, AWWA C652 or the local, State, or Federal regulation shall in all cases prevail.

1.02 SUBMITTALS:

A. Submit prints as specified in Section 01 33 00.

1.03 REFERENCES:

A. American Water Works Association (AWWA)
   1. C652 – Disinfection of Water Storage Facilities
   2. C655 – Field Dechlorination

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General: Materials used in the Work shall conform and meet the requirements of the class and type of material named.

B. Forms of Chlorine: The forms of chlorine that may be used in the disinfecting of the tank are:
   1. Liquid chlorine
   2. Sodium hypochlorite solution
   3. Calcium hypochlorite granules or tablets

PART 3 - EXECUTION

3.01 WATER AVAILABILITY:

A. Water for disinfection and water tightness test shall be provided by Owner

B. The Owner will provide for one time filling of the tank. Any other water required shall be at the expense of the Contractor.

C. Contractor shall submit procedures to measure volume of water used for disinfection to Engineer for approval.

D. Contractor shall record and submit documentation of the volume of used water to Owner and Engineer.

3.02 CLEANING:

A. The tank shall be cleaned upon completion.

B. Water used for cleaning shall be potable water.

C. All scaffolding, tools, and any other material that is not part of the structure of operating facility of the tank shall be removed. After the Engineer has inspected the tank, the floor shall

be swept clean, and the surfaces of the walls, floor and roof cleaned thoroughly using a high-pressure (200 psi or higher) water jet. All water, dirt, and foreign material accumulated in these cleaning operations shall be discharged through the floor drain or otherwise removed. The inlet and outlet pipe shall be capped to prevent entry of dirt and foreign matter during the cleaning operations.

D. Following cleaning, the vent screens shall be checked for correct placement to prevent birds, insects and other contaminants from entering the facility. The hatches shall be kept closed after cleaning and locked during non-working hours.

3.03 DISINFECTION:

A. Perform disinfection after cleaning and concrete structure is complete and capable of resisting the hydrostatic pressure of the water test. The concrete shall have achieved its full design strength (28 days minimum).

B. After the cleaning operations are complete, Engineer shall review the tank prior to disinfection procedure. After Engineer's review of tank cleaning, Contractor shall disinfect the tank in accordance with AWWA C652, Chlorination Method 2.

C. A solution of 200 mg/L available chlorine shall be applied directly to all the surfaces of the tank, including the floor, walls, underside of roof, and exposed piping such as the overflow piping and tank mixing system.

D. The chlorine solution shall be applied by spray equipment, and shall thoroughly coat all surfaces, and shall be applied to any separate draining piping such that it will have available chlorine of not less than ten (10) mg/L when filled with water.

E. The disinfected surfaces shall remain in contact with the strong chlorine solution for at least thirty (30) minutes, after which time potable water may be added into the tank, the drain pipeline purged of the ten (10) mg/L chlorinated water, and the tank filled to within six (6) inches of the overflow.

F. Prior to discharge to the environment, all chlorinated water shall be dechlorinated in accordance with AWWA C655. Contractor is required to obtain any associated discharge permits through CDPHE prior to discharge.

G. Following this procedure, the water quality shall be subjected to bacteriological testing in accordance with AWWA C652, Section 5.1.

END OF SECTION 13 08 41

DIVISION 22 – PLUMBING

SECTION 22 05 13 – COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small, and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):

1. IEEE 841 - Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and including 500 hp.

C. National Electrical Manufacturers Association (NEMA):

1. NEMA MG 1 - Motors and Generators.

1.04 COORDINATION:

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.
2. Torque, speed, and horsepower requirements of the load.
3. Ratings and characteristics of supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:

A. Comply with requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.02 MOTOR CHARACTERISTICS:

A. Duty: Continuous duty at ambient temperature of 40ºC and at altitude of 3,300 ft. above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS:

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.
D. Multispeed Motors: Variable torque.
   1. For motors with 2:1 speed ratio, consequent pole, single winding.
   2. For motors with other than 2:1 speed ratio, separate winding for each speed.
E. Multispeed Motors: Separate winding for each speed.
F. Rotor: Random-wound, squirrel cage.
G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust
H. Temperature Rise: Match insulation rating.
I. Insulation: Class F.
J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS:

A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
B. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS:

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 22 05 13

SECTION 22 05 17 – SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Sleeves.
   2. Stack-sleeve fittings.
   3. Sleeve-seal systems.
   4. Grout.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASTM International (ASTM):
      a. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      b. ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.04 SUBMITTALS:

A. Product data: For each type of product indicated.

PART 2 - PRODUCTS

2.01 SLEEVES:

A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.
B. Galvanized-Steel Wall Pipes: ASTM A53, Schedule 40, with plain ends and welded steel collar; zinc coated.
C. Galvanized-Steel-Pipe Sleeves: ASTM A53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.02 STACK-SLEEVE FITTINGS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Smith, Jay R. Mfg. Co.
   2. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
   3. Or Engineer Approved Equal.
B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.

2.03 SLEEVE-SEAL SYSTEMS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Metraflex Company (The).
   2. Link-Seal.
   3. Or Engineer Approved Equal.

B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
   1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.04 GROUT:

A. Standard: ASTM C1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
B. Characteristics: Nonshrink; recommended for interior and exterior applications.
C. Design Mix: 5,000-psi, 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.01 SLEEVE INSTALLATION:

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1 inch annular clear space between piping and concrete slabs and walls.
   1. Sleeves are not required for core-drilled holes.
C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
   2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
D. Install sleeves for pipes passing through interior partitions.
   1. Cut sleeves to length for mounting flush with both surfaces.
   2. Install sleeves that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.
   3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07.
E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07.

3.02 STACK-SLEEVE-FITTING INSTALLATION:

A. Install stack-sleeve fittings in new slabs as slabs are constructed.
   1. Install fittings that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.
   2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Division 07.
   3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.

4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack-sleeve fittings.

3.03 SLEEVE-SEAL-SYSTEM INSTALLATION:

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 SLEEVE AND SLEEVE-SEAL SCHEDULE:

A. Use sleeves and sleeve seals for the following piping-penetration applications:
   1. Exterior Concrete Walls above Grade:
      a. Piping Smaller than NPS 6: Galvanized-steel wall sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves.
   2. Exterior Concrete Walls below Grade:
      a. Piping Smaller than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
         (1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
   3. Concrete Slabs-on-Grade:
      a. Piping Smaller than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system.
         (1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
      b. Piping NPS 6 and Larger: Galvanized-steel wall sleeves with sleeve-seal system.
         (1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve-seal system.
   4. Concrete Slabs above Grade:
      a. Piping Smaller than NPS 6: PVC-pipe sleeves, Sleeve-seal fittings.
      b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves, PVC-pipe sleeves.
   5. Interior Partitions:
      a. Piping Smaller than NPS 6: Galvanized-steel-pipe sleeves, PVC-pipe sleeves.
      b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

END OF SECTION 22 05 17

SECTION 22 05 19 – METERS AND GAUGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section Includes:
   1. Gauge attachments.
   2. Test plugs.
   3. Test-plug kits.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME B1.1 - Unified Inch Screw Threads, UN and UNR Thread Form.
      b. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      c. ASME B40.100 - Pressure Gauges and Gauge Attachments.
      d. ASME B40.200 - Thermometers, Direct Reading and Remote Reading.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Product Certificates: For each type of meter and gauge, from manufacturer.
C. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.01 GAUGE ATTACHMENTS:

A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads and piston-type surge-dampening device. Include extension for use on insulated piping.
B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2 (DN 8 or DN 15), ASME B1.20.1 pipe threads.

2.02 TEST PLUGS:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flow Design, Inc.
   2. Miljoco Corporation.
   3. National Meter, Inc.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Trerice, H. O. Co.
   7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   8. Weiss Instruments, Inc.
B. Description: Test-station fitting made for insertion into piping tee fitting.
C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.
E. Minimum Pressure and Temperature Rating: 500 psig at 200ºF (3450 kPa at 93ºC).
F. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.03 TEST-PLUG KITS:

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Flow Design, Inc.
   2. Miljoco Corporation.
   3. National Meter, Inc.
   4. Peterson Equipment Co., Inc.
   5. Sisco Manufacturing Company, Inc.
   6. Trerice, H. O. Co.
   7. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
   8. Weiss Instruments, Inc.
B. Furnish one test-plug kit(s) containing one thermometer, one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch (25- to 51-mm) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220ºF (-18 to +104ºC).
D. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch (51- to 76-mm) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).
E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install valve and snubber in piping for each pressure gauge for fluids.
B. Install test plugs in piping tees.

3.02 CONNECTIONS:

A. Install meters and gauges adjacent to machines and equipment to allow service and maintenance of meters, gauges, machines, and equipment.

END OF SECTION 22 05 19

SECTION 22 05 23 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Bronze ball valves.
   2. Bronze swing check valves.

B. Related Sections:
   1. Division 22 Plumbing Piping Sections for specialty valves applicable to those sections only.
   2. Division 33 Water Distribution Piping Sections for general-duty and specialty valves for site construction piping.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME B1.20.1 - Pipe Threads, General Purpose (Inch).
      b. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
      c. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves.
      d. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
      e. ASME B16.34 - Valves - Flanged, Threaded, and Welding End.
      f. ASME B31.9 - Building Services Piping.
   2. ASTM International (ASTM):
      a. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. ASTM A536 - Specification for Ductile Iron Castings.
      c. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications
   3. Manufacturers Standardization Society of The Valve and Fittings Industry, Inc. (MSS):
      a. MSS SP-45 - Bypass and Drain Connections.
      b. MSS SP-67 - Butterfly Valves.
      c. MSS SP-70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
      d. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
      e. MSS SP-110 - Ball Valves, Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
   4. NSF International (NSF):
      a. NSF 61 - Drinking Water System Components - Health Effects.
      b. NSF 372 - Drinking Water System Components - Lead Content.

1.04 DEFINITIONS:

A. CWP: Cold working pressure.
B. EPDM: Ethylene propylene copolymer rubber.
C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
D. NRS: Nonrising stem.
E. OS&Y: Outside screw and yoke.
F. RS: Rising stem.

G. SWP: Steam working pressure.

1.05 SUBMITTALS:

A. Product Data: For each type of valve indicated.

1.06 QUALITY ASSURANCE:

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES:

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping, unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Hand lever: For quarter-turn valves NPS 6 and smaller.
4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Solder Joint: With sockets according to ASME B16.18.
3. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.02 SILICON BRONZE BALL VALVES:

A. Two-Piece, Regular-Port, Silicon Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. NIBCO INC.
d. Milwaukee Valve Company.
e. Or Engineer Approved Equal.
2. Description:
a. Standard: MSS SP-110.
b. Maximum Pressure/Temperature Rating: 100 psig at 300ºF.
c. CWP Rating: 600 psig.
d. Body Design: Two piece.
e. Body Material: Bronze.
f. Ends: Threaded or Solder.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.
i. Ball: Stainless steel.
j. Port: Regular.

2.03 SILICON BRONZE SWING CHECK VALVES:

A. Class 125, Silicon Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Crane Co.; Crane Valve Group; Crane Valves.
b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Crane Co.; Crane Valve Group; Stockham Division.
d. Milwaukee Valve Company.
e. NIBCO INC.
f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
g. Or Engineer Approved Equal.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 200 psig.
c. Body Design: Horizontal flow.
d. Body Material: ASTM B584, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
B. Operate valves in positions from fully open to fully close. Examine guides and seats made accessible by such operations.
C. Examine threads on valve and mating pipe for form and cleanliness.
D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
E. Do not attempt to repair defective valves; replace with new valves.

3.02 VALVE INSTALLATION:

A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
B. Locate valves for easy access and provide separate support where necessary.
C. Install valves in horizontal piping with stem at or above center of pipe.
D. Install valves in position to allow full stem movement.
E. Install chainwheels on operators for valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.
F. Install check valves for proper direction of flow and as follows:
    1. Swing Check Valves: In horizontal position with hinge pin level.

3.03 ADJUSTING:

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS:

A. If valve applications are not indicated, use the following:
    1. Shutoff Service: Ball, butterfly, or gate valves.
    2. Pump-Discharge Check Valves:
        a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
C. Select valves, except wafer types, with the following end connections:
    1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
    2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
    3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
    4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
    5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
    6. For Steel Piping, NPS 5 and Larger: Flanged ends.
    7. For Grooved-End [Copper Tubing] [and] [Steel Piping]: Valve ends may be grooved.

3.05 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE:

A. Pipe NPS 2 and Smaller:
    1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
    2. Ball Valves: Two-piece, regular port, bronze with stainless-steel trim.

3. Bronze Swing Check Valves: Class 125, nonmetallic disc.

B. Pipe NPS 2-1/2 and Larger:
   1. Iron, Lug Type Butterfly Valves: 200 CWP, EPDM seat, stainless-steel disc.

END OF SECTION 22 05 23

SECTION 22 05 29 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Metal pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe positioning systems.

1.03 RELATED REQUIREMENTS:

1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   2. American Welding Society (AWS):
      a. AWS D1.1 - Structural Welding Code - Steel.
   3. ASME International (ASME):
      a. ASME B31.9 - Building Services Piping.
      b. 2007 ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   4. ASTM International (ASTM):
      a. ASTM A36 - Specification for Carbon Structural Steel.
      b. ASTM A780 - Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      c. ASTM C533 - Specification for Calcium Silicate Block and Pipe Thermal Insulation.
      d. ASTM C552 - Specification for Cellular Glass Thermal Insulation.
      e. ASTM C591 - Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
      f. ASTM C1107 - Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   5. The International Association of Plumbing and Mechanical Officials (IAPMO):
      a. IAPMO PS 42 - Pipe Alignment and Secondary Support Systems.
   6. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
      a. MSS SP-58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
      b. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
      c. MSS SP-89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
   7. Metal Framing Manufacturers Association, Inc. (MFMA):
      a. MFMA-4 - Metal Framing Standards Publication.
      b. MFMA-103 - Guidelines for the Use of Metal Framing.

8. The Society for Protective Coatings (SSPC):
   a. SSPC-PA 1 - Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel.

1.05 DEFINITIONS:

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry, Inc.

1.06 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
   1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
   2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   3. Design seismic-restraint hangers and supports for piping and equipment[and obtain approval from authorities having jurisdiction].

1.07 SUBMITTALS:

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following: include Product Data for components:
   1. Trapeze pipe hangers.
   2. Metal framing systems.
   3. Pipe stands.

C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Detail fabrication and assembly of trapeze hangers.
   2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS:

A. Carbon-Steel Pipe Hangers and Supports:
   1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - EXECUTION), factory-fabricated components.
   2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
   3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
   4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
   5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58 (except as noted in PART 3 - EXECUTION), factory-fabricated components.
2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.

2.02 TRAPEZE PIPE HANGERS:

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 METAL FRAMING SYSTEMS:

A. MFMA Manufacturer Metal Framing Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cooper B-Line, Inc.
b. Flex-Strut Inc.
c. Powerstrut Corp.
d. Unistrut Corporation; Tyco International, Ltd.
e. Or Engineer Approved Equal.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
7. Paint Coating: Epoxy.
8. Plastic Coating: Epoxy.
9. []

2.04 THERMAL-HANGER SHIELD INSERTS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Carpenter & Paterson, Inc.
2. PHS Industries, Inc.
3. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.
4. Or Engineer Approved Equal.

B. Insulation-Insert Material for Cold Piping: ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C533, Type I calcium silicate with 100-psig; ASTM C552, Type II cellular glass with 100-psig or ASTM C591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS:

A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened Portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 PIPE POSITIONING SYSTEMS:

A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

2.07 MISCELLANEOUS MATERIALS:

A. Structural Steel: ASTM A36, carbon-steel plates, shapes, and bars; black and galvanized.
B. Grout: ASTM C1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
   1. Properties: Nonstaining, noncorrosive, and nongaseous.
   2. Design Mix: 5,000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION:

A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
B. The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, 12, 16, 19, 20, 23, 25, 27, 28, 29, and 30. However, Types 7, 9, 10, 10, 11, 19, and 23 may be used for nonferrous and plastic piping systems 2 inches and smaller.
C. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
   2. Field fabricate from ASTM A36, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
D. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
F. Fastener System Installation:
G. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 Plumbing Fixture Sections for requirements for pipe positioning systems for plumbing fixtures.
H. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
I. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

J. Install lateral bracing with pipe hangers and supports to prevent swaying.
K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
L. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
M. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
N. Insulated Piping:
    1. Attach clamps and spacers to piping.
        a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
        b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
        c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
    2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
        a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
    3. Shield Dimensions for Pipe: Not less than the following:
        a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
        b. NPS 4: 12 inches long and 0.06 inch thick.
        c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
        d. NPS 8 to NPS 14: 24 inches long and 0.075 inch thick.
        e. NPS 16 to NPS 24: 24 inches long and 0.105 inch thick.
    4. Pipes NPS 8 and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
    5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 METAL FABRICATIONS:

A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
C. Field Welding: Comply with qualified procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
    1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
    2. Obtain fusion without undercut or overlap.
    3. Remove welding flux immediately.
    4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.03 ADJUSTING:

A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.04 PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

3.05 HANGER AND SUPPORT SCHEDULE:

A. Specific hanger and support requirements are in sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system sections.

C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.

F. Use stainless-steel pipe hangers or fiberglass pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.

G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.

H. Use padded hangers for piping that is subject to scratching.

I. Use thermal-hanger shield inserts for insulated piping and tubing.

J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
   1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: Types 5, 6, 7, 9, 10, 11, and 12. However, Types 7, 9, 10, and 11 may be used for nonferrous and plastic piping systems 2 inches and smaller.
   2. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4-inches of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
   5. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
   6. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
   7. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
   8. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.

9. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
10. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
11. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
12. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
13. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
14. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Exception: The following figure type given in Figure 1 of MSS SP-69 will not be acceptable: Type 16.
2. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
3. Steel Clevises (MSS Type 14): For 120 to 450ºF piping installations.
4. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450ºF piping installations.

M. Building Attachments: Unless otherwise indicated and except as specified in piping system sections, install the following types:
1. Exception: The following figure types given in Figure 1 of MSS SP-69 will not be acceptable: 19, 20, 23, 25, 27, 28, 29, 30, and 34.
2. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
3. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
4. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
5. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
   a. Light (MSS Type 31): 750 pounds.
   b. Medium (MSS Type 32): 1,500 pounds.
   c. Heavy (MSS Type 33): 3,000 pounds.
6. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
7. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system sections, install the following types:
   1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
   2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
   3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system sections, install the following types:
   1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
   2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
   3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
   4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
   5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from hanger.
   6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from base support.
   7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25% to allow expansion and contraction of piping system from trapeze support.
   8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
      a. Horizontal (MSS Type 54): Mounted horizontally.
      b. Vertical (MSS Type 55): Mounted vertically.
      c. Trapeze (MSS Type 56): Two vertical type supports and one trapeze member.

P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system sections.

R. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

S. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 22 05 29

SECTION 22 05 53 – IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Equipment labels.
   2. Warning signs and labels.
   3. Pipe labels.
   4. Stencils.
   5. Valve tags.
   6. Warning tags.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Samples: For color, letter style, and graphic representation required for each identification material and device.
C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
D. Valve numbering scheme.
E. Valve Schedules: For each piping system to include in maintenance manuals.

1.05 COORDINATION:

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
B. Coordinate installation of identifying devices with locations of access panels and doors.
C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT LABELS:

A. Metal Labels for Equipment:
   1. Material and Thickness: Brass, 0.032 inch (0.8 mm), Stainless steel, 0.025 inch (0.64 mm), Aluminum, 0.032 inch (0.8 mm), or anodized aluminum, 0.032 inch (0.8 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
   3. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel rivets or self-tapping screws.

5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: Black.
3. Background Color: White.
4. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel rivets or self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

C. Label Content: Include equipment's Drawing designation or unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2 by 11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.02 WARNING SIGNS AND LABELS:

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
B. Letter Color: Black.
C. Background Color: White.
D. Maximum Temperature: Able to withstand temperatures up to 160ºF (71ºC).
E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
G. Fasteners: Stainless-steel rivets or self-tapping screws.
H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS:

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
B. Pretensioned Pipe Labels: Pre-coiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.04 STENCILS:

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, acrylic enamel black, unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1, unless otherwise indicated.

2.05 VALVE TAGS:

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Brass, 0.032 inch (0.8 mm), Stainless steel, 0.025 inch (0.64 mm), Aluminum, 0.032 inch (0.8 mm), or anodized aluminum, 0.032 inch (0.8 mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.
B. Valve Schedules: For each piping system, on 8-1/2 by 11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.

2.06 WARNING TAGS:

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.
   1. Size: Approximately 4 by 7 inches (100 by 178 mm).
   2. Fasteners: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: Yellow background with black lettering.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.02 EQUIPMENT LABEL INSTALLATION:

A. Install or permanently fasten labels on each major item of mechanical equipment.
B. Locate equipment labels where accessible and visible.

3.03 PIPE LABEL INSTALLATION:

A. Piping Color-Coding: Painting of piping is specified in Division 09.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 ft. (15 m) along each run. Reduce intervals to 25 ft. (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Low-Pressure, Compressed-Air Piping:
      a. Background Color: White.
      b. Letter Color: Black.
   2. Medium-Pressure, Compressed-Air Piping:
      a. Background Color: White.
      b. Letter Color: Black.
   3. Domestic Water Piping:
      a. Background Color: White.
      b. Letter Color: Black.
   4. Sanitary Waste Piping:
      a. Background Color: Yellow.
      b. Letter Color: Black.

3.04 WARNING-TAG INSTALLATION:

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 22 05 53

SECTION 22 07 19 – PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes requirements for insulating plumbing piping and devices.
   1. Indoor Domestic Hot, Cold, and Recirculated Water Piping.
   2. Indoor Stormwater and Overflow piping and Roof Drain and Overflow Bodies.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (latest editions):
   1. ASTM International (ASTM):
      a. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM C195 - Specification for Mineral Fiber Thermal Insulating Cement.
      e. ASTM C196 - Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement.
      f. ASTM C449 - Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
      g. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      h. ASTM C547 - Specification for Mineral Fiber Pipe Insulation.
      i. ASTM C553 - Specification for Mineral Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
      j. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      k. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
      l. ASTM C921 - Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
      m. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
      n. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
      o. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
      p. ASTM D1784 - Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
      q. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
      r. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
      s. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
   2. Code of Federal Regulations (CFR):

a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings," 2007.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

D. Field quality-control reports.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION:

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.

B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING:

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:

A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Manson Insulation Inc.; Alley Wrap.
   e. Owens Corning; SOFTR All-Service Duct Wrap.

2.02 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Aeroflex USA, Inc.; Aeroseal.
   b. Armacell LLC; Armaflex 520 Adhesive.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.
   d. K-Flex USA; R-373 Contact Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.
2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.03 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
   1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-30.
      b. Eagle Bridges - Marathon Industries; 501.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-35.
      d. Mon-Eco Industries, Inc.; 55-10.
   2. Water-Vapor Permeance: ASTM F1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9 mm) dry film thickness.
   3. Service Temperature Range: 0 to 180ºF (-18 to +82ºC).
   4. Solids Content: ASTM D1644, 44% by volume and 62% by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
      b. Eagle Bridges - Marathon Industries; 550.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
      d. Mon-Eco Industries, Inc.; 55-50.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
   4. Solids Content: 60% by volume and 66% by weight.
   5. Color: White.

2.04 SEALANTS:

A. Joint Sealants:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Pittsburgh Corning Corporation; Pittseal 444.
   2. Materials shall be compatible with insulation materials, jackets, and substrates.
   3. Permanently flexible, elastomeric sealant.
   4. Service Temperature Range: +100 to +300ºF (+73 to +149ºC).

5. Color: White or gray.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: +40 to +250ºF (+40 to +121ºC).
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.

2.06 FIELD-APPLIED JACKETS:

A. Field-applied jackets shall comply with ASTM C921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: Color-code jackets based on system.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

2.07 TAPES:

A. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.
1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 491 AWF FSK.

b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf./inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.
2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500%.
6. Tensile Strength: 18 lbf./inch (3.3 N/mm) in width.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5%.
6. Tensile Strength: 34 lbf./inch (6.2 N/mm) in width.

2.08 SECUREMENTS:

A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch (19-mm) wide, stainless steel or Monel.

C. Wire: 0.080-inch (2.0-mm) nickel-copper alloy or 0.062-inch (1.6-mm) soft-annealed, galvanized steel.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
   1. Verify that systems to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
E. Install multiple layers of insulation with longitudinal and end seams staggered.
F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
G. Keep insulation materials dry during application and finishing.
H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
I. Install insulation with least number of joints practical.
J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
   4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
L. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3-inch (75-mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.

a. For below-ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Cleanouts.

3.03 PENETRATIONS:

A. Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

C. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.04 GENERAL PIPE INSULATION INSTALLATION:

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt

each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
8. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gauges, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:
   1. Install preformed pipe insulation to outer diameter of pipe flange.
   2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
   3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
   4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:
   1. Install preformed sections of same material as straight segments of pipe insulation when available.
   2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
   3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   4. Install insulation to flanges as specified for flange insulation application.

3.06 FIELD-APPLIED JACKET INSTALLATION:

A. Where FSK jackets are indicated, install as follows:
   1. Draw jacket material smooth and tight.
   2. Install lap or joint strips with same material as jacket.
   3. Secure jacket to insulation with manufacturer's recommended adhesive.
   4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch (75-mm) wide joint strips at end joints.
   5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

B. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints. Seal with manufacturers recommended adhesive.
   1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

C. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with

weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

3.07 FINISHES:

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in DIVISION 09, Painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Engineer. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.08 PLUMBING PIPING INSULATION SCHEDULE, GENERAL:

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Subcontractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
   1. Drainage piping located in crawl spaces.
   2. Underground piping.
   3. Chrome-plated pipes and fittings unless insulation required per ADA requirements.

3.09 PLUMBING PIPING INSULATION SCHEDULE:

A. Indoor Domestic Hot, Cold, and Recirculated Water:
   1. All Pipe Sizes: Insulation shall be one of the following:
      a. Flexible Elastomeric: 1 inch (25 mm) thick.
      b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

3.10 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Subcontractor's option.

C. Indoor or Outdoor Piping, Concealed or Exposed:
   1. PVC: 30 mils (0.8 mm) thick.
   2. Aluminum, Smooth or Stucco Embossed: 0.024 inch (0.61 mm) thick.
   3. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish or Stucco Embossed: 0.016 inch (0.41 mm) thick.

END OF SECTION 22 07 19

SECTION 22 11 16 – DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings, including water piping serving domestic.
   2. Encasement for piping.

1.03 REFERENCED STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1079 - Dielectric Pipe Unions.
   2. American Water Works Association (AWWA):
      a. AWWA C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
      b. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems (ANSI).
      c. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings for Water (ANSI).
      d. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings (ANSI).
      e. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids (ANSI).
      f. AWWA C153/A21.53 - Ductile-Iron Compact Fittings for Water Service (ANSI).
      g. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
      h. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
      i. AWWA C606 - Grooved and Shouldered Joints.
      j. AWWA C651 - Disinfecting Water Mains.
      k. AWWA C652 - Disinfection of Water-Storage Facilities.
      l. AWWA M41 - Ductile-Iron Pipe and Fittings.
   3. American Welding Society (AWS):
      a. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding.
   4. ASME International (ASME):
      a. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      b. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. ASME B16.4 - Gray Iron Threaded Fittings: Classes 125 and 250.
      d. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      e. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      f. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500, and 2500.
      g. ASME B16.39 - Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
      h. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.
      i. ASME B31.9 - Building Services Piping.
   5. ASTM International (ASTM):

a. ASTM A53/A53M - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
b. ASTM A106/A106M - Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
c. ASTM A536 - Specification for Ductile Iron Castings.
d. ASTM A674 - Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
e. ASTM A733 - Specification for Welded and Seamless Carbon Steel and Austenitic Stainless-Steel Pipe Nipples.
f. ASTM B32 - Specification for Solder Metal.
g. ASTM B88 - Specification for Seamless Copper Water Tube.
h. ASTM B813 - Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
i. ASTM B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.

6. Code of Federal Regulations (CFR):
   a. 40 CFR 141, Subpart E – Special Regulations, Including Monitoring Regulations and Prohibition on Lead Use.
7. Copper Development Association:
   a. Copper Tube Handbook, 2006.
8. International Association of Plumbing and Mechanical Officials (IAPMO):
   a. IAPMO PS 66 - Dielectric Waterway Fittings.
9. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
   a. MSS SP-58 - Pipe Hangers and Supports - Selection and Application (ANSI).
   b. MSS SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
10. NSF International (NSF):
    a. NSF 14 - Plastics Piping System Components and Related Materials
    b. NSF 61 - Drinking Water System Components - Health Effects
    c. NSF 372 - Drinking Water System Components - Lead Content.

1.04 SUBMITTALS:

A. Product Data: For piping, transition fittings, and dielectric fittings. Submit schedule of pipe materials used for each application.
   1. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
B. System purging and disinfecting activities report.
C. Field quality-control reports.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
B. Potable-water piping and components shall comply with NSF 14, NSF 61, and NSF 372. Plastic piping components shall be marked with "NSF-pw."

C. Potable-water piping and components shall comply with 40 CFR 141, Subpart E including all amendments in place at the time of bids.

2.02 COPPER TUBE AND FITTINGS:

A. Hard Copper Tube: ASTM B88, Type K (ASTM B88M, Type A) and ASTM B88, Type L (ASTM B88M, Type B) water tube, drawn temper.
B. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
C. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
D. Copper Unions:
   1. MSS SP-123.
   2. Cast-copper alloy, hexagonal-stock body.
   3. Ball-and-socket, metal-to-metal seating surfaces.
   4. Solder-joint or threaded ends.
E. Copper Pressure-Seal Joint Fittings:
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      a. Elkhart Products Corporation.
      b. NIBCO, Inc.
      c. Viega, LLC.
   2. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
F. Copper-Tube, Extruded-Tee Connections:
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      a. T-Drill Industries, Inc.
      b. Engineer-approved equal.
   2. Description:
      a. Tee formed in copper tube according to ASTM F2014.
      b. Height shall be a minimum of three times the thickness of the branch tube wall.
      c. Branch tubes shall not restrict the flow in the run tube; a depth stop shall be formed in the branch tube to ensure that penetration into the collar is of the correct depth.

2.03 DUCTILE-IRON PIPE AND FITTINGS:

A. All ductile or gray iron fittings shall be cement mortar lined in accordance with AWWA C104.
B. Mechanical-Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51, with mechanical-joint bell and plain spigot end, unless grooved or flanged ends are indicated.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
C. Standard-Pattern, Mechanical-Joint Fittings:
   1. AWWA C110/A21.10, ductile or gray iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
D. Compact-Pattern, Mechanical-Joint Fittings:
   1. AWWA C153/A21.53, ductile iron.
   2. Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.
E. Push-on Joint, Ductile-Iron Pipe:
   1. AWWA C151/A21.51.

2. Push-on joint bell and plain spigot end, unless grooved or flanged ends are indicated.

F. Standard-Pattern, Push-on Joint Fittings:
1. AWWA C110/A21.10, ductile or gray iron.
2. Gaskets: AWWA C111/A21.11, rubber.

G. Compact-Pattern, Push-on Joint Fittings:
1. AWWA C153/A21.53, ductile iron.
2. Gaskets: AWWA C111/A21.11, rubber.

H. Plain-End, Ductile-Iron Pipe: AWWA C151/A21.51.

I. Appurtenances for Grooved-End, Ductile-Iron Pipe:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
a. Victaulic Company.
b. Engineer-approved equal.
2. Fittings for Grooved-End, Ductile-Iron Pipe: ASTM A47/A47M, malleable-iron castings or ASTM A536, ductile-iron castings with dimensions that match pipe.
3. Mechanical Couplings for Grooved-End, Ductile-Iron-Piping:
a. AWWA C606 for ductile-iron-pipe dimensions.
b. Ferrous housing sections.
c. EPDM-rubber gaskets suitable for hot and cold water.
d. Bolts and nuts.
e. Minimum Pressure Rating:
(1) NPS 14 to NPS 18 (DN 350 to DN 450): 250 psig (1725 kPa).
(2) NPS 20 to NPS 46 (DN 500 to DN 900): 150 psig (1035 kPa).

2.04 PIPING JOINING MATERIALS:

A. Pipe-Flange Gasket Materials:
1. AWWA C110/A21.10, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated.
2. Full-face or ring type, unless otherwise indicated.

B. Solder Filler Metals: ASTM B32, lead-free alloys.

C. Flux: ASTM B813, water flushable.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated.

2.05 ENCASEMENT FOR PIPING:

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Manufacturer’s standard.

2.06 TRANSITION FITTINGS:

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.3.
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:

a. Dresser, Inc.; Piping Specialties Products.
b. JCM Industries.
c. Smith, Jay R. Mfg. Co.
d. Smith-Blair, Inc.; a Sensus company.
e. Viking Johnson.

2.07 DIELECTRIC FITTINGS:

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
B. Dielectric Unions:
1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
a. Hart Industries International, Inc.
b. McDonald, A. Y. Mfg. Co.
c. Watts; a division of Watts Water Technologies, Inc.
d. Wilkins; a Zurn company.
e. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Pressure Rating: 125 psig (860 kPa), 150 psig (1035 kPa), or 250 psig (1725 kPa) at a minimum temperature of 180ºF (82ºC). Pressure rating shall be minimum 20 psi above system design pressure.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

PART 3 - EXECUTION

3.01 EARTHWORK:

A. Comply with requirements in DIVISION 31 for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated, unless deviations to layout are approved on coordination drawings.
B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.
D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A674 or AWWA C105/A21.5.
E. Install shutoff valve, hose-end drain valve, strainer, pressure gauge, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gauges in Section 22 05 19 - Meters and Gauges for Plumbing Piping and with requirements for drain valves and strainers in Section 22 11 19 - Domestic Water Piping Specialties.
F. Install shutoff valve immediately upstream of each dielectric fitting.
G. Install domestic water piping level with 0.25% slope downward toward drain, unless otherwise indicated, and plumb.
H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

I. Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
J. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless specifically indicated otherwise.
K. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
L. Install piping to permit valve servicing.
M. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below, unless otherwise indicated.
N. Install piping free of sags and bends.
O. Install fittings for changes in direction and branch connections.
P. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
Q. Install pressure gauges on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gauges in Section 22 05 19 - Meters and Gauges for Plumbing Piping.
R. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.
S. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

3.03 JOINT CONSTRUCTION:

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    1. Apply appropriate tape or thread compound to external pipe threads.
    2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
D. Brazed Joints for Copper Tubing: Comply with CDA's "Copper Tube Handbook," "Brazed Joints" chapter.
E. Soldered Joints for Copper Tubing: Apply ASTM B813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B828 or CDA's "Copper Tube Handbook."
F. Joint Construction for Solvent-Cemented Plastic Piping: Clean and dry joining surfaces. Join pipe and fittings according to the following:
    1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements. Apply primer.
G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.04 TRANSITION FITTING INSTALLATION:

A. Install transition couplings at joints of dissimilar piping.
B. Transition Fittings in Underground Domestic Water Piping:
    1. Fittings for NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
    2. Fittings for NPS 2 (DN 50) and Larger: Sleeve-type coupling.

C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 (DN 50) and Smaller: Plastic-to-metal transition fittings or unions.

3.05 DIELECTRIC FITTING INSTALLATION:

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric nipples or unions.
C. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges or flange kits.

3.06 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements for pipe hanger, support products, and installation in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet (30 m) if Indicated: MSS Type 49, spring cushion rolls.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   4. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support vertical piping and tubing at base and at each floor.
C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 4 (DN 80 to DN 10): 10 feet (3 m) with 1/2-inch (13-mm) rod.
E. Install supports for vertical copper tubing every 10 feet (3 m).
F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
   3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
   5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
   6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
   7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
   8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
G. Install supports for vertical steel piping every 15 feet (4.5 m).
H. Support piping and tubing not listed in this article according to MSS SP-58 and manufacturer's written instructions.

3.07 CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
   1. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code. Comply with requirements for connection sizes in DIVISION 22 Plumbing Fixture Sections.
   2. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.08 IDENTIFICATION:
A. Identify system components. Comply with requirements for identification materials and installation in Section 22 05 53 - Identification for Plumbing Piping and Equipment.
B. Label pressure piping with system operating pressure.

3.09 FIELD QUALITY CONTROL:
A. Perform the following tests and inspections:
   1. Piping Inspections:
      a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
      b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
         (1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
         (2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
      c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
      d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
   2. Piping Tests:
      a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
      b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
      c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
      d. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.
C. Prepare test and inspection reports.

3.10 ADJUSTING:

A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
b. Adjust calibrated balancing valves to flows indicated.
5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.11 CLEANING:

A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:
(1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
(2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
d. Repeat procedures if biological examination shows contamination.
e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
D. Clean interior of domestic water piping system. Remove dirt and debris as Work progresses.

3.12 PIPING SCHEDULE:

A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
B. Flanges and unions may be used for aboveground piping joints, unless otherwise indicated.
C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
D. Under-building-slab, domestic water, building-service piping, NPS 3 (DN 80) and smaller, shall be one of the following:
    1. Soft copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.
    2. Soft copper tube, ASTM B88, Type K (ASTM B88M, Type A); wrought-copper, pressure-seal fittings; and pressure-seal joints.
E. Under-building-slab, domestic water, building-service piping, NPS 4 (DN 100) and larger, shall be one of the following:
    1. Mechanical-joint, ductile-iron pipe; standard or compact-pattern, mechanical-joint fittings; and mechanical joints; installed with restrained joints.
    2. Plain-end, ductile-iron pipe; grooved-joint, ductile-iron-pipe appurtenances; and grooved joints.
F. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be one of the following:
    1. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
    2. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be one of the following:
    1. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed or soldered joints.
    2. Hard copper tube, ASTM B88, Type L (ASTM B88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.

3.13 VALVE SCHEDULE:

A. All valves serving potable water systems shall meet the requirements of NSF 61.
B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    1. Shutoff Duty: Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
    2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
    3. Drain Duty: Hose-end drain valves.
C. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 22 11 16

SECTION 22 11 19 – DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Vacuum breakers.
   2. Hose bibbs.
   3. Wall hydrants.
   4. Specialty valves.
   5. Flexible connectors.

1.03 RELATED REQUIREMENTS:

A. Section 22 05 19 - Meters and Gauges for Plumbing Piping for thermometers, pressure gauges, and flow meters in domestic water piping.
B. Section 22 11 16 - Domestic Water Piping for water meters.
C. Section 22 45 00 - Emergency Plumbing Fixtures for water tempering equipment.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American Society of Sanitary Engineering (ASSE):
   1. ASSE 1001 - Performance Requirements for Atmospheric Type Vacuum Breakers.
   2. ASSE 1003 - Performance Requirements for Water Pressure-Reducing Valves (ANSI).
   3. ASSE 1010 - Performance Requirements for Water-Hammer Arresters (ANSI).
   4. ASSE 1011 - Performance Requirements for Hose Connection Vacuum Breakers (ANSI).
   5. ASSE 1013 - Performance Requirements for Reduced-Pressure-Principle Backflow Preventers and Reduced-Pressure Fire-Protection Principle Backflow Preventers (ANSI).
   6. ASSE 1015 - Performance Requirements for Double-Check Backflow-Prevention Assemblies and Double-Check Fire-Protection Backflow Prevention Assemblies (ANSI).
   7. ASSE 1016 - Performance Requirements for Automatic Compensating Valves for Individual Showers and Tub/Shower Combinations (ANSI).
   8. ASSE 1017 - Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems.
   9. ASSE 1018 - Performance Requirements for Trap-Seal Primer Valves - Potable Water Supplied (ANSI).
   10. ASSE 1019 - Performance Requirements for Vacuum Breaker Wall Hydrants, Freeze Resistant, Automatic Draining Type (ANSI).
   11. ASSE 1020 - Performance Requirements for Pressure Vacuum Breaker Assembly (ANSI).
   12. ASSE 1022 - Performance Requirements for Backflow Preventer for Beverage Dispensing Equipment (ANSI).
   13. ASSE 1024 - Performance Requirements for Dual-Check Backflow Preventers (ANSI).
   14. ASSE 1032 - Performance Requirements for Dual-Check Valve Type Backflow Preventers for Carbonated Beverage Dispensers - Post Mix Type.
   15. ASSE 1035 - Performance Requirements for Laboratory Faucet Backflow Preventers.

16. ASSE 1044 - Performance Requirements for Trap-Seal Primer Devices - Drainage Types and Electronic Design Types (ANSI).
17. ASSE 1047 - Performance Requirements for Reduced-Pressure Detector Fire-Protection Backflow-Prevention Assemblies (ANSI).
18. ASSE 1048 - Performance Requirements for Double-Check Detector Fire-Protection Backflow-Prevention Assemblies (ANSI).
19. ASSE 1052 - Performance Requirements for Hose Connection Backflow Preventers (ANSI).
20. ASSE 1056 - Performance Requirements for Spill-Resistant Vacuum Breaker (ANSI).
21. ASSE 1057 - Performance Requirements for Freeze-Resistant Sanitary Yard Hydrant with Backflow Protection.

C. American Water Works Association (AWWA):
1. AWWA C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
2. AWWA C700 - Cold-Water Meters Displacement Type, Bronze Main Case.
3. AWWA C701 - Cold-Water Meters Turbine Type, for Customer Service.
4. AWWA C702 - Cold-Water Meters Compound Type.
5. AWWA C706 - Direct Reading, Remote Registration Systems for Cold-Water Meters.
6. AWWA C707 - Encoder Type Remote Registration Systems for Cold-Water Meters.
7. AWWA C710 - Cold-Water Meters - Displacement Type, Plastic Main Case.

D. ASME International (ASME):
1. ASME A112.1.2 - Air Gaps in Plumbing Systems (for Plumbing Fixtures and Water-Connected Receptors).
2. ASME A112.18.1 - Plumbing Supply Fittings.
3. ASME A112.21.3M - Hydrants for Utility and Maintenance Use.
4. ASME B1.20.7 - Hose Coupling Screw Threads, Inch.

E. ASTM International (ASTM):
1. ASTM B62 - Specification for Composition Bronze or Ounce Metal Castings.
2. ASTM B88 - Specification for Seamless Copper Water Tube.
3. ASTM B88M - Specification for Seamless Copper Water Tube.

F. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS):
1. MSS SP-80 - Bronze Gate, Globe, Angle and Check Valves.
2. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

G. NFPA:
1. NFPA 70 - National Electrical Code.

H. NSF International (NSF):
1. NSF 61 - Drinking Water System Components - Health Effects; Sections 1 through 9 (ANSI).
2. NSF 372 – Drinking Water System Components – Lead Content

I. Plumbing & Drainage Institute (PDI):
1. PDI-WH 201 - Water-Hammer Arresters.

1.05 SUBMITTALS:

A. Product Data: For each type of product.
B. Shop Drawings: For domestic water piping specialties.
1. Include diagrams for power, signal, and control wiring.
C. Field quality-control reports.
D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES:

A. Potable-water piping and components shall comply with NSF 61 and 372.

2.02 PERFORMANCE REQUIREMENTS:

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

2.03 VACUUM BREAKERS:

A. Hose-Connection Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Conbraco Industries, Inc.
      b. MIFAB, Inc.
      c. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      d. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      e. Zurn Industries, LLC; Plumbing Products Group.
   2. Standard: ASSE 1011.
   3. Body: Bronze, nonremovable, with manual drain.
   4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
   5. Finish: Chrome or nickel plated.

2.04 HOSE BIBBS:

A. Hose Bibbs:
   1. Standard: ASME A112.18.1 for sediment faucets.
   2. Body Material: Bronze.
   3. Seat: Bronze, replaceable.
   4. Supply Connections: NPS 1/2 or NPS 3/4 (DN 15 or DN 20) threaded or solder-joint inlet.
   5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
   6. Pressure Rating: 125 psig (860 kPa).
   7. Vacuum Breaker: Integral or field-installation, per drawings, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
   8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
   9. Finish for Service Areas: Rough bronze.
   10. Finish for Finished Rooms: Chrome or nickel plated.
   11. Operation for Equipment Rooms: Wheel handle or operating key.
   12. Operation for Service Areas: Wheel handle.
   13. Operation for Finished Rooms: Wheel handle.
   14. Include operating key with each operating-key hose bibb.
   15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.05 WALL HYDRANTS:

A. Non-freeze Wall Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company.
      b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products.
f. Woodford Manufacturing Company; a division of WCM Industries, Inc.
g. Zurn Industries, LLC.

2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Wheel handle.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze or Chrome plated.
10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
11. Nozzle and Wall-Plate Finish: Rough bronze.
12. Operating Keys(s): One with each wall hydrant.

B. Moderate-Climate Wall Hydrants (or inside Hydrants):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company.
b. MIFAB, Inc.
c. Chicago Faucet.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.
g. Watts Drainage Products.
h. Woodford Manufacturing Company; a division of WCM Industries, Inc.
i. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
j. Zurn Industries, LLC; Plumbing Products Group; Specification Drainage Products.
2. Standard: ASME A112.21.3M for exposed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
4. Operation: Wheel handle.
5. Inlet: NPS 3/4 or NPS 1 (DN 20 or DN 25).
6. Outlet:
a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7.
7. Box: Deep, flush mounted with cover.
8. Box and Cover Finish: Polished nickel bronze.
9. Outlet:
a. Concealed, with integral vacuum breaker or nonremovable hose-connection vacuum breaker complying with ASSE 1011 or backflow preventer complying with ASSE 1052.
b. Garden-hose thread complying with ASME B1.20.7.
10. Nozzle and Wall-Plate Finish: Rough bronze.

11. Operating Keys(s): One with each wall hydrant.

C. Vacuum Breaker Wall Hydrants:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Arrowhead Brass Products.
      b. Mansfield Plumbing Products, LLC.
      c. McDonald, A. Y. Mfg. Co.
      d. Prier Products, Inc.
      e. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
      f. Watts; a division of Watts Water Technologies, Inc.; Watts Regulator Company.
      g. Woodford Manufacturing Company; a division of WCM Industries, Inc.
      h. Zurn Industries, LLC; Plumbing Products Group; Light Commercial Products.
   2. Standard: ASSE 1019, Type A or Type B.
   3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
   4. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
   5. Pressure Rating: 125 psig (860 kPa).
   6. Operation: wheel handle.
   7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
   8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
   9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.06 SPECIALTY VALVES:

A. Comply with requirements for general-duty metal valves in DIVISION 22, Section "General-Duty Valves for Plumbing Piping."

2.07 FLEXIBLE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hyspan Precision Products, Inc.
   2. Metraflex, Inc.
   3. Design/Builder-approved equal.

B. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
   1. Working-Pressure Rating: Minimum 250 psig (1725 kPa).
   2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
   3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install water-control valves with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

B. Install outlet boxes recessed in wall or surface mounted on wall. Install 2- by 4-inch (38- by 89-mm) fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in DIVISION 06.

3.02 CONNECTIONS:

A. Comply with requirements for piping specified in other DIVISION 22 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Comply with requirements for ground equipment in DIVISION 26.
C. Fire-retardant-treated-wood blocking is specified in DIVISION 26 for electrical connections.

3.03 LABELING AND IDENTIFYING:

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Outlet boxes.
   2. Hose stations.
B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 22 05 53 - Identification for Plumbing Piping and Equipment.

3.04 FIELD QUALITY CONTROL:

A. Perform the following tests and inspections:
   1. Test each pressure vacuum breaker and backflow preventer according to authorities having jurisdiction and the device's reference standard.
B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
C. Prepare test and inspection reports.

END OF SECTION 22 11 19

SECTION 22 13 16 – SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Pipe, tube, and fittings.
   2. Specialty pipe fittings.
   3. Encasement for underground metal piping.

B. Related Sections:
   1. Section 22 14 29 - Sanitary Sewerage Pumps for effluent and sewage pumps.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   2. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1043 - Cast Iron Solvent Sanitary Drainage Systems.
      b. ASSE 1079 - Dielectric Pipe Unions.
   3. American Water Works Association (AWWA):
      a. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems.
      b. AWWA C110/A21.10 - Ductile-Iron and Gray-Iron Fittings for Water.
      c. AWWA C111/A21.11 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      d. AWWA C151/A21.51 - Ductile-Iron Pipe, Centrifugally Cast, for Water or Other Liquids.
      e. AWWA C153/A21.53 - Ductile-Iron Compact Fittings for Water Service.
      f. AWWA C219 - Bolted, Sleeve-Type Couplings for Plain-End Pipe.
      g. AWWA C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
      h. AWWA C606 - Grooved and Shouldered Joints.
   4. ASME International (ASME):
      a. ASME A112.3.1 - Performance Standard and Installation Procedures for Stainless Steel Drainage Systems for Sanitary, Storm, and Chemical Applications, Above and Below Ground.
      b. ASME B1.20.1 - Pipe Threads, General Purpose, Inch.
      c. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings - Classes 25, 125, and 250.
      d. ASME B16.4 - Gray Iron Threaded Fittings - (Classes 125 and 250).
      e. ASME B16.12 - Cast Iron Threaded Drainage Fittings.
      f. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
      g. ASME B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
      h. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
      i. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
      j. ASME B16.24 - Cast Copper Alloy Pipe Flanges and Flanged Fittings - Classes 150, 300, 600, 900, 1500, and 2500.
      k. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings-DWV.

l. ASME B16.39 - Malleable Iron Threaded Pipe Unions.
m. ASME B16.45 - Cast Iron Fittings for Solvent Drainage Systems.
n. ASME B18.2.1 - Square and Hex Bolts and Screws, Inch Series.

5. ASTM International (ASTM):
   a. ASTM A47 - Specification for Ferritic Malleable Iron Castings.
   b. ASTM A48 - Specification for Gray Iron Castings.
   c. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.
   e. ASTM A106 - Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   f. ASTM A234 - Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High-Temperature Service.
   g. ASTM A536 - Specification for Ductile Iron Castings.
   h. ASTM A674 - Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
   i. ASTM A733 - Specification for Welded and Seamless Carbon Steel and Austenitic Stainless Steel Pipe Nipples.
   j. ASTM A888 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   k. ASTM B29 - Specification for Refined Lead.
   l. ASTM B32 - Specification for Solder Metal.
   m. ASTM B88 - Specification for Seamless Copper Water Tube.
   n. ASTM B306 - Specification for Copper Drainage Tube (DWV).
   o. ASTM B813 - Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper Alloy Tube.
   p. ASTM B828 - Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
   q. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
   r. ASTM C1173 - Specification for Flexible Transition Couplings for Underground Piping Systems.
   s. ASTM C1277 - Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
   t. ASTM C1460 - Specification for Shielded Transition Couplings for Use with Dissimilar DWV Pipe and Fittings Above Ground.
   u. ASTM C1540 - Specification for Heavy-Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
   v. ASTM D2235 - Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
   w. ASTM D2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   x. ASTM D2564 - Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   y. ASTM D2661 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
   z. ASTM D2665 - Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.

aa. ASTM D2855 - Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
bb. ASTM D3311 - Specification for Drain, Waste, and Vent (DWV) Plastic Fittings Patterns.
cc. ASTM D5926 - Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Plastic Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
dd. ASTM F402 - Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
ee. ASTM F477 - Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
ff. ASTM F628 - Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe with a Cellular Core.
gg. ASTM F656 - Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
hh. ASTM F891 - Specification for Coextruded Poly (Vinyl Chloride) (PVC) Plastic Pipe with a Cellular Core.
ii. ASTM F1476 - Performance of Gasketed Mechanical Couplings for Use in Piping Applications.

6. Cast Iron Soil Pipe Institute (CISPI):
   a. CISPI 301 - Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   c. Cast Iron Soil Pipe and Fittings Handbook, 2006.
7. Code of Federal Regulations (CFR):
   a. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings.
8. Copper Development Association:
   a. Copper Tube Handbook, 2007.
9. International Association of Plumbing and Mechanical Officials (IAPMO):
   a. IAPMO PS 66 - Dielectric Waterway Fittings.
10. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
    a. MSS SP-69 - Pipe Hangers and Supports - Selection and Application.
    b. MSS SP-123 - Non-Ferrous Threaded and Solder-Joint Unions for Use with Copper Water Tube.
11. NSF International (NSF):
    a. NSF/ANSI 14 - Plastics Piping System Components and Related Materials.

1.04 PERFORMANCE REQUIREMENTS:

A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
   1. Soil, Waste, and Vent Piping: 10-foot head of water.
   2. Waste, Force-Main Piping: 50 psig.

1.05 ACTION SUBMITTALS:

A. Product Data: For each type of product indicated.

1.06 INFORMATIONAL SUBMITTALS:

A. Field quality-control reports.

1.07 QUALITY ASSURANCE:

A. Piping materials shall bear label, stamp, or other markings of specified testing agency.

B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS:

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.02 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS:

A. Pipe and Fittings: ASTM A888 or CISPI 301.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ANACO-Husky.
   b. Clamp-All Corp.
   c. Dallas Specialty & Mfg. Co.
   d. MIFAB, Inc.
   e. Mission Rubber Company; a division of MCP Industries, Inc.
   f. Stant.
   g. Tyler Pipe.
   h. Or Engineer Approved Equal.
2. Standards: ASTM C1277 and ASTM C1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C564, rubber sleeve with integral, center pipe stop.

C. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. MG Piping Products Company.
   b. Or Engineer Approved Equal.
2. Standard: ASTM C1277.
3. Description: Two-piece ASTM A48, cast-iron housing; stainless-steel bolts and nuts; and ASTM C564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron Flanges: ASME B16.1, Class 125.

1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8 inch maximum thickness, unless thickness or specific material is indicated.
2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.03 ABS PIPE AND FITTINGS:

A. Solid-Wall ABS Pipe: ASTM D2661, Schedule 40.

B. Cellular-Core ABS Pipe: ASTM F628, Schedule 40.

C. ABS Socket Fittings: ASTM D2661, made to ASTM D3311, drain, waste, and vent patterns.

D. Solvent Cement: ASTM D2235.

2.04 PVC PIPE AND FITTINGS:

A. Solid-Wall PVC Pipe: ASTM D2665, drain, waste, and vent.
B. Cellular-Core PVC Pipe: ASTM F891, Schedule 40.
C. PVC Socket Fittings: ASTM D2665, made to ASTM D3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.
D. Adhesive Primer: ASTM F656.
E. Solvent Cement: ASTM D2564.

2.05 SPECIALTY PIPE FITTINGS:

A. Transition Couplings:
   1. General Requirements: Fitting or device for joining piping with small differences in ODs or of different materials. Include end connections same size as and compatible with pipes to be joined.
   2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
   3. Unshielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         (1) Dallas Specialty & Mfg. Co.
         (2) Fernco, Inc.
         (3) Mission Rubber Company; a division of MCP Industries, Inc.
         (4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.
         (5) Or Engineer Approved Equal.
      b. Standard: ASTM C1173.
      c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
      d. Sleeve Materials:
         (1) For Cast-Iron Soil Pipes: ASTM C564, rubber.
         (2) For Plastic Pipes: ASTM F477, elastomeric seal or ASTM D5926, PVC.
         (3) For Dissimilar Pipes: ASTM D5926, PVC or other material compatible with pipe materials being joined.
   4. Shielded, Nonpressure Transition Couplings:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         (1) Cascade Waterworks Mfg. Co.
         (2) Mission Rubber Company; a division of MCP Industries, Inc.
         (3) Or Engineer Approved Equal.
      b. Standard: ASTM C1460.
      c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
B. Dielectric Fittings:
   1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

2.06 ENCASEMENT FOR UNDERGROUND METAL PIPING:

A. Standard: ASTM A674 or AWWA C105/A21.5.

B. Material: Linear low-density polyethylene film of 0.008 inch or high-density, cross-laminated polyethylene film of 0.004 inch minimum thickness.
C. Form: Sheet or tube.
D. Color: Black or natural.

PART 3 - EXECUTION

3.01 EARTH MOVING:

A. Comply with requirements for excavating, trenching, and backfilling specified in Division 31.

3.02 PIPING INSTALLATION:

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless specifically indicated otherwise.
D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
E. Install piping to permit valve servicing.
F. Install piping at indicated slopes.
G. Install piping free of sags and bends.
H. Install fittings for changes in direction and branch connections.
I. Install piping to allow application of insulation.
J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch, and 1/8-bend fittings if two fixtures are installed back-to-back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
L. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
    1. Building Sanitary Drain: 2% downward in direction of flow for piping NPS 3 and smaller; 1% downward in direction of flow for piping NPS 4 and larger.
    2. Horizontal Sanitary Drainage Piping: 2% downward in direction of flow.
    3. Vent Piping: 1% down toward vertical fixture vent or toward vent stack.
M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
N. Install steel piping according to applicable plumbing code.
O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.

P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
Q. Install aboveground ABS piping according to ASTM D2661.
R. Install aboveground PVC piping according to ASTM D2665.
S. Install underground ABS piping according to ASTM D2321.
T. Install engineered soil and waste drainage and vent piping systems as follows:
   1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
   2. Solvent Drainage System: Comply with ASSE 1043 and solvent fitting manufacturer's written installation instructions.
   3. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.
   4. Install encasement on piping according to ASTM A674 or AWWA C105/A21.5.
U. Install force mains at elevations indicated.
V. Plumbing Specialties:
   1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 22 13 19 - Sanitary Waste Piping Specialties.
   2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping. Comply with requirements for cleanouts specified in Section 22 13 19 - Sanitary Waste Piping Specialties.
   3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 22 13 19 - Sanitary Waste Piping Specialties.
W. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
X. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.
Y. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 22 05 17 - Sleeves and Sleeve Seals for Plumbing Piping.

3.03 JOINT CONSTRUCTION:

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
   1. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
   2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
E. Grooved Joints: Cut groove ends of pipe according to AWWA C606. Lubricate and install gasket over ends of pipes or pipe and fitting. Install coupling housing sections, over gasket, with keys seated in piping grooves. Install and tighten housing bolts.

F. Flanged Joints: Align bolt holes. Select appropriate gasket material, size, type, and thickness. Install gasket concentrically positioned. Use suitable lubricants on bolt threads. Torque bolts in cross pattern.
G. Plastic, Nonpressure-Piping, Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
   1. Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.
   2. ABS Piping: Join according to ASTM D2235 and ASTM D2661 Appendixes.
   3. PVC Piping: Join according to ASTM D2855 and ASTM D2665 Appendixes.

3.04 SPECIALTY PIPE FITTING INSTALLATION:

A. Transition Couplings:
   1. Install transition couplings at joints of piping with small differences in ODs.
   2. In Drainage Piping: [Unshielded] [Shielded], nonpressure transition couplings.
   3. In Aboveground Force Main Piping: Fitting-type transition couplings.
   4. In Underground Force Main Piping:
      a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
      b. NPS 2 and Larger: Pressure transition couplings.
B. Dielectric Fittings:
   1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
   2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
   3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
   4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.05 VALVE INSTALLATION:

A. General valve installation requirements are specified in Section 22 05 23 - General-Duty Valves for Plumbing Piping.
B. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.06 HANGER AND SUPPORT INSTALLATION:

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
   2. Install stainless-steel pipe hangers for horizontal piping in corrosive environments.
   3. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
   4. Install stainless-steel pipe support clamps for vertical piping in corrosive environments.
   5. Vertical Piping: MSS Type 8 or Type 42 clamps.
   6. Install individual, straight, horizontal piping runs:
      a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer than 100 Feet: MSS Type 43, adjustable roller hangers.
      c. Longer than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
   7. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
   8. Base of Vertical Piping: MSS Type 52, spring hangers.
B. Support horizontal piping and tubing within 12 inches of each fitting[, valve,] and coupling.
C. Support vertical piping and tubing at base and at each floor.
D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
   2. NPS 3: 60 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 60 inches with 7/8-inch rod.
   6. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6 and NPS 8: 12 feet with 3/4-inch rod.
   8. NPS 10 and NPS 12: 12 feet with 7/8-inch rod.

H. Install supports for vertical steel piping every 15 feet.

I. Install hangers for stainless-steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 2: 84 inches with 3/8-inch rod.
   2. NPS 3: 96 inches with 1/2-inch rod.
   3. NPS 4: 108 inches with 1/2-inch rod.
   4. NPS 6: 10 feet with 5/8-inch rod.

J. Install supports for vertical stainless-steel piping every 10 feet.

K. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 72 inches with 3/8-inch rod.
   2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
   3. NPS 2-1/2: 108 inches with 1/2-inch rod.
   4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
   5. NPS 6: 10 feet with 5/8-inch rod.
   6. NPS 8: 10 feet with 3/4-inch rod.

L. Install supports for vertical copper tubing every 10 feet.

M. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/2 and NPS 2: 48 inches with 3/8-inch rod.
   2. NPS 3: 48 inches with 1/2-inch rod.
   3. NPS 4 and NPS 5: 48 inches with 5/8-inch rod.
   4. NPS 6 and NPS 8: 48 inches with 3/4-inch rod.
   5. NPS 10 and NPS 12: 48 inches with 7/8-inch rod.

N. Install supports for vertical PVC piping every 48 inches.

O. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Comply with requirements for cleanouts and drains specified in Section 22 13 19 - Sanitary Waste Piping Specialties.
5. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.

D. Connect force-main piping to the following:

1. Sanitary Sewer: To exterior force main.
2. Sewage Pump: To sewage pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following, unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.08 IDENTIFICATION:

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 09 90 00 – Protective Coatings.

3.09 FIELD QUALITY CONTROL:

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections, and arrange for reinspection.

C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION:

A. Clean interior of piping. Remove dirt and debris as work progresses.
B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
C. Place plugs in ends of uncompleted piping at end of day and when work stops.
D. Exposed ABS and PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

3.11 PIPING SCHEDULE:

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:

1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid-wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

E. Aboveground, vent piping NPS 5 and larger shall be any of hubless-piping couplings; and coupled joints.
1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
2. Solid wall ABS pipe, ABS socket fittings, and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

G. Underground, soil, and waste piping NPS 5 and larger shall be any of the following:
1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; coupled joints.
2. Solid-wall PVC pipe; PVC socket fittings; and solvent-cemented joints.
3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

H. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
1. Galvanized-steel pipe, pressure fittings, and threaded joints.

I. Aboveground sanitary-sewage force mains NPS 2-1/2 to NPS 6 shall be any of the following:
1. Galvanized-steel pipe, pressure fittings, and threaded joints.

J. Underground sanitary-sewage force mains NPS 4 and smaller shall be any of the following:
1. Ductile-iron, mechanical-joint piping, and mechanical joints.
2. Fitting-type transition coupling for piping smaller than NPS 1-1/2 and pressure transition coupling for NPS 1-1/2 and larger if dissimilar pipe materials.

END OF SECTION 22 13 16

SECTION 22 13 19 – SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01, Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Cleanouts.
   2. Floor drains.
   3. Roof flashing assemblies.
   4. Miscellaneous sanitary drainage piping specialties.
   5. Flashing materials.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. American Society of Sanitary Engineering (ASSE):
      a. ASSE 1050 - Stack Air Admittance Valves for Sanitary Drainage Systems.
      b. ASSE 1051 - Individual and Branch Type Air Admittance Valves for Sanitary Drainage Systems.
   2. ASME International (ASME):
      a. ASME A112.1.2 - Air Gaps in Plumbing Systems.
      b. ASME A112.3.1 - Performance Standard and Installation Procedures for Stainless Steel Drainage Systems for Sanitary, Storm and Chemical Applications, Above and Below Ground.
      c. ASME A112.6.3 - Floor and Trench Drains.
      d. ASME A112.14.1 - Backwater Valves.
      e. ASME A112.14.3 - Grease Interceptors.
      f. ASME A112.14.4 - Grease Removal Devices.
      g. ASME A112.21.2M - Roof Drains.
      h. ASME A112.36.2M - Cleanouts.
   3. ASTM International (ASTM):
      a. ASTM A48 - Specification for Gray Iron Castings.
      b. ASTM A74 - Specification for Cast Iron Soil Pipe and Fittings.
      c. ASTM A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      d. ASTM B32 - Specification for Solder Metal.
      e. ASTM B152 - Specification for Copper Sheet, Strip, Plate, and Rolled Bar.
      f. ASTM B749 - Specification for Lead and Lead Alloy Strip, Sheet, and Plate Products.
      g. ASTM C564 - Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
      h. ASTM D4068 - Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.
   4. International Association of Plumbing and Mechanical Officials (IAPMO):
      a. IAPMO PS 118 - FOG (Fats, Oils & Greases) Disposal Systems.
   5. NFPA:
      a. NFPA 70 - National Electrical Code.
   6. NSF International (NSF):

a. NSF 14 - Plastics Piping Components and Related Materials.
7. Plumbing and Drainage Institute (PDI):
a. PDI-G101 - Testing and Rating Procedure for Grease Interceptors.
8. SSPC: The Society for Protective Coatings:
a. SSPC-Paint 12 - Paint Specification No. 12: Cold-Applied Asphalt Mastic (Extra Thick Film).
9. Underwriters Laboratories, Inc. (UL):
a. UL 1479 - Fire Tests of Through-Penetration Firestops.

1.04 DEFINITIONS:
A. ABS: Acrylonitrile-butadiene-styrene plastic.
B. HDPE: High-density polyethylene plastic.
C. PE: Polyethylene plastic.
D. PP: Polypropylene plastic.
E. PVC: Polyvinyl chloride plastic.

1.05 ACTION SUBMITTALS:
A. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
1. Wiring Diagrams: Power, signal, and control wiring.

1.06 INFORMATIONAL SUBMITTALS:
A. Field quality-control test reports.

1.07 CLOSEOUT SUBMITTALS:
A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.08 QUALITY ASSURANCE:
A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.09 COORDINATION:
A. Coordinate size and location of roof penetrations.

1.10 EXTRA MATERIALS:

PART 2 - RODUCTS

2.01 CLEANOUTS:
A. Exposed Metal Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Or Engineer Approved Equal.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk or raised-head, brass or plastic plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Wall Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Josam Company; Josam Div.
b. MIFAB, Inc.
c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
d. Tyler Pipe; Wade Div.
e. Watts Drainage Products, Inc.
f. Zurn Plumbing Products Group; Specification Drainage Operation.
g. Or Engineer Approved Equal.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.

C. Plastic Floor Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Canplas, LLC.
b. IPS Corporation.
c. NDS, Inc.
d. Plastic Oddities; a division of Diverse Corporate Technologies.
e. Sioux Chief Manufacturing Company, Inc.
f. Zurn Plumbing Products Group; Light Commercial Operation.
g. Or Engineer Approved Equal.
2. Size: Same as connected branch.
3. Body: PVC.
4. Closure Plug: PVC.
5. Riser: Drainage pipe fitting and riser to cleanout of same material as drainage piping.

2.02 FLOOR DRAINS:

A. Cast-Iron Floor Drains:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Commercial Enameling Co.
b. Josam Company; Josam Div.
c. MIFAB, Inc.
d. Prier Products, Inc.
e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
f. Tyler Pipe; Wade Div.

g. Watts Drainage Products, Inc.
h. Zurn Plumbing Products Group; Light Commercial Operation.
i. Zurn Plumbing Products Group; Specification Drainage Operation.
j. Or Engineer Approved Equal.

2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Clamping Device: Not required.
6. Outlet: Bottom.
7. Backwater Valve: Not required.
8. Coating on Interior and Exposed Exterior Surfaces: Not required.
9. Sediment Bucket: [Not required] <Insert description>.
10. Top or Strainer Material: Bronze.
11. Top of Body and Strainer Finish: Rough bronze.
12. Top Shape: Round.
13. Top Loading Classification: Heavy Duty.
14. Funnel: Not required.
15. Trap Material: Cast-iron.
16. Trap Pattern: Standard P-trap.
17. Trap Features: Trap-seal.

2.03 ROOF FLASHING ASSEMBLIES:

A. Roof Flashing Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Acorn Engineering Company; Elmdor/Stoneman Div.
b. Thaler Metal Industries Ltd.
c. Or Engineer Approved Equal.

B. Description: Manufactured assembly made of 6.0 lb./sq. ft., 0.0938 inch thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
1. Open-Top Vent Cap: Without cap.

2.04 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES:

A. Floor-Drain, Trap-Seal Primer Fittings <Insert drawing designation if any>:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

B. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

C. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

2.05 FLASHING MATERIALS:

A. Lead Sheet: ASTM B749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0 lb./sq. ft., 0.0625 inch thickness.
   2. Vent Pipe Flashing: 3.0 lb./sq. ft. 0.0469 inch thickness.
   3. Burning: 6 lb./sq. ft., 0.0938 inch thickness.

B. Copper Sheet: ASTM B152, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft..
   2. Vent Pipe Flashing: 8 oz./sq. ft.

C. Zinc-Coated Steel Sheet: ASTM A653, with 0.20% copper content and 0.04 inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D4068, flexible, chlorinated polyethylene, 40 mil minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheetmetal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.06 MOTORS:

A. General requirements for motors are specified in Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping, unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
   4. Locate at base of each vertical soil and waste stack.

B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

a. Radius, 30 Inches or Less: Equivalent to 1% slope, but not less than 1/4 inch total depression.
b. Radius, 30 to 60 Inches: Equivalent to 1% slope.
c. Radius, 60 Inches or Larger: Equivalent to 1% slope, but not greater than 1 inch total depression.

3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.
F. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.
G. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.
H. Install vent caps on each vent pipe passing through roof.
I. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
J. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
K. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.02 CONNECTIONS:
A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.03 FLASHING INSTALLATION:
A. Fabricate flashing from single piece, unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
1. Lead Sheets: Burn joints of lead sheets 6.0 lbs./sq. ft., 0.0938 inch thickness or thicker. Solder joints of lead sheets 4.0 lbs./sq. ft., 0.0625 inch thickness or thinner.
2. Copper Sheets: Solder joints of copper sheets.
B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.
C. Set flashing on floors and roofs in solid coating of bituminous cement.
D. Secure flashing into sleeve and specialty clamping ring or device.
E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07.
F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

3.04 FIELD QUALITY CONTROL:

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.05 PROTECTION:

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
B. Place plugs in ends of uncompleted piping at end of each day or when Work stops.

END OF SECTION 22 13 19

SECTION 22 14 29 – SUMP PUMPS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Submersible sump pumps.
B. Related Section:
   1. Section 22 14 29 - Sanitary Sewerage Pumps for effluent and sewage pumps.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. ASME International (ASME):
      a. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
      b. ASME B16.4 - Gray Iron Threaded Fittings.
   2. ASTM International (ASTM):
      a. ASTM A48 - Specification for Gray Iron Castings.
      b. ASTM A53 - Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. ASTM A532 - Specification for Abrasion-Resistant Cast Irons.
      d. ASTM B584 - Specification for Copper Alloy Sand Castings for General Applications.
   3. Hydraulic Institute (HI):
      a. HI 1.1-1.2 - Centrifugal Pumps for Nomenclature and Definitions.
      b. HI 1.3 - Centrifugal Pumps for Design and Application.
      c. HI 1.4 - Centrifugal Pumps for Installation, Operation and Maintenance.
   4. National Electrical Manufacturers Association (NEMA):
      a. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).
   5. NFPA:
      a. NFPA 70 - National Electrical Code.
   6. Underwriters Laboratories, Inc. (UL):
      a. UL 778 - Motor Operated Water Pumps.

1.04 ACTION SUBMITTALS:

A. Product Data: For each type of product indicated. [Include construction details, material descriptions, dimensions of individual components and profiles.] [Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.]
B. Wiring Diagrams: For power, signal, and control wiring.

1.05 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.06 QUALITY ASSURANCE:

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Retain shipping flange protective covers and protective coatings during storage.
B. Protect bearings and couplings against damage.
C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.01 SUBMERSIBLE SUMP PUMPS:

A. Submersible, Fixed-Position, Single-Seal Sump Pumps:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Barnes; Crane Pumps & Systems.
      b. Bell & Gossett Domestic Pump; ITT Corporation.
      c. Flo Fab, Inc.
      d. Glentronics, Inc.
      e. Goulds Pumps; ITT Corporation.
      f. Grundfos Pumps Corp.
      g. Liberty Pumps.
      h. Little Giant Pump Co.
      i. McDonald, A. Y. Mfg. Co.
      j. Pentair Pump Group; Hydromatic Pumps.
      k. Pentair Pump Group; Myers.
      l. Stancor, Inc.
      m. Sta-Rite Industries, Inc.
      n. Weil Pump Company, Inc.
      o. Weinman Division; Crane Pumps & Systems.
      p. Zoeller Company.
      q. Or Engineer Approved Equal.
   2. Description: Factory-assembled and -tested sump-pump unit.
   3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
   4. Pump Casing: Cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
   5. Impeller: Statically and dynamically balanced, ASTM B584, cast bronze, design for clear wastewater handling, and keyed and secured to shaft.
   6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
   7. Seal: Mechanical.
   8. Motor: Hermetically sealed capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
   9. Controls:
      a. Enclosure: NEMA 250, Type 1.
      b. Switch Type: Pedestal-mounted float switch with float rods and rod buttons.
      c. Float Guides: Pipe or other restraint for floats and rods in basins of depth greater than 60 inches.
      d. High-Water Alarm: Cover-mounted, compression-probe alarm, with electric bell; 120Vac, with transformer and contacts for remote alarm bell.

10. Controls:
    a. Enclosure: NEMA 250, Type 1; wall-mounted.
    b. Switch Type: Mechanical-float type, in NEMA 250, Type 6 enclosures with mounting rod and electric cables.
    c. Automatic Alternator: Start pumps on successive cycles and start multiple pumps if one cannot handle load.
    d. High-Water Alarm: Rod-mounted, NEMA 250, Type 6 enclosure with mechanical-float, mercury-float, or pressure switch matching control and electric bell; 120Vac, with transformer and contacts for remote alarm bell.
11. Control-Interface Features:
    a. Remote Alarm Contacts: Alarms to send to SCADA high water, continuous pump run and pump fault.

2.02 MOTORS:

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 22 05 13 - Common Motor Requirements for Plumbing Equipment.
   1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
   2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 26 Sections.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.01 EARTHWORK:

A. Excavation and filling are specified in Division 31.

3.02 EXAMINATION:

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.03 INSTALLATION:

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.04 CONNECTIONS:

A. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Install piping adjacent to equipment to allow service and maintenance.

3.05 FIELD QUALITY CONTROL:

A. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:
   1. Perform each visual and mechanical inspection.
   2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Pumps and controls will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports.

3.06 STARTUP SERVICE:

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.07 ADJUSTING:

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.
B. Adjust control set points.

END OF SECTION 22 14 29

DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING

SECTION 23 05 13 – COMMON MOTOR REQUIREMENTS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation. For all equipment at material site conditions ratings refer to SECTION 01 11 00.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. IEEE 841-2009 - Standard for Petroleum and Chemical Industry - Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors - Up to and Including 370 kW (500 hp).
   2. National Electrical Manufacturers Association (NEMA):
      a. NEMA MG 1 - Motors and Generators.

1.04 COORDINATION:

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS:

A. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.
B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS:

A. Duty: Continuous duty at ambient temperature of 40º and at site conditions.
B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS:

A. Description: NEMA MG 1, Design B, medium induction motor.
B. Efficiency: Energy efficient, as defined in NEMA MG 1.
C. Service Factor: 1.15.

D. Rotor: Random-wound, squirrel cage.
E. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
F. Temperature Rise: Match insulation rating.
G. Insulation: Class F.
H. Code Letter Designation:
   1. Motors 15 HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
I. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.04 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS:

A. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.
   2. Bearing Protection: All motors operated on variable frequency drives shall be equipped with maintenance free, 360 degree circumferential conductive microfiber shaft grounding ring with a minimum two continuous rows of conductive micro-fibers completely surrounding the motor shaft to discharge electrical shaft voltages away from the motor's bearings to ground. Note: Friction/spring contact brushes shall not be acceptable.
   3. Application Note: Motors up to 100HP shall be provided with a minimum of one shaft grounding ring as described above installed by the manufacturer internally to the motor or externally on the drive end. Motors over 100HP shall be provided with an insulated bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or contractor and shall be installed in accordance with the manufacturer's recommendations.
   4. Energy- and Premium-Efficient Motors: Class B temperature rise; Class F insulation.
   5. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
   6. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.
B. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.05 SINGLE-PHASE MOTORS:

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
   1. Permanent-split capacitor.
   2. Split phase.
   3. Capacitor start, inductor run.
   4. Capacitor start, capacitor run.
B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
C. Bearings: Pre-lubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
D. Motors 1/20 HP and Smaller: Shaded-pole type.
E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (NOT APPLICABLE)

END OF SECTION 23 05 13

SECTION 23 05 93 – TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Balancing Air Systems:
      a. Constant-volume air systems.
   2. Other Systems/Equipment:
      a. Heat exchangers.
      b. Motors.
      c. Condensing units.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (latest edition):
   1. Air Movement and Control Association International Inc. (AMCA):
      a. 201 - Fans and Systems.
   2. American National Standards Institute (ANSI):
      a. S1.4 - Specification for Sound Level Meters.
      b. S1.11 - Specification for Octave Band and Fraction Octave Band Analog and Digital Filters.
      c. S1.13 - Methods for the Measurement of Sound Pressure Levels.
      d. S1.40 - Specification for Acoustical Calibrators.
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
      b. 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
   4. Associated Air Balance Council (AABC):
      a. National Standards for Total System Balance.
   5. National Environmental Balancing Bureau (NEBB):
      a. Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
   6. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. HVAC Systems - Duct Design.
      b. HVAC Systems - Testing, Adjusting, and Balancing.

1.04 DEFINITIONS:

A. AABC: Associated Air Balance Council.
B. NEBB: National Environmental Balancing Bureau.
C. TAB: Testing, Adjusting, and Balancing.
D. TABB: Testing, Adjusting, and Balancing Bureau.
E. TAB Specialist: An entity engaged to perform TAB Work.
F. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.
G. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

H. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.
I. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin that is normally dissipated.
J. NC: Noise criteria.
K. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.
L. RC: Room criteria.
M. Report Forms: Test data sheets for recording test data in logical order.
N. Smoke-Control System: An engineered system that uses fans to produce airflow and pressure differences across barriers to limit smoke movement.
O. Smoke-Control Zone: A space within a building that is enclosed by smoke barriers and is a part of a zoned smoke-control system.
P. Stair Pressurization System: A type of smoke-control system that is intended to positively pressurize stair towers with outdoor air by using fans to keep smoke from contaminating the stair towers during an alarm condition.
Q. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.
R. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.
S. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
T. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.
U. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.
V. Test: A procedure to determine quantitative performance of systems or equipment.
W. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.05 SUBMITTALS:

A. Qualification Data: Submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
B. Contract Documents Examination Report: Submit the Contract Documents review report as specified in Part 3.
C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
D. Certified TAB reports.
E. Sample report forms.
F. Instrument calibration reports, to include the following:
    1. Instrument type and make.
    2. Serial number.
    3. Application.
    4. Dates of use.
    5. Dates of calibration.

1.06 QUALITY ASSURANCE:

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
   1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
   2. TAB Technician: Employee of the TAB contractor and who is certified by AABC NEBB or TABB as a TAB technician.

B. TAB Conference: Meet with mechanical contractor on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
   1. Agenda Items:
      a. The Contract Documents examination report.
      b. The TAB plan.
      c. Coordination and cooperation of trades and subcontractors.
      d. Coordination of documentation and communication flow.

C. Certify TAB field data reports and perform the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Commissioning Representative.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.07 PROJECT CONDITIONS:

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.08 COORDINATION:

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. Perform TAB after leakage and pressure tests on air distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
B. Examine systems for installed balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
C. Examine the approved submittals for HVAC systems and equipment.
D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 23 31 13 - Metal Ducts and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
F. Examine Equipment performance data including fan and pump curves.
    1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
    2. Calculate system-effect factors to reduce performance ratings of HVAC Equipment when installed under conditions different from the conditions used to rate Equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
G. Examine system and equipment installations and verify that field quality control testing, cleaning, and adjusting specified in individual Sections have been performed.
H. Examine test reports specified in individual system and equipment Sections.
I. Examine HVAC Equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
M. Examine system pumps to ensure absence of entrained air in the suction piping.
N. Examine operating safety interlocks and controls on HVAC Equipment.
O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.
P. Examine automatic temperature system components to verify the following:
    1. Dampers, valves, and other controlled devices are operated by the intended controller.
    2. Dampers and valves are in the position indicated by the controller.
    3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.

4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
5. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
6. Sensors are located to sense only the intended conditions.
7. Sequence of operation for control modes in according to the Contract Documents.
8. Controller set points are set at indicated values.
9. Interlocked systems are operating.
10. Changeover from heating to cooling mode occurs according to indicated values.

3.02 PREPARATION:

A. Prepare a TAB plan that includes strategies and step-by-step procedures.
B. Complete system-readiness checks and prepare reports. Verify the following:
   1. Permanent electrical-power wiring is complete.
   2. Automatic temperature-control systems are operational.
   3. Equipment and duct access doors are securely closed.
   4. Balance dampers are open.
   5. Isolating and balancing valves are open and control valves are operational.
   6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
   7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.03 GENERAL PROCEDURES FOR TESTING AND BALANCING:

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance," ASHRAE 111 NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
   1. Comply with requirements in ASHRAE 62.1, Section 7.2.2, "Air Balancing."
B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
   1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
   2. Install and join new insulation that matches removed materials.
C. Mark Equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.04 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS:

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
B. Prepare schematic diagrams of systems' "as-built" duct layouts.
C. For variable-air-volume systems, develop a plan to simulate diversity.
D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.
I. Check for airflow blockages.
J. Check condensate drains for proper connections and functioning.
K. Check for proper sealing of air-handling-unit components.
L. Verify that air duct system is sealed as specified in Section 23 31 13 - Metal Ducts.

3.05 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS:

1. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
2. Obtain approval from mechanical contractor for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
3. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.
   a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
2. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.06 PROCEDURES FOR MOTORS:

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.07 PROCEDURES FOR CONDENSING UNITS:

A. Verify proper rotation of fans.
B. Measure entering- and leaving-air temperatures.
C. Record compressor data.

3.08 PROCEDURES FOR HEAT-TRANSFER COILS:

A. Measure, adjust, and record the following data for each electric heating coil:
   1. Nameplate data.
   2. Airflow.
   3. Entering- and leaving-air temperature at full load.
   4. Calculated heat at full load.
   5. Fuse or circuit-breaker rating for overload protection.
B. Measure, adjust, and record the following data for each refrigerant coil:
   1. Dry-bulb temperature of entering and leaving air.
   2. Wet-bulb temperature of entering and leaving air.
   3. Airflow.
   4. Air pressure drop.
   5. Refrigerant suction pressure and temperature.

3.09 TOLERANCES:

A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: ±10%.
   2. Air Outlets and Inlets: 0 to +10%.
   3. Heating-Water Flow Rate: 0 to +10%.
   4. Cooling-Water Flow Rate: 0 to +10%.

3.10 REPORTING:

A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
B. Status Reports: Prepare weekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT:

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
   1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
   2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Fan curves.
   2. Manufacturers' test data.
   3. Field test reports prepared by system and equipment installers.
   4. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Engineer's name and address.
   6. Subcontractor's name and address.
   7. Report date.
   8. Signature of TAB supervisor who certifies the report.
   9. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   10. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   11. Nomenclature sheets for each item of equipment.
   12. Data for terminal units, including manufacturer's name, type, size, and fittings.
   13. Notes to explain why certain final data in the body of reports vary from indicated values.
   14. Test conditions for fans and pump performance forms including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Face and bypass damper settings at coils.
      e. Fan drive settings including settings and percentage of maximum pitch diameter.
      f. Inlet vane settings for variable-air-volume systems.
      g. Settings for supply-air, static-pressure controller.
      h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
   1. Quantities of outdoor, supply, return, and exhaust airflows.
   2. Duct, outlet, and inlet sizes.
   3. Pipe and valve sizes and locations.
   4. Terminal units.
   5. Balancing stations.
   6. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
   1. Unit Data:
      a. Unit identification.
      b. Location.
      c. Make and type.
      d. Model number and unit size.
      e. Manufacturer's serial number.

f. Unit arrangement and class.
g. Discharge arrangement.
h. Sheave make, size in inches (mm), and bore.
i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
j. Number, make, and size of belts.
k. Number, type, and size of filters.

2. Motor Data:
a. Motor make, and frame type and size.
b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches (mm), and bore.
f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

3. Test Data (Indicated and Actual Values):
a. Total air flow rate in cfm (L/s).
b. Total system static pressure in inches w.g. (Pa).
c. Fan rpm.
d. Discharge static pressure in inches w.g. (Pa).
e. Filter static-pressure differential in inches w.g. (Pa).
f. Cooling-coil static-pressure differential in inches w.g. (Pa).
g. Heating-coil static-pressure differential in inches w.g. (Pa).
h. Outdoor airflow in cfm (L/s).
i. Return airflow in cfm (L/s).
j. Outdoor-air damper position.
k. Return-air damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in ft.^{2} (m^2).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches w.g. (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in ºF (ºC).
e. Return-air, wet- and dry-bulb temperatures in ºF (ºC).
f. Entering-air, wet- and dry-bulb temperatures in ºF (ºC).
g. Leaving-air, wet- and dry-bulb temperatures in ºF (ºC).
h. Refrigerant expansion valve and refrigerant types.
i. Refrigerant suction pressure in psig (kPa).
j. Refrigerant suction temperature in ºF (ºC).

k. Inlet steam pressure in psig (kPa).

G. Electric-Coil Test Reports: For electric furnaces, duct coils, and electric coils installed in central-station air-handling units, include the following:
   1. Unit Data:
      a. System identification.
      b. Location.
      c. Coil identification.
      d. Capacity in Btu/hr. (kW).
      e. Number of stages.
      f. Connected volts, phase, and hertz.
      g. Rated amperage.
      h. Air flow rate in cfm (L/s).
      i. Face area in ft.² (m²).
      j. Minimum face velocity in fpm (m/s).
   2. Test Data (Indicated and Actual Values):
      a. Heat output in Btu/hr. (kW).
      b. Air flow rate in cfm (L/s).
      c. Air velocity in fpm (m/s).
      d. Entering-air temperature in ºF (ºC).
      e. Leaving-air temperature in ºF (ºC).
      f. Voltage at each connection.
      g. Amperage for each phase.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:
   1. Fan Data:
      a. System identification.
      b. Location.
      c. Make and type.
      d. Model number and size.
      e. Manufacturer's serial number.
      f. Arrangement and class.
      g. Sheave make, size in inches (mm), and bore.
      h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
   2. Motor Data:
      a. Motor make, and frame type and size.
      b. Horsepower and rpm.
      c. Volts, phase, and hertz.
      d. Full-load amperage and service factor.
      e. Sheave make, size in inches (mm), and bore.
      f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
      g. Number, make, and size of belts.
   3. Test Data (Indicated and Actual Values):
      a. Total airflow rate in cfm (L/s).
      b. Total system static pressure in inches w.g. (Pa).
      c. Fan rpm.
      d. Discharge static pressure in inches w.g. (Pa).
      e. Suction static pressure in inches w.g. (Pa).

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:
    a. System and air-handling-unit number.
    b. Location and zone.
    c. Traverse air temperature in ºF (ºC).
    d. Duct static pressure in inches w.g. (Pa).
    e. Duct size in inches (mm).
    f. Duct area in ft.² (m²).
    g. Indicated air flow rate in cfm (L/s).
    h. Indicated velocity in fpm (m/s).
    i. Actual air flow rate in cfm (L/s).
    j. Actual average velocity in fpm (m/s).
    k. Barometric pressure in psig (Pa).

J. Air-Terminal-Device Reports:
1. Unit Data:
    a. System and air-handling unit identification.
    b. Location and zone.
    c. Apparatus used for test.
    d. Area served.
    e. Make.
    f. Number from system diagram.
    g. Type and model number.
    h. Size.
    i. Effective area in ft.² (m²).
2. Test Data (Indicated and Actual Values):
    a. Air flow rate in cfm (L/s).
    b. Air velocity in fpm (m/s).
    c. Preliminary air flow rate as needed in cfm (L/s).
    d. Preliminary velocity as needed in fpm (m/s).
    e. Final air flow rate in cfm (L/s).
    f. Final velocity in fpm (m/s).
    g. Space temperature in ºF (ºC).

K. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:
1. Unit Data:
    a. System and air-handling-unit identification.
    b. Location and zone.
    c. Room or riser served.
    d. Coil make and size.
    e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
    a. Air flow rate in cfm (L/s).
    b. Entering-water temperature in ºF (ºC).
    c. Leaving-water temperature in ºF (ºC).
    d. Water pressure drop in feet of head or psig (kPa).
    e. Entering-air temperature in ºF (ºC).
    f. Leaving-air temperature in ºF (ºC).

L. Compressor and Condenser Reports: For refrigerant side of unitary systems, stand-alone refrigerant compressors, air-cooled condensing units, or water-cooled condensing units, include the following:

1. Unit Data:
   a. Unit identification.
   b. Location.
   c. Unit make and model number.
   d. Compressor make.
   e. Compressor model and serial numbers.
   f. Refrigerant weight in lb. (kg).
   g. Low ambient temperature cutoff in ºF (ºC).
2. Test Data (Indicated and Actual Values):
   a. Inlet-duct static pressure in inches w.g. (Pa).
   b. Outlet-duct static pressure in inches w.g. (Pa).
   c. Entering-air, dry-bulb temperature in ºF (ºC).
   d. Leaving-air, dry-bulb temperature in ºF (ºC).
   e. Control settings.
   f. Unloader set points.
   g. Low-pressure-cutout set point in psig (kPa).
   h. High-pressure-cutout set point in psig (kPa).
   i. Suction pressure in psig (kPa).
   j. Suction temperature in ºF (ºC).
   k. Condenser refrigerant pressure in psig (kPa).
   l. Condenser refrigerant temperature in ºF (ºC).
   m. Voltage at each connection.
   n. Amperage for each phase.
   o. Kilowatt input.
   p. Crankcase heater kilowatt.
   q. Number of fans.
   r. Condenser fan rpm.
   s. Condenser fan airflow rate in cfm (L/s).
   t. Condenser fan motor make, frame size, rpm, and horsepower.
   u. Condenser fan motor voltage at each connection.
   v. Condenser fan motor amperage for each phase.

3.12 INSPECTIONS:

A. Initial Inspection:
   1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
   2. Check the following for each system:
      a. Measure airflow of at least 10% of air outlets.
      b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
      c. Verify that balancing devices are marked with final balance position.
      d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:
   1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Commissioning Representative.

2. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
3. If the number of "FAILED" measurements is greater than 10% of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB work will be considered defective if it does not pass final inspections. If TAB work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.13 ADDITIONAL TESTS:

A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 23 05 93

SECTION 23 07 13 – DUCT INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes requirements for insulating sheet metal ductwork.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. ASTM International (ASTM):
      a. ASTM A167 - Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
      b. ASTM A240/A240M - Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
      c. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM B209M - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      e. ASTM C534 - Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
      f. ASTM C553 - Specification for Mineral Fiber Blanket and Thermal Insulation for Commercial and Industrial Applications.
      g. ASTM C612 - Specification for Mineral Fiber Block and Board Thermal Insulation.
      h. ASTM C795 - Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
      i. ASTM C871 - Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions.
      j. ASTM C1136 - Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
      k. ASTM C1290 - Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
      l. ASTM D1644 - Test Methods for Nonvolatile Content of Varnishes.
      m. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
      n. ASTM E96/E96M - Test Methods for Water Vapor Transmission of Materials.
      o. ASTM F1249 - Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infrared Sensor.
   2. Code of Federal Regulations (CFR):
      a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 -"National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings," 2007.
   3. NFPA:
      a. NFPA 90A - Installation of Air-Conditioning and Ventilating Systems.
      b. NFPA 90B - Installation of Warm Air Heating and Air-Conditioning Systems.

1.04 SUBMITTALS:

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and field-applied jackets (if any).

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
   3. Detail application of field-applied jackets.
   4. Detail application at linkages of control devices.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.05 QUALITY ASSURANCE:

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
   1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
   2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.07 COORDINATION:

A. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

B. Coordinate installation and testing of heat tracing.

1.08 SCHEDULING:

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.01 INSULATION MATERIALS:

A. Comply with requirements in "Duct Insulation Schedule, General," "Aboveground Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II and ASTM C1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corp.; SoftTouch Duct Wrap.
   b. Johns Manville; Microlite.
   c. Knauf Insulation; Friendly Feel Duct Wrap.
   d. Owens Corning; SOFTR All-Service Duct Wrap.

G. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. For duct and plenum applications, provide insulation with FSK or ASJ factory-applied jacket.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. CertainTeed Corp.; Commercial Board.
   b. Fibrex Insulations, Inc.; FBX.
   c. Johns Manville; 800 Series Spin-Glass.
   d. Knauf Insulation; Insulation Board.
   e. Owens Corning; Fiberglas 700 Series.

2.02 ADHESIVES:

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Mineral-Fiber Board or Blanket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.
   d. Mon-Eco Industries, Inc.; 22-25.

C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.
   b. Eagle Bridges - Marathon Industries; 225.
   c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.
   d. Mon-Eco Industries, Inc.; 22-25.

2.03 MASTICS:

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
      b. Vimasco Corporation; 749.
   2. Water-Vapor Permeance: ASTM E96/E96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
   3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
   4. Solids Content: ASTM D1644, 58% by volume and 70% by weight.
   5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
      b. Eagle Bridges - Marathon Industries; 550.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.
      d. Mon-Eco Industries, Inc.; 55-50.
      e. Vimasco Corporation; WC-1/WC-5.
   2. Water-Vapor Permeance: ASTM F1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
   3. Service Temperature Range: -20 to +180ºF (-29 to +82ºC).
   4. Solids Content: 60% by volume and 66% by weight.
   5. Color: White.

2.04 SEALANTS:

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide products by one of the following:
      a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
      b. Eagle Bridges - Marathon Industries; 405.
      c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.

d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide products by the following:
   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40 to +250ºF (-40 to +121ºC).
5. Color: White.

2.05 FACTORY-APPLIED JACKETS:

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, Kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with Kraft-paper backing; complying with ASTM C1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E96/E96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.06 TAPES:

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

1. Products: Subject to compliance with requirements, provide products by one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches (75 mm).
3. Thickness: 11.5 mils (0.29 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

1. Products: Subject to compliance with requirements, provide products by one of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).
3. Thickness: 6.5 mils (0.16 mm).
4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2%.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

2.07 SECUREMENTS:

A. Bands:
1. Products: Subject to compliance with requirements, provide products by one of the following:
a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
2. Stainless Steel: ASTM A167 or ASTM A240/A240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.
3. Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H 14, 0.020 inch (0.51 mm) thick, 1/2 inch (13 mm) wide with wing seal or closed seal.

B. Insulation Pins and Hangers:
1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated.
a. Products: Subject to compliance with requirements, provide products by one of the following:
(1) AGM Industries, Inc.; CWP-1.
(2) GEMCO; CD.
(3) Midwest Fasteners, Inc.; CD.
(4) Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch (3.5-mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
a. Products: Subject to compliance with requirements, provide products by one of the following:
(1) AGM Industries, Inc.; CHP-1.
(2) GEMCO; Cupped Head Weld Pin.
(3) Midwest Fasteners, Inc.; Cupped Head.
(4) Nelson Stud Welding; CHP.
3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
a. Products: Subject to compliance with requirements, provide products by one of the following:
(1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.

(2) GEMCO; Perforated Base.
(3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated.
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) GEMCO; Nylon Hangers.
      (2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
   c. Spindle: Nylon, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; Tactoo Self-Adhering Insul-Hangers.
      (2) GEMCO; Peel & Press.
      (3) Midwest Fasteners, Inc.; Self Stick.
   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated.
   d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick, galvanized-steel or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Products: Subject to compliance with requirements, provide products by one of the following:
      (1) AGM Industries, Inc.; RC-150.
      (2) GEMCO; R-150.
      (3) Midwest Fasteners, Inc.; WA-150.
      (4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
        (1) GEMCO.
        (2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch (19-mm) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
    a. C & F Wire.

2.08 CORNER ANGLES:

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1- by 1-inch (25- by 25-mm) aluminum according to ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

B. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1- by 1-inch (25- by 25-mm) stainless steel according to ASTM A167 or ASTM A240/A240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
1. Verify that systems to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.03 GENERAL INSTALLATION REQUIREMENTS:

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces, free of voids throughout the length of ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.
I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
   1. Install insulation continuously through hangers and around anchor attachments.
   2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
   3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
K. Install insulation with factory-applied jackets as follows:
   1. Draw jacket tight and smooth.
   2. Cover circumferential joints with 3 inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches (50 mm) o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
L. Cut insulation in a manner to avoid compressing insulation more than 75% of its nominal thickness.
M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.04 PENETRATIONS:

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
   1. Seal penetrations with flashing sealant.
   2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
   3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.
   4. Seal jacket to roof flashing with flashing sealant.
B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
   1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches (50 mm).
1. Comply with requirements in DIVISION 07.

E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches (50 mm).
2. Seal penetrations through fire-rated assemblies. Comply with requirements in DIVISION 07.

3.05 INSTALLATION OF MINERAL-FIBER INSULATION:

A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
   a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
   b. On duct sides with dimensions larger than 18 inches (450 mm), place pins 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not over compress insulation during installation.
   e. Impale insulation over pins and attach speed washers.
   f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50ºF (10ºC) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) o.c.
6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch (150-mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches (150-mm) o.c.

B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
a. On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16-inches (400-mm) o.c.
b. On duct sides with dimensions larger than 18 inches (450 mm), space pins 16-inches (400-mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
d. Do not over compress insulation during installation.
e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch (13-mm) outward-clinching staples, 1-inch (25-mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50ºF (10ºC) at 18-foot (5.5-m) intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the

surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches (75 mm).

5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch (150-mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6-inches (150-mm) o.c.

3.06 FIELD-APPLIED JACKET INSTALLATION:

A. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12-inches (300-mm) o.c. and at end joints.

3.07 FINISHES:

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in DIVISION 09 Painting Sections.
   1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
      a. Finish Coat Material: Interior, flat, latex-emulsion size.
B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
D. Do not field paint aluminum or stainless-steel jackets.

3.08 DUCT INSULATION SCHEDULE, GENERAL:

A. Plenums and Ducts Requiring Insulation:
   1. Indoor, supply and return ductwork (see exemption in #8 below).
   2. Indoor outside air ductwork.
   3. Outdoor exposed ductwork.
B. Items Not Insulated:
   1. Fibrous-glass ducts.
   2. Metal ducts with duct liner is only allowed where indicated for sound attenuation.
   3. Factory-insulated flexible ducts.
   4. Factory-insulated plenums and casings.
   5. Flexible connectors.
   6. Vibration-control devices.
   7. Factory-insulated access panels and doors.
   8. Ductwork exposed with-in conditioned space it’s serving without mechanical cooling.

3.09 ABOVEGROUND INDOOR DUCT AND PLENUM INSULATION SCHEDULE:

A. Indoor supply, return, and outside air duct insulation shall be one of the following:
   1. Mineral-Fiber Blanket: 2 inches (50 mm) thick and 1.5-lb./cu. ft. (24-kg/cu. m) nominal density.

2. Mineral-Fiber Board: 1-1/2 inches (38 mm) thick and 2-lb./cu. ft. (32-kg/cu. m) nominal density.

3.10 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE:

A. Aboveground outdoor rectangular duct insulation shall be one of the following:
   1. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb./cu. ft. (48-kg/cu. m) nominal density.

3.11 INDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. Ducts and Plenums:
   1. ASJ
   2. FSK

3.12 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE:

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
B. If more than one material is listed, selection from materials listed is Contractor's option.
C. Ducts and Plenums, Concealed:
   1. Aluminum, Smooth or Stucco Embossed: 0.024 inch (0.61 mm) thick.
   2. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish or Stucco Embossed: 0.016 inch (0.41 mm) thick.

END OF SECTION 23 07 13

SECTION 23 09 00 – INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. Air Movement and Control Association International, Inc. (AMCA):
      a. AMCA 500D - Methods of Testing Dampers for Rating.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 135 - BACnet - A Data Communication Protocol for Building Automation and Control Networks.
   3. ASME International (ASME):
      a. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
      b. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   4. ASTM International (ASTM):
      a. ASTM A126 - Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. ASTM A536 - Specification for Ductile Iron Casting.
      c. ASTM B88 - Specification for Seamless Copper Water Tube.
      d. ASTM B280 - Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
      e. ASTM D2737 - Specification for Polyethylene (PE) Plastic Tubing.
   5. Electronic Industries Alliance/Canadian Electricity Association (EIA/CEA):
      a. EIA/CEA 709.1-B - Control Network Protocol Specification.
   6. The Instrumentation, Systems, and Automation Society (67 Alexander Dr., Research Triangle Park, NC 27709; 919-549-8411) (ISA):
      a. ISA 50.00.01 - Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   7. National Electrical Manufacturers Association (NEMA):
      a. NEMA 250 - Enclosures for Electrical Equipment (100V Maximum).
      b. NEMA DC 3 - Residential Controls - Electrical Wall-Mounted Room Thermostats.
   8. NFPA:
      a. NFPA 70 - National Electrical Code.

1.04 DEFINITIONS:

A. DDC: Direct digital control.
B. I/O: Input/output.
C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.
D. MS/TP: Master slave/token passing.
E. PC: Personal computer.
F. PID: Proportional plus integral plus derivative.
G. RTD: Resistance temperature detector.

1.05 SYSTEM PERFORMANCE:

A. Comply with the following performance requirements:

1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
   a. Water Temperature: ±1ºF (0.5ºC).
   b. Water Pressure: ±2% of full scale.
   c. Space Temperature: ±1ºF (0.5ºC).
   d. Ducted Air Temperature: ±1ºF (0.5ºC).
   e. Outside Air Temperature: ±2ºF (1.0ºC).
   f. Dew Point Temperature: ±3ºF (1.5ºC).
   g. Temperature Differential: ±0.25ºF (0.15ºC).
   h. Relative Humidity: ±5%.
   i. Airflow (Pressurized Spaces): ±3% of full scale.
   j. Airflow (Measuring Stations): ±5% of full scale.
   k. Airflow (Terminal): ±10% of full scale.
   l. Air Pressure (Space): ±0.01-inch wg (2.5 Pa).
   m. Air Pressure (Ducts): ±0.1-inch wg (25 Pa).
   n. Carbon Monoxide: ±5% of reading.
   o. Carbon Dioxide: ±50 ppm.
   p. Electrical: ±5% of reading.

1.06 SUBMITTALS:

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
   2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
   3. Wiring Diagrams: Power, signal, and control wiring.
   4. Details of control panel faces, including controls, instruments, and labeling.
   5. Written description of sequence of operation.
   6. Schedule of dampers including size, leakage, and flow characteristics.
   7. Schedule of valves including flow characteristics.
   8. DDC System Hardware:
      a. Wiring diagrams for control units with termination numbers.
      b. Schematic diagrams and floor plans for field sensors and control hardware.
      c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
   9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
   10. Controlled Systems:
      a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
      b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
      c. Written description of sequence of operation including schematic diagram.
      d. Points list.

C. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.

D. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

E. Qualification Data: For Installer.

F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
   1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
   2. Interconnection wiring diagrams with identified and numbered system components and devices.
   3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
   4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
   5. Calibration records and list of set points.

I. Software and Firmware Operational Documentation: Include the following:
   1. Software operating and upgrade manuals.
   2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
   3. Device address list.

4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

J. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat, positioning relay.
2. Maintenance Materials: One thermostat adjusting key(s).
3. Maintenance Materials: One pneumatic thermostat test kit.

1.07 QUALITY ASSURANCE:

A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.09 COORDINATION:

A. Coordinate location of thermostats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 28 to achieve compatibility with equipment that interfaces with that system and with building master clock.

C. Coordinate equipment with Division 27 to achieve compatibility with equipment that interfaces with that system.

D. Coordinate equipment with Division 26 to achieve compatibility with equipment that interfaces with that system.

E. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

F. Coordinate equipment with Division 26 to achieve compatibility of communication interfaces.

G. Coordinate equipment with Division 26 to achieve compatibility with starter coils and annunciation devices.

H. Coordinate equipment with Division 26 to achieve compatibility with motor starters and annunciation devices.

I. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.01 CONTROL SYSTEM:

A. Manufacturers:
1. Alerton Inc.
2. American Auto-Matrix.
3. Andover Controls Corporation.
4. Automated Logic Corporation.

5. Delta Controls Inc.
6. Honeywell International Inc.; Home & Building Control.
7. Invensys Building Systems.
8. Johnson Controls, Inc.; Controls Group.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.02 UNITARY CONTROLLERS:

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
   1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
   2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
   3. Enclosure: Waterproof rated for operation at 40 to 150ºF (5 to 65ºC).

2.03 ALARM PANELS:

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06 inch (1.5 mm) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.
   1. Alarm Condition: Indicating light flashes and horn sounds.
   2. Acknowledge Switch: Horn is silent and indicating light is steady.
   3. Second Alarm: Horn sounds and indicating light is steady.
   4. Alarm Condition Cleared: System is reset and indicating light is extinguished.
   5. Contacts in alarm panel allow remote monitoring by independent alarm company.

2.04 ANALOG CONTROLLERS:

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range -10 to +70ºF (-23 to +21ºC), and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55% and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

E. Receiver Controllers: Single- or multiple-input models with control-point adjustment, direct or reverse acting with mechanical set-point adjustment with locking device, proportional band adjustment, authority adjustment, and proportional control mode.
1. Remote-control-point adjustment shall be ±20% of sensor span, input signal of 3 to 13 psig (21 to 90 kPa).
2. Proportional band shall extend from 2 to 20% for 5 psig (35 kPa).
3. Authority shall be 20 to 200%.
4. Air-supply pressure of 18 psig (124 kPa), input signal of 3 to 15 psig (21 to 103 kPa), and output signal of zero to supply pressure.
5. Gauges: 2-1/2 inches (64 mm) in diameter, 2.5% wide-scale accuracy, and range to match transmitter input or output pressure.

2.05 TIME CLOCKS:

A. Manufacturers:
1. ATC-Diversified Electronics.
2. Grasslin Controls Corporation.
3. Paragon Electric Co., Inc.
4. Precision Multiple Controls, Inc.
5. SSAC Inc.; ABB USA.
6. TCS/Basys Controls.
7. Theben AG - Lumilite Control Technology, Inc.
8. Time Mark Corporation.

B. Seven-day, programming-switch timer with synchronous-timing motor and seven-day dial; continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover; multiple-switch trippers; minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

C. Solid-state, programmable time control with 8 separate programs each with up to 100 on-off operations; 1-second resolution; lithium battery backup; keyboard interface and manual override; individual on-off-auto switches for each program; 365-day calendar with 20 programmable holidays; choice of fail-safe operation for each program; system fault alarm; and communications package allowing networking of time controls and programming from PC.

2.06 ELECTRONIC SENSORS:

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. BEC Controls Corporation.
b. Ebtron, Inc.
c. Heat-Timer Corporation.
d. I.T.M. Instruments Inc.
e. MAMAC Systems, Inc.

f. RDF Corporation.
2. Accuracy: ±0.36ºF (0.2ºC) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
   a. Set-Point Adjustment: Exposed.
   b. Set-Point Indication: Exposed.
   c. Thermometer: Exposed.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BEC Controls Corporation.
   b. MAMAC Systems, Inc.
   c. RDF Corporation.
2. Accuracy: ±0.2% at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 18 inches (460 mm) long, rigiduse where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Pressure Transmitters/Transducers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. BEC Controls Corporation.
   b. General Eastern Instruments.
   c. MAMAC Systems, Inc.
   d. ROTRONIC Instrument Corp.
   e. TCS/Basys Controls.
   f. Vaisala.
2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2% of full scale with repeatability of 0.5%.
b. Output: 4 to 20 mA.
c. Building Static-Pressure Range: 0- to 0.25-inch wg (0 to 62 Pa).
d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

E. Room Sensor Cover Construction: Manufacturer's standard locking covers.
F. Room sensor accessories include the following:
1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.

2.07 STATUS SENSORS:

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).
B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175% of rated motor current.
D. Voltage Transmitter (100 to 600Vac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1% full-scale accuracy.
E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2% error at 1.0 power factor and 2.5% error at 0.5 power factor.
F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2 to 10Vdc, feedback signal.
H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. BEC Controls Corporation.
b. I.T.M. Instruments Inc.

2.08 THERMOSTATS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Erie Controls.
2. Danfoss, Inc.; Air-Conditioning and Refrigeration Div.

3. Heat-Timer Corporation.
4. Sauter Controls Corporation.
5. tekmar Control Systems, Inc.
6. Theben AG - Lumilite Control Technology, Inc.

B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.
1. Label switches "FAN HIGH-MED-LOW-OFF".
2. Mount on single electric switch box.

C. Electric, solid-state, microcomputer-based room thermostat with remote sensor.
1. Automatic switching from heating to cooling.
2. Preferential rate control to minimize overshoot and deviation from set point.
3. Set up for four separate temperatures per day.
4. Instant override of set point for continuous or timed period from 1 hour to 31 days.
5. Short-cycle protection.
6. Programming based onevery day of week.
7. Selection features include ºF or ºC display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.
8. Battery replacement without program loss.
9. Thermostat display features include the following:
   a. Time of day.
   b. Actual room temperature.
   c. Programmed temperature.
   d. Programmed time.
   e. Duration of timed override.
   f. Day of week.
   g. System mode indications include "heating," "off," "fan auto," and "fan on."

D. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85ºF (13 to 30ºC) set-point range, and 2ºF (1ºC) maximum differential.

E. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85ºF (13 to 30ºC) set-point range, and 2ºF (1ºC) maximum differential.
1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.
2. Selector Switch: Integral, manual on-off-auto.

F. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.
1. Bulbs in water lines with separate wells of same material as bulb.
2. Bulbs in air ducts with flanges and shields.
3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.
4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.
6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

7. Dual-Temperature Thermostats: Automatic changeover from normal setting to lower setting for unoccupied cycles, with manual-reset lever to permit return to normal temperatures during unoccupied cycles, with automatic reset to normal during next cycle of operation.
8. Limits: Field adjustable, to limit setting cooling set point below 75ºF (24ºC), and heating set point above 75ºF (24ºC).
9. Room Thermostat Cover Construction: Manufacturer's standard locking covers.
    a. Set-Point Adjustment: Exposed.
    b. Set-Point Indication: Exposed.
    c. Thermometer: Exposed.
10. Room thermostat accessories include the following:
    a. Insulating Bases: For thermostats located on exterior walls.
    b. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
    c. Adjusting Key: As required for calibration and cover screws.
    d. Aspirating Boxes: For flush-mounted aspirating thermostats.
    e. Set-Point Adjustment: 1/2-inch (13-mm) diameter, adjustment knob.

G. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gauge, remote bulb, bimetal rod and tube, or averaging element.

H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.
1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.
1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

J. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig (172 kPa), and cast housing with position indicator and adjusting knob.

2.09 ACTUATORS:

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
1. Comply with requirements in Section 23 05 13 – "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. by lbf (16.9 N by m) and breakaway torque of 300 in. by lbf (33.9 N by m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. by lbf (16.9 N by m).

5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. by lbf (16.9 N by m) and breakaway torque of 300 in. by lbf (33.9 N by m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. by lbf (16.9 N by m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Belimo Aircontrols (USA), Inc.
2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
3. Dampers: Size for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. (49.6 kg-cm/sq. m) of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
   e. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1,000 to 2,500 fpm (5 to 13 m/s): Increase running torque by 1.5.
   f. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2,500 to 3,000 fpm (13 to 15 m/s): Increase running torque by 2.0.
4. Coupling: V-bolt and V-shaped, toothed cradle.
5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
7. Power Requirements (Two-Position Spring Return): 24Vac.
8. Power Requirements (Modulating): Maximum 10 VA at 24Vac or 8 W at 24Vdc.
9. Proportional Signal: 2 to 10Vdc or 4 to 20 mA, and 2 to 10Vdc position feedback signal.
10. Temperature Rating: 40 to 104ºF (5 to 40ºC).
11. Temperature Rating (Smoke Dampers): -22 to +250ºF (-30 to +121ºC).
12. Run Time: 12 seconds open, 5 seconds closed.
13. Pilot Positioners: With the following characteristics:
   a. Start Point: Adjustable from 2 to 12 psig (14 to 83 kPa).
   b. Operating Span: Adjustable from 5 to 13 psig (35 to 90 kPa).
   c. Linearity: ±10% of output signal span.
   d. Hysteresis: 3% of span.
   e. Response: 0.25-psig (1723-Pa) input change.
   f. Maximum Pilot Signal Pressure: 20 psig (140 kPa).
   g. Maximum Control Air-Supply Pressure: 60 psig (410 kPa).
14. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140ºF (10 to 60ºC) unless located in return-air plenums.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that conditioned power supply is available to control units and operator workstation.
B. Verify that pneumatic piping and duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

3.02 INSTALLATION:

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
B. Connect and configure equipment and software to achieve sequence of operation specified.
C. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches (1220 mm)above the floor.
    1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
D. Install guards on thermostats in the following locations:
    1. Entrances.
    2. Public areas.
    3. Where indicated.
E. Install automatic dampers according to Section 23 33 00 – "Air Duct Accessories."
F. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
G. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

3.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION:

A. Install raceways, boxes, and cabinets according to Division 26.
B. Install building wire and cable according to Division 26.
C. Install signal and communication cable according to Division 27.
    1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
    2. Install exposed cable in raceway.
    3. Install concealed cable in raceway.
    4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
    5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
    6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
    7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

3.04 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
2. Test and adjust controls and safeties. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
3. Test each point through its full operating range to verify that safety and operating control set points are as required.
4. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
5. Test each system for compliance with sequence of operation.
6. Test software and hardware interlocks.
7.

C. DDC Verification:
1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material, and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gauges are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.05 ADJUSTING:

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100% of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100% output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.

e. Check resistance temperature inputs at 0, 50, and 100% of span using a precision-resistant source.

5. Flow:
   a. Set differential pressure flow transmitters for 0 and 100% values with 3-point calibration accomplished at 50, 90, and 100% of span.
   b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
   a. Calibrate pressure transmitters at 0, 50, and 100% of span.
   b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
   a. Calibrate resistance temperature transmitters at 0, 50, and 100% of span using a precision-resistance source.
   b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100% open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100% closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Construction Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.06 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01.

END OF SECTION 23 09 00

SECTION 23 31 13 – METAL DUCTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Single-wall rectangular ducts and fittings.
   2. Single-wall round and flat-oval ducts and fittings.
   3. Sheet metal materials.
   4. Duct liner.
   5. Sealants and gaskets.
   6. Hangers and supports.

1.03 RELATED REQUIREMENTS:

A. Section 23 05 93 - Testing, Adjusting and Balancing for HVAC for testing, adjusting, and balancing requirements for metal ducts.

B. Section 23 33 00 - Air Duct Accessories for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.04 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
      a. ASCE/SEI 7 - Minimum Design Loads for Buildings and Other Structures.
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
   4. American Welding Society (AWS):
      a. AWS D1.1/D1.1M - Structural Welding Code - Steel.
      b. AWS D1.2/D1.2M - Structural Welding Code - Aluminum.
      c. AWS D9.1M/D9.1 - Sheet Metal Welding Code.
   5. ASTM International (ASTM):
      a. ASTM A36/A36M - Specification for Carbon Structural Steel.
      b. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      c. ASTM A492 - Specification for Stainless Steel Rope Wire.
      d. ASTM A603 - Specification for Zinc-Coated Steel Structural Wire Rope.
      e. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      f. ASTM A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
      g. ASTM B209 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

h. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
i. ASTM C916 - Specification for Adhesives for Duct Thermal Insulation.
j. ASTM C920 - Specification for Elastomeric Joint Sealants.
k. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
l. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
m. ASTM E488 - Test Methods for Strength of Anchors in Concrete and Masonry Elements.

6. Code of Federal Regulations (CFR):
   a. 40 CFR - Protection of Environment, Chapter I - Environmental Protection Agency, Part 59 - "National Volatile Organic Compound Emission Standards for Consumer and Commercial Products," Subpart D - "National Volatile Organic Compound Emission Standards for Architectural Coatings."
7. National Air Duct Cleaners Association (NADCA):
   a. NADCA 1992 - Mechanical Cleaning of Non-Porous Air Conveyance System Components.
   b. NADCA ACR - Assessment, Cleaning and Restoration of HVAC Systems.
8. NFPA:
   a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
   b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
   c. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations (ANSI).
9. The North American Insulation Manufacturers Association (NAIMA):
   a. NAIMA AH124 - Fibrous Glass Duct Liner Standard.
10. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
    a. HVAC Air Duct Leakage Test Manual.
    b. HVAC Duct Construction Standards - Metal and Flexible.
    c. IAQ Guidelines for Occupied Buildings under Construction - Appendix G, Duct Cleanliness for New Construction Guidelines.
    d. Seismic Restraint Manual: Guidelines for Mechanical Systems.
11. Underwriters Laboratories, Inc. (UL):
    a. UL 723 - Test for Surface Burning Characteristics of Building Materials.

1.05 PERFORMANCE/DESIGN CRITERIA:

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible".
C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.06 SUBMITTALS:

A. Product Data: For each type of the following products:
   1. Liners and adhesives.
   2. Sealants and gaskets.
   3. Seismic-restraint devices.
   4. Duct-Cleaning Test Report for Prerequisite IEQ 1: Documentation of work performed for compliance with ASHRAE 62.1, Section 7.2.4, "Ventilation System Start-up."

B. Shop Drawings:
   1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   2. Factory- and shop-fabricated ducts and fittings.
   3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   4. Elevation of top of ducts.
   5. Dimensions of main duct runs from building grid lines.
   6. Fittings.
   7. Reinforcement and spacing.
   8. Seam and joint construction.
   9. Penetrations through fire-rated and other partitions.
   10. Equipment installation based on equipment being used on Project.
   11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
   12. Hangers and supports, including methods for duct and building attachment, and vibration isolation.

C. Delegated-Design Submittal:
   1. Sheet metal thicknesses.
   2. Joint and seam construction and sealing.
   3. Reinforcement details and spacing.
   4. Materials, fabrication, assembly, and spacing of hangers and supports.
   5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

D. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
   1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
   2. Suspended ceiling components.
   3. Structural members to which duct will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Penetrations of smoke barriers and fire-rated construction.
   6. Items penetrating finished ceiling including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Perimeter moldings.

E. Welding Procedure Specification (WPS) and Welder Performance Qualification Record (WPQR)
F. Field quality-control reports.

1.07 QUALITY ASSURANCE:

A. Welding Qualifications: Qualify welding procedures, welders, and welding operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports. Welding Qualifications: Qualify welding procedures, welders, and welding operators according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
   2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5, "Systems and Equipment" and Section 7, "Construction and System Start-Up."

PART 2 - PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class, unless otherwise indicated.
B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS:

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class, unless otherwise indicated.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Lindab, Inc.
      b. McGill AirFlow, LLC.
      c. SEMCO Incorporated.
      d. Sheet Metal Connectors, Inc.
      e. Spiral Manufacturing Co., Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Transverse Joints in Ducts Larger Than 60 inches (1524 mm) in Diameter: Flanged.
D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
   1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
   2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS:

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods, unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
B. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: G60 (Z180) or better.
   2. Finishes for Surfaces Exposed to View: Mill phosphatized.
C. Carbon-Steel Sheets: Comply with ASTM A1008/A1008M, with oiled, matte finish for exposed ducts.
D. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
E. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
F. Reinforcement Shapes and Plates: ASTM A36/A36M, steel plates, shapes, and bars; black and galvanized.
   1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.04 DUCT LINER:

A. Fibrous-Glass Duct Liner: Comply with ASTM C1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. CertainTeed Corporation; Insulation Group.
      b. Johns Manville.
      c. Knauf Insulation.
      d. Owens Corning.
      e. Maximum Thermal Conductivity:
         (1) Type II, Rigid: 0.23 Btu by in./h by sq. ft. by ºF (0.033 W/m by K)at 75ºF (24ºC) mean temperature.
   2. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.
   3. Solvent or Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

B. Natural-Fiber Duct Liner: 85% cotton, 10% borate, and 5% polybinding fibers, treated with a microbial growth inhibitor and complying with NFPA 90A or NFPA 90B.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Bonded Logic, Inc.
      b. Reflectix, Inc.
   2. Maximum Thermal Conductivity: 0.24 Btu by in./h by sq. ft. by ºF (0.034 W/m by K) at 75ºF (24ºC) mean temperature when tested according to ASTM C518.
   3. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to ASTM E84; certified by an NRTL.
   4. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.

C. Insulation Pins and Washers:
   1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch (2.6-mm) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.
   2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch (0.41-mm) thick stainless steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

D. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."
   1. Adhere a single layer of indicated thickness of duct liner with at least 90% adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
   2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
   3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2,500 fpm (12.7 m/s).
7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    a. Fan discharges.
    b. Intervals of lined duct preceding unlined duct.
    c. Upstream edges of transverse joints in ducts where air velocities are higher than 2,500 fpm (12.7 m/s) or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
    a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23%.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.05 SEALANT AND GASKETS:

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:
    1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
    2. Tape Width: 4 inches (102 mm).
    3. Sealant: Modified styrene acrylic.
    4. Water resistant.
    5. Mold and mildew resistant.
    6. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive and negative.
    7. Service: Indoor and outdoor.
    8. Service Temperature: -40 to +200ºF (-40 to +93ºC).
    9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

C. Water-Based Joint and Seam Sealant:
    1. Application Method: Brush on.
    2. Solids Content: Minimum 65%.
    3. Shore A Hardness: Minimum 20.
    4. Water resistant.

5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:
1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60%.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. Maximum Static-Pressure Class: 10-inch w.g. (2500 Pa), positive or negative.
9. Service: Indoor or outdoor.
10. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. Flanged Joint Sealant: Comply with ASTM C920.
1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

2.06 HANGERS AND SUPPORTS:

A. Hanger Rods for Noncorrosive Environments: Zinc-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A492.

F. Zinc-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:
1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

PART 3 - EXECUTION

3.01 DUCT INSTALLATION:

A. Coordinate duct layout and duct accessory arrangement with Drawings. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated, unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," unless otherwise indicated.

C. Install ducts with fewest possible joints.

D. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

E. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

F. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

G. Install ducts with a clearance of 1 inch (25 mm), plus allowance for insulation thickness.

H. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.

I. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches (38 mm).

J. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 23 33 00 - Air Duct Accessories for fire and smoke dampers.

K. Protect duct interiors from moisture, construction debris and dust, and other foreign materials.

3.02 INSTALLATION OF EXPOSED DUCTWORK:

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.03 DUCT SEALING:

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

3.04 HANGER AND SUPPORT INSTALLATION:

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
   1. Where practical, install concrete inserts before placing concrete.
   2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
   3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick. These fasteners shall not be used to support ductwork larger than 24 inches square.
   4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1 (Table 5-1M), "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at maximum intervals of 16 feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.05 CONNECTIONS:

A. Make connections to equipment with flexible connectors complying with Section 23 33 00 - Air Duct Accessories.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.06 PAINTING:

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in DIVISION 09 Painting Sections.

3.07 FIELD QUALITY CONTROL:

A. Perform tests and inspections.

B. Leakage Tests:
   1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
   2. Test the following systems:

3.08 START UP:

A. Air Balance: Comply with requirements in Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

3.09 DUCT SCHEDULE:

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
   1. Underground Ducts: Concrete-encased, PVC-coated, galvanized sheet steel with thicker coating on duct exterior.

B. Supply Ducts:
   1. Ducts Connected to Constant-Volume Air-Handling Units:
      a. Pressure Class: Positive w.g. 3-inch w.g. (750 Pa).
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.
   2. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive 3-inch w.g. (750 Pa)
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.

C. Return Ducts:
   1. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 2-inch w.g. (500 Pa) w.g..
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 12.
   2. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive or negative 3-inch w.g. (750 Pa).
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.

D. Exhaust Ducts:
   1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
      a. Pressure Class: 3-inch w.g. (750 Pa).
      b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 12.
      d. SMACNA Leakage Class for Round and Flat Oval: 12.
   2. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive or negative 3-inch w.g. (750 Pa).
      b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
      c. SMACNA Leakage Class for Rectangular: 12.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts, alternative engineer approved specialty outside air system acceptable:
   1. Ducts Connected to Air-Handling Units:
      a. Pressure Class: Positive or negative 3-inch w.g. (750 Pa).
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.
   2. Ducts Connected to Equipment Not Listed Above:
      a. Pressure Class: Positive or negative 3-inch w.g. (750 Pa).
      b. Minimum SMACNA Seal Class: B.
      c. SMACNA Leakage Class for Rectangular: 12.

F. Intermediate Reinforcement:
   1. Galvanized-Steel Ducts: Galvanized steel or carbon steel coated with zinc-chromate primer.

G. Liner:
   1. Return Air Ducts: Fibrous glass, Type I or Natural fiber, 1 inch (25 mm) thick.

2. Exhaust Air Ducts: Fibrous glass, Type I or Natural fiber, 1 inch (25 mm) thick.
3. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II or Natural fiber, 1 inch (25 mm) thick.
4. Transfer Ducts: Fibrous glass, Type I or Natural fiber, 1 inch (25 mm) thick.

H. Elbow Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Velocity 1,000 fpm (5 m/s) or Lower:
      (1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
      (2) Mitered Type RE 4 without vanes.
   b. Velocity 1,000 to 1,500 fpm (5 to 7.6 m/s):
      (1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
      (2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
      (3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
   c. Velocity 1,500 fpm (7.6 m/s) or Higher:
      (1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      (2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
      (3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
   a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
   b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
   c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
   a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
      (1) Velocity 1,000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
      (2) Velocity 1,000 to 1,500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
      (3) Velocity 1,500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
      (4) Radius-to Diameter Ratio: 1.5.
   b. Round Elbows, 12 inches (305 mm) and Smaller in Diameter: Stamped or pleated.
   c. Round Elbows, 14 inches (356 mm) and Larger in Diameter: Welded.

I. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
   a. Rectangular Main to Rectangular Branch: 45-degree entry.

b. Rectangular Main to Round Branch: Spin in.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90-Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
   a. Velocity 1,000 fpm (5 m/s) or Lower: 90-degree tap.
   b. Velocity 1,000 to 1,500 fpm (5 to 7.6 m/s): Conical tap.
   c. Velocity 1,500 fpm (7.6 m/s) or Higher: 45-degree lateral.

END OF SECTION 23 31 13

SECTION 23 33 00 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Manual volume dampers.
   2. Turning vanes.
   3. Flexible connectors.
   4. Duct accessory hardware.

1.03 REFERENCE STANDARDS:

A. Applicable Standards (Latest Edition):
   1. Air Movement and Control Association International, Inc. (AMCA):
      a. AMCA 500-D - Laboratory Methods of Testing Dampers for Rating (ANSI).
   2. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
   4. ASTM International (ASTM):
      a. ASTM A480/A480M - Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
      b. ASTM A653/A653M - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      c. ASTM B209-07 - Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. ASTM B221-07 - Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
      e. ASTM E84-09a - Test Method for Surface Burning Characteristics of Building Materials.
      f. ASTM E477-06a - Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
   5. NFPA:
      a. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).
      b. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).
      c. NFPA 96 - Ventilation Control and Fire Protection of Commercial Cooking Operations.
   6. North American Insulation Manufacturers Association (The) (NAIMA):
      a. NAIMA AH116 - Fibrous Glass Duct Construction Standards.
   7. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).
      a. HVAC Duct Construction Standards - Metal and Flexible
   8. Underwriters Laboratories, Inc. (UL):
      a. UL 181 - Factory-Made Air Ducts and Air Connectors.
      b. UL 555 - Fire Dampers.

c. UL 555C - Ceiling Dampers.
d. UL 555S - Smoke Dampers.
e. UL 1978 - Standard for Grease Ducts.
f. Fire Resistance Directory.

1.04 SUBMITTALS:

A. Product Data: For each type of product.
   1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
   1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances, and method of field assembly into duct systems and other construction. Include the following:
      a. Special fittings.
      b. Manual volume damper installations.
      c. Control-damper installations.
      d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
      e. Duct security bars.
      f. Wiring Diagrams: For power, signal, and control wiring.
C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
D. Source quality-control reports.
E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.
F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fusible Links: Furnish quantity equal to 10% of amount installed.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION:

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS:

A. Galvanized Sheet Steel: Comply with ASTM A653/A653M.
   1. Galvanized Coating Designation: G60 (Z180) or better.
   2. Exposed-Surface Finish: Mill phosphatized.
B. Stainless-Steel Sheets: Comply with ASTM A480/A480M, Type 304, and having a No. 2 finish for concealed ducts and exposed ducts.

C. Aluminum Sheets: Comply with ASTM B209 (ASTM B209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
D. Extruded Aluminum: Comply with ASTM B221 (ASTM B221M), Alloy 6063, Temper T6.
E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.03 MANUAL VOLUME DAMPERS:

A. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. American Warming and Ventilating; a division of Mestek, Inc.
b. McGill AirFlow, LLC.
c. Pottorff.
d. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
a. Frame: Hat-shaped, minimum 0.094 inch (2.4 mm) thick, galvanized sheet steel.
b. Mitered and welded corners.
c. Flanges for attaching to walls and flangeless frames for installing in ducts.
5. Blades:
a. Multiple or single blade.
b. Parallel- or opposed-blade design.
c. Stiffen damper blades for stability.
d. Galvanized or Stainless-steel, 0.064 inch (1.62 mm) thick.
6. Blade Axles: Galvanized steel or Stainless steel.
7. Bearings:
a. Oil-impregnated bronze, Oil-impregnated stainless-steel sleeve, or Stainless-steel sleeve.
b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Galvanized steel.

B. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Air Balance, Inc.; a division of Mestek, Inc.
b. American Warming and Ventilating; a division of Mestek, Inc.
c. McGill AirFlow, LLC.
d. Pottorff.
e. Ruskin Company.
2. Comply with AMCA 500-D testing for damper rating.
3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
4. Suitable for horizontal or vertical applications.
5. Frames:
a. Minimum 0.094 inch (2.4 mm) thick, galvanized sheet steel.
b. Mitered and welded corners.

c. Flanges for attaching to walls and flangeless frames for installing in ducts.

6. Blades:
   a. Multiple or single blade.
   b. Parallel- or opposed-blade design.
   c. Stiffen damper blades for stability.
   d. Galvanized or Stainless, roll-formed steel, 0.064 inch (1.62 mm) thick.
7. Blade Axles: Galvanized steel or Stainless steel.
8. Bearings:
   a. Oil-impregnated bronze, molded synthetic, Oil-impregnated stainless-steel sleeve, Stainless-steel sleeve.
   b. Dampers in ducts with pressure classes of 3-inch w.g. (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
9. Blade Seals: Vinyl or Neoprene.
10. Jamb Seals: Cambered stainless steel or aluminum.
11. Tie Bars and Brackets: Galvanized steel or aluminum.
12. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

C. Jackshaft:
1. Size: minimum 0.5-inch (13-mm) diameter.
2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.

D. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch (2.4-mm) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.04 TURNING VANES:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne, Inc.
3. Elgen Manufacturing.
4. METALAIRE, Inc.
5. SEMCO, Incorporated.
6. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."

E. Vane Construction: Double wall.

2.05 FLEXIBLE CONNECTORS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne, Inc.
   3. Elgen Manufacturing.
   4. Ventfabrics, Inc.
   5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Materials: Flame-retardant or noncombustible fabrics.

C. Coatings and Adhesives: Comply with UL 181, Class 1.

D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4 inches (70 mm) wide, 0.028 inch (0.7 mm) thick, galvanized sheet steel or 0.032 inch (0.8 mm) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
   1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
   2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
   3. Service Temperature: -40 to +200ºF (-40 to +93ºC).

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
   1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
   2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
   3. Service Temperature: -50 to +250ºF (-45 to +121ºC).

G. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80% of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50% of the required deflection at rated load.
   4. Lateral Stiffness: More than 80% of rated vertical stiffness.
   5. Overload Capacity: Support 200% of rated load, fully compressed, without deformation or failure.
   6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.06 DUCT ACCESSORY HARDWARE:

1. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
2. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
   1. Install steel volume dampers in steel ducts.

D. Set dampers to fully open position before testing, adjusting, and balancing.

E. Install test holes at fan inlets and outlets and elsewhere as indicated.

F. Install fire/ smoke dampers according to UL listing.

G. Connect ducts to duct silencers with flexible duct connectors.

H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
   1. On both sides of duct coils.
   2. Upstream from duct filters.
   3. At outdoor-air intakes and mixed-air plenums.
   4. At drain pans and seals.
   5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
   6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
   7. At each change in direction and at maximum 50-foot (15-m) spacing.
   8. Upstream and downstream from turning vanes.
   9. Upstream or downstream from duct silencers.
   10. Control devices requiring inspection.
   11. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Access Door Sizes:
   1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
   2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
   3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
   4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
   5. Body Access: 25 by 14 inches (635 by 355 mm).
   6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

K. Label access doors according to Section 23 05 93 - Identification for HVAC Piping and Equipment to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch w.g. (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch (6-mm) movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL:

A. Tests and Inspections:
   1. Operate dampers to verify full range of movement.
   2. Inspect locations of access doors and verify that purpose of access door can be performed.
   3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
   4. Inspect turning vanes for proper and secure installation.
   5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 23 33 00

SECTION 23 37 13 – DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Louver face diffusers.
   2. Fixed face registers and grilles.

1.03 RELATED REQUIREMENTS:

A. Section 23 33 00 - Air Duct Accessories for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. Applicable Standards (Latest Edition):
   1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets (ANSI).

1.05 SUBMITTALS:

A. Action Submittals:
   1. Product Data: For each type of product indicated, include the following:
      a. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
      b. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
   2. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
   3. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

B. Informational Submittals:
   1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
      a. Ceiling suspension assembly members.
      b. Method of attaching hangers to building structure.
      c. Size and location of initial access modules for acoustical tile.
      d. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
      e. Duct access panels.
   2. Source quality-control reports.

PART 2 - PRODUCTS

2.01 DIFFUSERS, REGISTERS, AND GRILLES:

A. For all diffusers, registers, and grilles:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Krueger.
      b. Price Industries.
      c. Titus.
   2. All products shall conform to the schedules.

2.02 SOURCE QUALITY CONTROL:

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install diffusers, registers, and grilles level and plumb.
B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.03 ADJUSTING:

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13

SECTION 23 74 13 – PACKAGED, OUTDOOR, CENTRAL-STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes packaged, outdoor, central-station air handling units (rooftop units) with the following components and accessories:
   1. Direct-expansion cooling.
   2. Electric heating coils.
   3. Economizer outdoor- and return-air damper section.
   4. Integral, space temperature controls.
   5. Roof curbs.

1.03 REFERENCES:

A. Applicable Standards (Latest Edition):
   1. Air-Conditioning & Refrigeration Institute (ARI):
      a. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
      b. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
      c. ARI 340/360 - Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment.
      d. ARI Guideline B - Roof-Mounted Outdoor Air-Conditioning Installations.
   2. American National Standards Institute (ANSI):
      a. ANSI Z21.47 - Gas-Fired Central Furnaces.
   3. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. ASHRAE 15 - Safety Standard for Refrigeration Systems.
      b. ASHRAE 33 - Methods of Testing Forced Circulation Air Cooling and Heating Coils (ANSI).
      c. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter (ANSI).
      d. ASHRAE 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI).
      e. ASHRAE 62.1 - Ventilation for Acceptable Indoor Air Quality (ANSI).
   4. American Society of Heating, Refrigerating and Air-Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. ASHRAE/IESNA 90.1 - Energy Standard for Buildings except Low-Rise Residential Buildings (ANSI).
   5. ASTM International (ASTM):
      a. ASTM C916 - Specification for Adhesives for Duct Thermal Insulation.
      b. ASTM C1071 - Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
   6. National Roofing Contractors Association:
      a. Low-Slope Membrane Roofing Construction Details Manual Vol. 1.
   7. NFPA:
      a. NFPA 54 - National Fuel Gas Code (ANSI).
      b. NFPA 70 - National Electrical Code.
      c. NFPA 90A - Installation of Air Conditioning and Ventilating Systems (ANSI).

d. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems (ANSI).

8. Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE):
   a. SEI/ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
9. Underwriters Laboratories, Inc. (UL):
   a. UL 1995 - Heating and Cooling Equipment.

1.04 DEFINITIONS:

A. DDC: Direct-digital controls.
B. ECM: Electrically commutated motor.
C. Outdoor-Air Refrigerant Coil: Refrigerant coil in the outdoor-air stream to reject heat during cooling operations and to absorb heat during heating operations. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
D. Outdoor-Air Refrigerant Coil Fan: The outdoor-air refrigerant coil fan in RTUs. "Outdoor air" is defined as the air outside the building or taken from outdoors and not previously circulated through the system.
E. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
F. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
G. Supply-Air Refrigerant Coil: Refrigerant coil in the supply-air stream to absorb heat (provide cooling) during cooling operations and to reject heat (provide heating) during heating operations. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.05 PERFORMANCE REQUIREMENTS:

A. Wind-Restraint Performance:
   1. Reference Structural drawings for wind loading information.
   2. Minimum 10 lb./ft.^{2} (48.8 kg/m^2) multiplied by the maximum area of the mechanical component projected on a vertical plane that is normal to the wind direction, and 45 degrees either side of normal.

1.06 ACTION SUBMITTALS:

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

1.07 INFORMATIONAL SUBMITTALS:

A. Field quality control test reports.
B. Warranty: Special warranty specified in this Section.

1.08 CLOSEOUT SUBMITTALS:

A. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.09 MAINTENANCE MATERIAL SUBMITTALS:

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set for each belt-driven fan.
   2. Filters: One set of filters for each unit.

1.10 QUALITY ASSURANCE:

A. ARI Compliance:
   1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.
   2. Comply with ARI 270 for testing and rating sound performance for RTUs.
B. ASHRAE Compliance:
   1. Comply with ASHRAE 15 for refrigeration system safety.
   2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.
E. UL Compliance: Comply with UL 1995.
F. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.11 WARRANTY:

A. Warranty Period for Compressors: The warranty shall comply with the requirements of SECTION 01 78 36 and shall extend for 5 years.
B. Warranty Period for Gas Furnace Heat Exchangers: The warranty shall comply with the requirements of SECTION 01 78 36 and shall extend for 5 years.
C. Warranty Period for Solid-State Ignition Modules: The warranty shall comply with the requirements of SECTION 01 78 36.
D. Warranty Period for Control Boards: The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AAON, Inc.
   2. AbsoluteAire
   3. Addison Products Company.
   4. Carrier Corporation.
   5. Daikin North America LLC.
   6. Engineered Air.
   7. Lennox Industries, Inc.
   8. McQuay International.
   9. Trane; American Standard Companies, Inc.
   10. YORK International Corporation.

2.02 CASING:

A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.

B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
   1. Exterior Casing Thickness: 0.052 inch (1.3 mm) thick.

C. Inner Casing Fabrication Requirements:
   1. Inside Casing: Galvanized steel, 0.028 inch (0.7 mm) thick, perforated 40% free area.

D. Casing Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   1. Materials: ASTM C1071, Type I.
   2. Thickness: 1/2 inch (13 mm).
   3. Liner materials shall have air stream surface coated with an erosion- and temperature-resistant coating or faced with a plain or coated fibrous mat or fabric.
   4. Liner Adhesive: Comply with ASTM C916, Type I.

E. Condensate Drain Pans: Formed sections of galvanized-steel sheet, a minimum of 2 inches (50 mm) deep.
   1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
   2. Drain Connections: Threaded nipple.
   3. Pan-Top Surface Coating: Corrosion-resistant compound.

F. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

2.03 FANS:

A. Direct-Driven Supply-Air Fans: Double width, backward inclined, centrifugal; with permanently lubricated, ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

B. Belt-Driven Supply-Air Fans: Double width, forward curved, centrifugal; with permanently lubricated, single-speed motor installed on an adjustable fan base resiliently mounted in the casing. Aluminum or painted-steel wheels, and galvanized- or painted-steel fan scrolls.

C. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

D. Relief-Air Fan: Propeller, shaft mounted on permanently lubricated motor.

E. Fan Motor: Comply with requirements in Section 23 05 13 - Common Motor Requirements for HVAC Equipment.

2.04 COILS:

A. Supply-Air Refrigerant Coil:
   1. Aluminum-plate fin and seamless internally grooved copper tube in steel casing with equalizing-type vertical distributor.
   2. Condensate Drain Pan: Galvanized steel with corrosion-resistant coating formed with pitch and drain connections.

B. Electric-Resistance Heating:
   1. Open Heating Elements: Resistance wire of 80% nickel and 20% chromium, supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.
   2. Overtemperature Protection: Disk-type, automatically reset, thermal-cutout, safety device; serviceable through terminal box.

3. Overcurrent Protection: Manual-reset thermal cutouts, factory wired in each heater stage.
4. Control Panel: Unit mounted with disconnecting means and overcurrent protection. Include the following controls:
    a. Magnetic contactors.
    b. Step Controller: Pilot lights and override toggle switch for each step.
    c. Time-delay relay.
    d. Airflow proving switch.

2.05 REFRIGERANT CIRCUIT COMPONENTS:

A. Number of Refrigerant Circuits: Two.

B. Compressor: Hermetic, reciprocating or Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high temperature protection, internal pressure relief, and crankcase heater.

C. Refrigeration Specialties:
1. Refrigerant: R-407C or R-410A.
2. Expansion valve with replaceable thermostatic element.
3. Refrigerant filter/dryer.
4. Manual-reset high-pressure safety switch.
5. Automatic-reset low-pressure safety switch.
6. Minimum off-time relay.
7. Automatic-reset compressor motor thermal overload.
8. Brass service valves installed in compressor suction and liquid lines.
9. Low-ambient kit high-pressure sensor.
10. Hot-gas bypass solenoid valve with a replaceable magnetic coil.

2.06 ELECTRIC-RESISTANCE HEATING COIL:

A. UL Compliance: Comply with requirements in UL 1995.

B. Electric-Resistance Heating Elements:
1. Open-Coil Resistance Wire: 80% nickel and 20% chromium.
2. Supports and Insulation: Floating ceramic bushings recessed into casing openings; fastened to supporting brackets and mounted in galvanized-steel frame.
3. Heating Capacity: Low density 35 W per inch^2 (54 kW per m^2), factory wired for single-point wiring connection; with time delay for element staging and overcurrent- and overheat-protection devices.
4. Safety Controls:
    a. Blower-motor interlock, air-pressure switch.
    b. Quiet mercury contactors.
    c. Time delay between steps.
    d. Integral, nonfused power disconnect switch.

2.07 AIR FILTRATION:

A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: Minimum 90% arrestance, and MERV 7.

2.08 DAMPERS:

A. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in

reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.

1. Damper Motor: Modulating with adjustable minimum position.
2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

2.09 OUTDOOR-AIR INTAKE HOOD:

A. Type: Manufacturer's standard hood or louver.
B. Materials: Match cabinet.
C. Bird Screen: Comply with requirements in ASHRAE 62.1.
D. Configuration:
   1. Designed to inhibit wind-driven rain and snow from entering unit.
   2. Fabricate intake louvers of aluminum with frame matching cabinet.
   3. Depth: Six inches with plenum.
   4. Provide aluminum bird screen, removable for cleaning from outside.
   5. Delrin bearings on intake damper if provided.

2.10 FILTERS:

A. Cleanable Pre-Filters: 2 inches (50 mm) thick, [MERV 8] cleanable metal mesh.
B. Disposable Panel Filters:
   1. Comply with NFPA 90A.
   2. Factory-fabricated, viscous-coated, flat-panel type.
   3. Thickness: 1 inch (25 mm).
   4. Minimum Merv: 7, according to ASHRAE 52.2.
   5. Media: Interlaced glass fibers sprayed with nonflammable adhesive.
C. Mounting Frames:
   1. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
   2. Extended surface filters arranged for flat orientation, removable from access plenum.
   3. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.
   4. Provide factory mounted differential pressure gauge on cabinet exterior for each filter bank.

2.11 ELECTRICAL POWER CONNECTION:

A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.
B. Wiring: Numbered and color-coded to match wiring diagram.
C. Wiring Location: Install factory wiring outside an enclosure in a raceway.
D. Power Interface: Field power interface shall be to heavy-duty, nonfused disconnect switch.
E. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
   1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
   2. NEMA KS 1, heavy-duty, nonfusible switch.
   3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
F. Factory-Mounted, Overcurrent-Protection Service: For each motor.

G. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
H. Controls: Factory wire unit-mounted controls where indicated.
I. Lights: Factory wire unit-mounted lights.
J. Receptacle: Factory wire unit-mounted, ground fault interrupt (GFI) duplex receptacle.
K. Control Relays: Auxiliary and adjustable time-delay relays.

2.12 CONTROLS:

A. Basic Unit Controls:
1. Control-voltage transformer.
2. Wall-mounted thermostat or sensor with the following features:
a. Heat-cool-off switch.
b. Fan on-auto switch.
c. Fan-speed switch.
d. Automatic changeover.
e. Adjustable dead band.
f. Exposed set point.
g. Exposed indication.
h. ºF indication.
i. Unoccupied-period-override push button.
j. Data entry and access port to input temperature set points, occupied and unoccupied periods, and output room temperature, supply-air temperature, operating mode, and status.
3. Remote Wall-Mounted Annunciator Panel for Each Unit:
a. Lights to indicate power on, cooling, heating, fan running, filter dirty, and unit alarm or failure.
b. DDC controller or programmable timer and interface with HVAC instrumentation and control system.
c. Digital display of outdoor-air temperature, supply-air temperature, return-air temperature, economizer damper position, indoor-air quality, and control parameters.

B. Refrigeration System Controls:
1. Unit-mounted enthalpy controller shall lock out refrigerant system when outdoor-air enthalpy is less than 28 Btu/lb. (65 kJ/kg) of dry air or outdoor-air temperature is less than 60ºF (15ºC).

C. Electric-Resistance Heat Controls:
1. Wall-mounted, space-temperature sensor with temperature adjustment on remote-control panel to control electric coil to maintain temperature.
2. Capacity Controls: On/off.

D. Barometric Relief Dampers: Gravity damper shall open to relieve positive pressure in the return air section when required building pressurization achieved.

2.13 ACCESSORIES:

A. Duplex, 115V, ground-fault-interrupter outlet with 15 A overcurrent protection. Include transformer if required.
B. Low-ambient kit using staged condenser fans for operation down to 35ºF (1.7ºC).
C. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
D. Hail guards of galvanized steel painted to match casing.

2.14 ROOF CURBS:

A. Provide factory standard curb with unit.

B. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
   a. Materials: ASTM C1071, Type I or II.
   b. Thickness: 1 inch (25 mm).
2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
   a. Liner Adhesive: Comply with ASTM C916, Type I.
   b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
   c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
   d. Liner Adhesive: Comply with ASTM C916, Type I.

C. Curb Height: 18 inches.

2.15 CAPACITIES AND CHARACTERISTICS:

A. Refer to drawings for unit capacities and characteristics.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Roof Curb: Install on roof structure or concrete base, level and secure, according to NRCA's "Low-Slope Membrane Roofing Construction Details Manual," Illustration "Raised Curb Detail for Rooftop Air Handling Units and Ducts." Install RTUs on curbs and coordinate roof penetrations and flashing with roof construction specified in Division 07. Secure RTUs to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts.

3.03 CONNECTIONS:

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Install piping adjacent to RTUs to allow service and maintenance.

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.
2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3. Connect supply ducts to RTUs with flexible duct connectors specified in Section 23 33 00 - Air Duct Accessories.
4. Install return-air duct continuously through roof structure.

3.04 FIELD QUALITY CONTROL:

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing. Report results in writing.

C. Tests and Inspections:
1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

3.05 STARTUP SERVICE:

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to furnace combustion chamber.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Remove packing from vibration isolators.
11. Inspect operation of barometric relief dampers.
12. Inspect operation of barometric relief dampers.
13. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Adjust fan belts to proper alignment and tension.
16. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
17. Inspect and record performance of interlocks and protective devices; verify sequences.
18. Operate unit for an initial period as recommended or required by manufacturer.
19. Calibrate thermostats.

20. Adjust and inspect high temperature limits.
21. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
22. Start refrigeration system and measure and record the following when ambient is a minimum of 15ºF (8ºC) above return air temperature:
    a. Coil leaving air, dry and wet bulb temperatures.
    b. Coil entering air, dry and wet bulb temperatures.
    c. Outdoor air, dry bulb temperature.
    d. Outdoor air coil, discharge air, dry bulb temperature.
23. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.
24. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.
    a. Supply air volume.
    b. Return air volume.
    c. Relief air volume.
    d. Outdoor air intake volume.
25. Simulate maximum cooling demand and inspect the following:
    a. Compressor refrigerant suction and hot gas pressures.
    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.
26. Verify operation of remote panel including pilot light operation and failure modes. Inspect the following:
    a. High temperature limit on electric heating coil.
    b. Low temperature safety operation.
    c. Filter high-pressure differential alarm.
    d. Economizer to minimum outdoor-air changeover.
    e. Relief-air fan operation.
    f. Smoke and firestat alarms.
27. After startup and performance testing and prior to Construction Acceptance, replace existing filters with new filters.

3.06 CLEANING AND ADJUSTING:

A. Adjust initial temperature set points.
B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
C. Occupancy Adjustments: When requested within 12 months of date of Construction Acceptance, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Site during other-than-normal occupancy hours for this purpose.
D. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.07 DEMONSTRATION:

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain RTUs. Refer to Division 01.

END OF SECTION 23 74 13

DIVISION 26 – ELECTRICAL

SECTION 26 00 00 – GENERAL ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SUMMARY:

A. This SECTION includes requirements for electrical Work by this Contract.

B. The following administrative and procedural requirements are included in this SECTION to expand the requirements specified in DIVISION 01:
   1. Submittals.
   2. Coordination drawings.
   3. Record documents.
   4. Maintenance manuals.
   5. Rough-ins.
   6. Electrical installations.
   7. Cutting and patching.
   8. Touch-up painting.

C. Install and make suitable for operation equipment furnished by others per the Drawings and Specifications.

D. Provide Equipment as specified in Division 26.

E. Furnish and install Material for electrical equipment and systems; including supports, conduit, fittings, wiring and connectors.

F. Furnish all Labor and Materials to complete the Work as specified in accordance with national, state and local governing bodies having jurisdiction.

G. All Equipment and Material shall be rated for the Project Site conditions as specified in DIVISION 01.

H. Provide all temporary construction power and lighting.

I. Provide skilled labor and technical assistance to manufacturer's service representatives for the configuration and startup of electrical Equipment and Systems.

J. Perform Work in the follow locations at the Project Site:
   1. Pump Station interior.
   2. Pump Station exterior.
   3. Potable and Reuse water tanks and duct bank in between.

K. Coordinate Work with others as specified in this SECTION PART 3 - EXECUTION.

1.02 RELATED REQUIREMENTS:

A. DIVISION 01 - General Requirements.

B. DIVISION 03 - Concrete.

C. SECTION 09 90 00 - Protective Coatings

D. DIVISION 23 - Heating, Ventilating, and Air Conditioning (HVAC).

E. SECTION 26 05 19 - Low-Voltage Conductors and Cables

F. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems

G. SECTION 26 05 29 - Hangers and Supports for Electrical Systems

H. SECTION 26 05 33 - Raceway and Boxes for Electrical Systems

I. SECTION 26 05 43 - Underground Ducts and Raceways for Electrical Systems

J. SECTION 26 05 44 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling

K. SECTION 26 05 53 - Identification for Electrical Systems

L. SECTION 26 05 73 - Electrical Studies

M. SECTION 26 22 13 - Low Voltage Distribution Transformers

N. SECTION 26 24 13 - Switchboards

O. SECTION 26 24 16 - Panelboards
P. SECTION 26 24 19 - Motor Control Centers
Q. SECTION 26 27 26 - Wiring Devices
R. SECTION 26 28 16 - Enclosed Switches and Circuit Breakers
S. SECTION 26 29 00 - Enclosed Controllers
T. SECTION 26 29 23 - Variable Frequency Motor Controllers
U. SECTION 26 32 13 - Engine Generator Sets
V. SECTION 26 33 53 - Static Uninterruptible Power Supply
W. SECTION 26 35 26 - Harmonic Filters
X. SECTION 26 41 00 - Lightning Protection System
Y. SECTION 26 43 13 - Surge Protective Devices
Z. SECTION 26 50 00 - Lighting
AA. SECTION 28 10 00 – Electronic Access Control and Intrusion Detection
BB. SECTION 40 60 00 - Process Control and Instrumentation General Requirements
CC. SECTION 40 61 96 - Process Control System Programming and Reports
DD. SECTION 40 66 00 - Process Control Networks
EE. SECTION 40 67 00 - Control System Panels & Hardware
FF. SECTION 40 68 00 - Process Control Software
GG. SECTION 40 70 00 - Instrumentation for Process Systems

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of the Issued For Construction (IFC) date of the Contract Documents unless otherwise indicated.
B. American National Standards Institute (ANSI)
C. ASTM International (ASTM)
D. Federal Information Processing Standards Publication (FIPS)
E. Insulated Cable Engineer's Association (ICEA)
F. Institute of Electrical and Electronic Engineers (IEEE)
G. National Electrical Contractors Association (NECA)
H. National Electric Manufacturers Association (NEMA)
I. National Electrical Installation Standards (NEIS)
J. National Fire Protection Association (NFPA)
    1. National Electrical Code (NFPA 70) – Latest Adopted Version
    2. Standard for Electrical Safety in the Workplace (NFPA 70E)
K. Telecommunications Industry Association (TIA)
L. Underwriter's Laboratories, Inc (UL)

1.04 DEFINITIONS:

A. Definition:
    1. Direct Buried: Installed underground without encasement in concrete or other protective material.
    2. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include, but are not limited to, the following:
        a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting or pad mounting. Cabinet is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.

b. Conduit Body: A means for providing access to the interior of a raceway system through one or more removable covers at an outlet, conduit box or terminal point.
c. Conduit Box: A box having threaded openings or knockouts for conduit, flexible metal tubing, or fittings.
d. Device Box: A box with provisions for mounting a wiring device directly to the box.
e. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
f. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
g. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
h. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
i. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
j. Raised-Floor Box: A floor box intended for use in raised floors.
k. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.

3. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It includes the parts to protect the light source and the driver to connect to the light source power supply.
4. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
5. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Refer to each Section of this Division for specific Product Data, Shop drawing and additional Submittal requirements.
   1. Preliminary Short Circuit Study is to be submitted based on equipment intended to be provided. Short Circuit Study is to be approved prior to purchase orders for equipment being released/issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve proper equipment ratings.
C. Product Data, manufactured equipment:
   1. Include data specification sheets, equipment cut sheets, outline drawings, electrical equipment ratings for pressure temperature and voltage.
D. Shop Drawings, fabricated equipment:

1. Include fabrication drawings, connection point size type and rating, field wiring and ratings for pressure, temperature, power, current and voltage.
2. Clearly specify any components not provided with requirement required for safe and proper operating of equipment.

E. Coordination Drawings: in accordance with DIVISION 01, for equipment rooms, and other congested areas to a scale of 1/4 inch=1 foot-0 inch, or larger if required. Detail major electrical Systems, Equipment and Material indicated on floor plans and section detail. Check for interferences with architectural, structural or mechanical systems, installations, and building components. Do not allow electrical systems to be installed where plumbing or water systems are above electrical systems. Drawings shall indicate where space is limited for installation, maintenance access, working clearances. Drawings shall indicate where sequencing and coordination of Work is important for efficient flow of the Work and to reduce any rework. At a minimum include:
1. Elevation size and route of cable trays and raceways.
2. Relationships and clearance distances between components and adjacent architectural, structural, electrical, and mechanical elements.
3. Working clearances for equipment, including space for equipment disassembly required for periodic maintenance.
4. Exterior wall, floor, and foundation penetrations.
5. Fire-rated wall and floor penetrations.
6. Equipment connections and support details.
7. Size and location of concrete pads, footers and bases.
8. Support details.
9. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
10. Elevations, sizes of sleeves to indicate penetrations in floors, walls, and ceilings, and their relationship to other penetrations and installations.
11. Elevation of ceilings and ceiling components to coordinate and integrate installations, air outlets, air inlets, light fixtures, communications systems' components, sprinklers, heat detectors, smoke detectors, motion detectors, speakers, access panels and other ceiling-mounted devices.
12. Coordinate chases, slots, inserts, sleeves, and openings with electrical equipment. In general verify all panel connections align with each other and with other equipment where possible.

F. As-Built Records:
1. Redline all Contract Drawings and Shop Drawings to indicate changes after Issued For Construction (IFC) set of drawings.
2. Include:
   a. Major raceway systems (2” conduits and above, or groupings of 4 or more conduits of any size), size and location for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; disconnects, fuse size and location, circuit breaker sizes and arrangements.
   b. Equipment locations dimensioned from prominent building lines.
   c. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
3. Including changes resulting from:
   a. Requests for Information (RFI).
   b. Purchase Change Orders (PCO).
   c. Engineering Change Notices (ECN).

d. Requests for substitution or alternate products.

G. Operation and Maintenance (O&M) manuals: in accordance with SECTION 01 78 00 - Contract Closeout. In addition to the requirements specified in DIVISION 01, include the following:
   1. Description of function, normal operating characteristics and limitations, performance curves, engineering data, tests, and complete nomenclature and commercial numbers of replacement parts.
   2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; lockout/tagout procedures; and summer and winter operating instructions.
   3. Maintenance procedures for routine preventive maintenance and troubleshooting; disassembly, repair, reassembly; aligning and adjusting instructions.
   4. Product Data
   5. Shop Drawings
   6. Servicing instructions, lubrication charts and schedules.
   7. As-Built Records.

H. Field quality-control reports.

1.06 QUALITY ASSURANCE:

A. Installer Qualifications:
   1. Contractor shall have electrical experience in the Water and Wastewater industry for at least 5 years performing similar type of work described in the Contract Documents.

B. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer’s latest standard design that has been in satisfactory use for at least 1 year prior to Bid opening. Each major component of the equipment shall have the manufacturer’s name and type identified on the equipment. All products supplied shall be specifically designed and manufactured for use with plant communications systems. All items of the same class of equipment shall be the products of a single manufacturer unless indicated otherwise.

1.07 SOURCE QUALITY CONTROL:

A. Tests, inspections: At the shop, factory, plant, or place of manufacture.

B. Verification of performance:
   1. All Equipment and Material designs furnished shall be identical to equipment and material designs having an acceptable history of domestic service for a period of not less than three years at comparable temperature, voltage, and design stress levels.
   2. Equipment and Material designs with less than three years of actual service will be considered from established manufacturers, but shall be furnished only if accepted by Engineer and Owner prior to award of Contract.

C. Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Packing, shipping, receiving and onsite storage:
   1. Deliver products to the Project Site properly identified with names, model numbers, types, grades, compliance labels, and Engineer’s Tag Number indicated on the Contract Drawings.
   2. Protect all Equipment shipment from moisture and physical abuse which may cause:
      a. Damage to movement, mechanisms, or electronics.

b. Corrosion.
c. Reduced normal operating life.

3. Protect all Equipment connections including, but not limited to, motor electrical connections with suitable end covers to prevent entrance of foreign material.
4. Handle package store all equipment according to the manufacturer's recommendations and requirements.

1.09 PROJECT SITE CONDITIONS:

A. Approximate Site Location: Broomfield, CO
B. Altitude = 5500 feet above mean sea level.
C. Minimum and maximum outdoor ambient temperature range = -20 ºF - 105ºF.
D. Minimum and maximum indoor non-conditioned temperature range = 50ºF - 110ºF.
E. Minimum and maximum indoor conditioned temperature range = 50ºF - 85ºF.
F. Maximum Outdoor Relative Humidity = 100%.
G. Seismic Factors: Refer to Structural.

1.10 WARRANTY:

A. Provide a minimum one-year warranty on all electrical Equipment and Systems. Warranty period shall begin after Project Site Final Acceptance unless specified otherwise. Contractor shall provide written notification to Owner prior to this warranty start date.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Furnish and install Materials in accordance with NEC and NFPA 70E.
B. All components and Material shall be new and free of defects using UL recognized components.
C. All electrical Equipment, motors, panels, systems and skids shall be UL listed.
D. Fabricated panels and skids in accordance with applicable NEMA and UL standards.
E. All equipment conductor termination provisions and equipment lugs shall be UL listed for 75ºC.
F. Identify and label with permanent labels all Equipment and Material used to complete this Work. Labels clearly indicating design intent in accordance with the Contract Drawings and as specified in DIVISION 26.
G. Perform all Work Source Limitations: To the fullest extent possible, provide products of the same kind from a single source.

2.02 SYSTEMS:

A. Furnish, install and make suitable for operation the following systems:
1. 480V, 3-phase, 60 hertz, 4-wire & 3-wire power distribution system.
2. 208/120 V, 3-phase, 60 hertz, 4-wire: lighting, receptacle power, and small power system.
3. Grounding and bonding system.
4. Diesel engine-generators.
5. Ethernet Network components.
6. Card access components.
7. Security components.
8. Lightning Protection System
9. Lighting systems.

2.03 ELECTRICAL MATERIAL SERVICE REQUIREMENTS, ENVIRONMENTAL RATINGS & HAZARDOUS LOCATIONS:

A. Refer to Electrical Drawing 00E-002.

PART 3 - EXECUTION

3.01 GENERAL

A. Perform all Work in accordance with:
   1. NEC and NFPA 70E.
   2. NECA National Electrical Installation Standards (NEIS)
B. Perform all Work necessary to furnish, receive, store, install, connect, tube, wire, pipe and commission electrical equipment:
   1. In strict accordance with the manufacturer's recommendations.
   2. To power and operate the systems and process.
   3. As specified and indicated on the motor schedule, equipment schedule, valve schedule, Process and Instrumentation diagrams (P&IDs), and Electrical Drawings.
C. Provide all Material to mount on floor or wall.
D. Concrete work for all electrical equipment pads, foundations, duct banks and other DIVISION 26 applications shall conform to DIVISION 03 – Concrete.
   1. Provide concrete mounting pads for equipment located outdoors.
   2. Provide housekeeping pads for Equipment located indoors.
E. Install systems, Equipment and Material level, plumb, parallel, and perpendicular to other building systems and components, where installed in finished spaces.
F. Install electrical Equipment and Material to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting with minimum of interference with other installations.
G. Install raceways, cables, wireways clear of obstructions and clear of the required working space of equipment.
H. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
I. Provide all equipment, materials, scaffolding, rigging, and tools to complete the Work.
J. Provide all labor, including expert and common, specialized personnel, fitters, electricians, and attendance of such personnel.
K. Electrical Plan Drawings shall be used to determine approximate location of Equipment to be installed and cable lengths. Contractor shall advise the Engineer of interferences.
L. Equipment not indicated on the Electrical Plan Drawings but listed in Equipment schedules, shall be field located by the Contractor with the assistance of the Engineer.
M. Install permanent equipment labels for all Equipment, Material and devices or as directed by the Engineer.

3.02 COORDINATION AND SCHEDULING:

A. Coordinate all installation activities involving others. Identify restraints caused by others which affect performance of the Work. Resolve such restraints where possible and notify the Engineer when additional action is required to complete the Work.
B. Provide a complete construction sequence document to:
   1. List construction milestones
   2. List electrical commissioning activities
   3. Outline the needs for temporary construction power

C. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service. Include necessary application and utility construction fees.

3.03 PREPARATION:

A. Verify existing Site conditions match the specifications.

B. Verify the Contract Documents are consistent with the existing equipment and material installation. Notify Engineer of discrepancies.
   1. Verify all existing dimensions by field measurements.
   2. Arrange for chases, slots, and openings in other building components during progress of construction to allow for electrical installations.
   3. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components as they are constructed.

C. Sequence, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building. Coordinate concrete pads, bases, roof curbs, and related items.

D. Verify final locations for rough-ins with field measurements and with the requirements of the actual equipment to be connected.

E. Refer to equipment specifications in DIVISIONS 23 through 46 and the equipment submittals for rough-in requirements.

3.04 INSTALLATION:

A. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Should coordination requirements conflict with individual system requirements, Notify the Engineer of any conflicts.

B. Where mounting heights are not specifically detailed, specified, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

C. All electrical equipment and installations shall be of adequate strength to withstand, without failure, forces encountered in defined Seismic conditions.

D. For equipment provided by this Contractor, the design indicates a variety of motor horsepower/kilowatt ratings, over current protection device ratings (circuit breakers or fuses), and conductor sizes. These sizes are to be considered approximate and are to be coordinated with final sizing and ratings of equipment included in approved submittals; if the Contractor installs a different size or type, then at no additional cost to the Owner, the Contractor shall provide components, Equipment, and Materials as recommended by the equipment manufacturer or as required to stay compliant with the NEC. Including but not limited to:
   1. Fuses or circuit breakers.
   2. Motor controllers.
   3. Conduit.
   4. Cables.
   5. Cable Lugs.
   6. Disconnects.
   7. Power Distribution Equipment.

3.05 TESTING:

A. Test all electrical Equipment upon completion of installation to ensure that the Equipment operates satisfactorily to the Owner and conforms to Contract Documents.

B. Furnish temporary power sources of proper type for testing purposes when normal supply is not available at the time of testing.

3.06 FINISHES:

A. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit degree of damage at each location.

B. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.

C. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

D. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

E. Repair damage to protective coatings in accordance with SECTION 09 90 00 - Protective Coatings.

3.07 CLEANING:

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

3.08 PROTECTION:

A. Protect equipment and installations and maintain conditions to ensure that coatings, finishes and cabinets are without damage or deterioration at time of Substantial Completion.

3.09 CLOSEOUT:

A. Instructions, training, and manufacturer’s service representative:

1. Provide on-site instructions and training of Owner's personnel as specified.
2. Provide on-site services of a manufacturer's authorized service representative as specified.

END OF SECTION 26 00 00

SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION includes the requirements for furnishing and installing (including terminations) all low-voltage electrical conductors, cable, and accessories.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 33 - Raceway and Boxes for Electrical Systems
D. SECTION 26 05 43 - Underground Duct Banks and Manholes
E. SECTION 26 05 44 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling
F. SECTION 26 05 53 - Identification for Electrical Systems
G. DIVISION 31 - Earthwork
H. SECTION 40 66 00 - Process Control Networks.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of the date of the Contract Documents unless otherwise indicated.
B. ASTM International (ASTM):
    1. ASTM B3 – Standard Specification for Soft or Annealed Copper Wire.
    2. ASTM B8 – Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
    3. ASTM B33 – Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
    4. ASTM B172 – Rope-Lay Stranded Copper Conductors Having Bunch-Stranded Members, for Electrical Conductors.
C. Insulated Cable Engineers Association (ICEA):
    1. ANSI/ICEA S-81-570 – 600Volt Rated Cables of Ruggedized Design for Direct Burial Installations as Single Conductors or Assemblies of Single Conductors.
    2. ANSI/ICEA S-105-692 – 600Volt Single Layer Thermoset Insulated Utility Underground Distribution Cables.
D. Institute of Electrical and Electronics Engineers (IEEE):
    1. IEEE 1202 – Flame-Propagation Testing of Wire and Cable.
E. International Electrical Testing Association (NETA):
    1. ANSI/NETA ATS – Acceptance Testing Specifications for Electrical Power Equipment and Systems.
F. National Electric Manufacturers Association (NEMA) and Insulated Cable Engineers Association (ICEA):
    1. ANSI/NEMA WC 53/ICEA T-27-581 – Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test
    2. NEMA WC57/ ICEA S-73-532 – Standard for Control, Thermocouple Extension, and Instrumentation Cables.
    3. ANSI/NEMA WC 70/ICEA S-95-658 – Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy
G. National Fire Protection Association (NFPA):

1. NFPA 70 – National Electrical Code (NEC).

H. Underwriters Laboratories, Inc. (UL):
1. UL 44 – Thermoset Insulated Wires and Cables.
2. UL 83 – Thermoplastic Insulated Wires and Cables.
3. UL 854 – Service Entrance Cables.
4. UL 1581 – Reference Standard for Electrical Wires, Cables, and Flexible Cords

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Product Data: For each type of product submit the following marked for intended location and use:
1. Data sheets for each wire and cable type specified.
2. Data sheets for wire and cable accessories.
3. Cable manufacturer's approval of splicing and terminating materials.
4. Cable manufacturer's approval of pulling compounds.
5. Cable manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radii, and other considerations.
6. Other Equipment and Materials to be used.

C. Special Procedure Submittals:
1. Test Plan:
a. Provide a complete and detailed test plan for network cabling system including a complete list of test equipment.
2. Include procedures for certification, validation, and testing.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.

1.07 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.

B. Factory Tests:
1. Quality Control Test Protocol: The manufacturer shall conduct tests according to industry standard requirements. These tests shall be performed routinely on sample sizes sufficient to verify quality and continuity or as specified.

C. Installer Qualifications:
1. Prior to installation, submit data of installer's experience and qualifications.
2. Network equipment installers shall be a Building Industry Consulting Service International (BICSI) Registered Cabling Installation Technician or have experience which shall include 3 years on projects of similar complexity.
3. Include written certification from previous clients where systems have performed satisfactorily for not less than 18 months.
4. Include specific experience in installing and testing structured communications distribution systems using managed Ethernet switches, and Category 6 and fiber optic cabling systems included in the design.

1.08 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Cable Connectors for Control and Instrument Cable:
   1. TE Connectivity Ltd.
   2. Hollingsworth Solderless Terminal Company.
   3. Panduit Corporation.
   4. 3M Company.
   5. Thomas and Betts Company, Inc.

B. Cable Connectors for Power Cable:
   1. TE Connectivity Ltd.
   2. Thomas and Betts Company, Inc.
   3. 3M Company.
   4. Panduit Corporation.

C. Termination and Splice Kits:
   1. 3M Company.
   2. Raychem.

D. Tape and Insulation Putty:
   1. 3M Company.

E. Cable Ties:
   1. TE Connectivity Ltd.
   2. Avery-Dennison Corporation.
   3. Panduit Corporation.
   4. 3M Company.
   5. Thomas and Betts Company, Inc.

F. Cable Supports:
   1. Emerson - O. Z./ Gedney Company.
   2. Hubbell, Kellems Grips.

G. Terminal Blocks:
   1. Allen Bradley.
   2. Buchanan.
   3. Phoenix Contact.
   4. Square D Company.
   5. Weidmuller.

H. Cable Identification Tags:
   1. Refer to SECTION 26 05 53.

2.02 WIRE AND CABLE:

A. General:
   1. All cables surface printing on the cable shall show manufacturer's name, cable type and size, number of conductors, insulation type, and Underwriters Laboratories (UL) Listed.
   2. All cable shall be tested and certified to be in conformance with UL1581 and UL 1685 for the following:
      a. Flame exposure
      b. Riser cable
      c. Crush
      d. Impact
      e. Flex

f. Pull

3. Provide wiring as indicated below. For location and area classification refer to SECTION 26 00 00, Electrical Material Service Requirements.
   a. For cables, size #6 AWG and smaller, routed only through dry environments, cable insulation shall be:
      (1) Polyvinyl chloride "PVC" and rated as Type THHN/THWN.
      (2) Nylon outer jacket outdoor rated Sunlight Resistant, and Oil Resistant.
      (3) THHN/THWN tested and certified to be in conformance with UL 83.
   b. For cables size #4 AWG and larger routed through dry environments, and all cables routed through a wet or corrosive environments, , cable insulation shall be:
      (1) Cross-linked polyethylene "XLPE" and rated as Type XHHW-2.
      (2) XHHW-2 tested and certified to be in conformance with UL 44.
   c. All cables shall be suitable for operation under the following maximum conductor temperatures:
      (1) 90°C --- Continuous, dry locations
      (2) 75°C --- Continuous, wet locations
   d. For corrosive environments all conductors and terminations should be tin coated.
   e. For cables that enter into a hazardous location:
      (1) Cables shall meet or exceed the hazardous area location rating.
      (2) Connections to Motors:
         (a) Class 1, Division 1 (wet or dry): Type MC-HL, continuous corrugated welded (CCW) with listed fittings where required..
         (b) Class 1, Division 1 (wet or dry): XHHW wire with listed flexible connection and fittings. Refer to Section 26 05 33 for requirements and materials of listed flexible connection and fittings where required.
         (c) Class 1, Division 2 (wet or dry): Cord connection using cord listed for extra-hard service and listed fittings where required.
         (d) Class 1, Division 2 (wet or dry): XHHW wire with liquid-tight, flexible-metallic conduit with listed fittings where required. Refer to Section 26 05 33 for raceway requirements.
4. All thermocouple extension cables shall be tested and certified to be in conformance with ANSI/NEMA WC 57.

B. Communication Cables: As specified in the Cable Schedule.
   1. Refer to SECTION 40 66 00 – Process Control Networks.

C. Control Cables: As specified in the Cable Schedule.
   1. All Control and Instrument cables shall be tested and certified to be in conformance with ANSI/NEMA WC 53.
   2. 600 V RMS.
   3. Conductor Size #14 AWG.
   4. Cross-linked polyethylene insulation
   5. Where required, provide a designated neutral conductor.
   6. Provide cables with shields based on application:
      a. Unshielded for 120 VAC control signals.
      b. Shielded for 24 VDC andalog and discrete control signals. Aluminized mylar or polyester tape and tinned copper drain wire.
   7. Single conductor cable:
      a. Class B stranded annealed copper.
   8. Multi conductor cable:

a. Type TC
b. Class B or C stranded annealed copper.
c. Color coding shall be Method 1 (NEMA WC57/ICEA S 73-532 Appendix E, Paragraph. E3.1) using color pigmented compounds with colors as designated by Table E-2 (K-2).
d. Polyvinyl chloride "PVC" outer jacket and rated for outdoor use.

D. Ground Conductors: Applies to all cables as specified in SECTION 26 05 26 - Grounding and Bonding for Electrical Systems and as indicated on the electrical Grounding Drawings.
1. Annealed, tinned bare copper
2. Solid in sizes #4 AWG and smaller. (ASTM B3)
3. Class B stranded in sizes #2 AWG and larger (ASTM B8)

E. Instrument Cables: As specified in the Cable Schedule
1. All Control and Instrument cables shall be tested and certified to be in conformance with ANSI/NEMA WC 53.
2. 600 V RMS.
3. Conductor Size #16 AWG twisted shielded pair.
4. Class B or C stranded annealed copper.
5. Color coding shall be Method 1 (NEMA WC57/ICEA S 73-532 Appendix E, Paragraph. E3.1) using color pigmented compounds with colors as designated by Table E-2 (K-2).
6. Polyvinyl chloride "PVC" and rated for outdoor use.

F. Power Cables: Applies to all cables to provide power for Wiring Devices and Lighting fixtures and as specified in the Cables schedule.
1. All Power cables shall be tested and certified to be in conformance with ANSI/NEMA WC 70.
2. Individual conductors or multi-conductor cables shall be identified by means of solid colors, stripes, or printing, and in accordance with NEMS WC 70.
3. Conductor sized as specified in the cable schedule, with a minimum of #12 AWG or larger.
4. Single conductor cable shall be used as specified in the cable schedule, outdoors and in underground duct bank applications:
a. Class B stranded annealed copper.
5. Multi conductor cable shall be used indoors:
a. Class B or C stranded annealed copper.
b. Polyvinyl chloride "PVC" outer jacket and rated for outdoor use.
6. Multi conductor cables intended to be used for variable frequency drive applications to use cables specifically designed for variable frequency applications. Refer to plans for equivalent Belden brand part numbers.
7. Metal clad:
a. Type MC
(1) Class B or C stranded annealed copper
(2) Class B stranded insulated copper ground conductor sized in accordance with Table 5-2 NEMA WC70/ICEA S-95-658
(3) Conductors cabled together, binder tape bearing the print legend wrapped around the assembly, and an aluminum interlocked armor applied over the assembly.

2.03 CONNECTORS:

A. General Requirements:

1. Designed and sized for specific cable being connected.
2. Solderless, pressure type connectors constructed of non-corrodible tin-plated copper.
3. Application tooling for connectors shall contain die or piston stops to prevent over crimping and cycling or pressure relief to prevent under crimping. Dies of all application tooling shall provide dot or wire size coding for quality control verification. All tooling shall be manufactured by the connector manufacturer.

B. Power Connectors (#10 AWG and Smaller) 600V and Below:
1. "Scotchlok" pre-insulated spring wire connectors.
2. Buchanan open end copper splicing caps, applied with "Lok Seal" tool, with nylon snap on insulators.

C. Power Connectors (sizes #8 to #4 AWG) 600V and Below:
1. Non-insulated ring tongue type.
2. Ring tongue sized to match terminal stud size.
3. Brazed barrel seam.
4. Application tooling designed to crimp the wire barrel (conductor grip) with a one-step crimp.

D. Power Connectors (sizes #2 AWG to 750 MCM) 600V and Below:
1. Non-insulated one hole rectangular tongue for sizes #2 AWG through #3/0 AWG and two hole rectangular tongue for #4/0 AWG through 750 MCM.
2. Acceptable manufacturers' cross reference chart is listed at end of this SECTION.

E. Power Connectors (sizes #2 AWG to 750 MCM) above 600V:
1. Non-insulated one hole rectangular tongue for sizes #2 AWG through #3/0 AWG and two hole rectangular tongue for #4/0 AWG through 750 MCM.
2. Voltage rating equal or greater than that of the cable being used.
3. Application tooling shall be hydraulically operated.

F. Control, Instrument, and Specialty Cable Connectors:
1. Tin-plated copper.
2. Vinyl or nylon pre-insulated ring tongue type. Spade lugs will not be permitted.
3. Vinyl pre-insulated spring type spade terminals. (Hollingsworth "Mini Spring Spades"; Thomas and Betts "Locking Fork"; Panduit "Locking Fork.")
4. Sized to match terminal stud size.
5. Have insulation grip sleeve to firmly hold to cable insulation.
6. Insulation grip sleeve shall be funneled to facilitate wire insertion and prevent turned back strands.
7. Application tooling designed to crimp the wire barrel (conductor grip) and the insulation grip sleeve with a one-step crimp.

G. Network Connectors:
1. Refer to SECTION 40 66 00 – Process Control Networks.

2.04 MOTOR LEAD TERMINATION/SPLICE (LOW VOLTAGE, 600 V AND BELOW, POWER CABLE):

A. Splices shall be made using compression type connectors bolted together. The compression type connectors shall be properly sized for the cables. Reference acceptable connector manufacturer's cross reference chart.

B. Splice to be covered with heat shrinkable tubing connector insulators or slip-on rubber boot or sleeve.

C. Splicing shall be done in accordance with the instructions provided with the Raychem brand MCK Motor Connector Kit or 3M Company 5300 Series Motor Lead Splice Kit.

2.05 CABLE SUPPORTS:

A. Cable supports for cables in vertical conduit risers shall be Emerson – O.Z. Gedney Type "R" wedging plug type or approved equal.

B. Kellems stainless steel, basket-type wire mesh grip for cables where indicated.

2.06 CABLE TIES:

A. Nylon self-locking type.

B. Have a normal service temperature range of 40°C to 85°C.

C. Be weather resistant type for outdoor use.

D. TE Connectivity "AMP TY," Avery-Dennison "BAR LOK," Panduit Corporation "PAN TY," Thomas & Betts "TY RAP," or 3M Brand cable ties.

2.07 TERMINAL BLOCKS:

A. For mounting in terminal boxes (TBs):

1. Designed and sized for the cables being terminated.
2. Block rated 600V.
3. Binding screw type terminals for power cables and strap screw or tubular clamp terminals for control and instrument cables.
4. Rated current carrying capacity equal to or greater than the cable being terminated.
5. Marking strip.

B. For Mounting in Cabinets, Panels, Control Boards, etc.:

1. Designed and sized for the cables being terminated.
2. Block rated 600V.
3. Binding screw type terminals for power cables and current transformer circuits and strap screw or tubular clamp terminals for control and instrument cables.
4. Rated current carrying capacity equal to or greater than the cable being terminated.
5. Marking strip on blocks for power cables and control and instrument cables.
6. Short circuit strips with one shorting screw for each terminal for current transformer circuits.
7. Shorting type terminal blocks rated for #10 AWG shall be used for all cables connected to current transformers (CTs).

2.08 CABLE IDENTIFICATION TAGS:

A. Provide cable identification tags as specified in SECTION 26 05 53.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General Requirements:

1. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
2. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
3. Install in conduit, duct system, or direct burial as indicated.
4. Cable shall not be subjected to pulling tensions or sidewall pressures in excess of the manufacturer's recommendations.
5. Attach pulling grips over the cable sheath to prevent slipping of the insulation.
6. Do not subject cable to bending radius less than those recommended by the cable manufacturer or as noted below (whichever is greater) during or after installation:

a. Eight times the cable outside diameter for 600V or lower rated cables.

7. Install intermediate pull boxes as indicated or as required to avoid subjecting cable to excessive pulling tension or sidewall pressures.
8. Support cables at connections or termination points such that any strain on cable will not be transmitted to the connection or termination.
9. Install cable supports in vertical runs of conduit, at boxes and at terminations in equipment, and as required to meet intermediate support requirements of National Electrical Code (NEC).
10. All pulling compounds shall be approved by wire and cable manufacturer as being compatible with cable materials.
11. Attach a cable identification tag to each cable at all termination or end points.
12. Install fire and smoke stop fittings at all cable penetrations of fire rated walls, floors, and ceilings.
13. Install conduit seals for conduits that terminate in a junction box located in an area identified as Hazardous (Classified) Location on the Contract Drawings.

B. Power (600V and Below), Control, Instrument, and Specialty Cable:

1. Install metallic barrier in all boxes to separate power, control, and instrumentation from low level signal (50V or less) instrumentation circuits where run in the same tray or box.
2. Tie together with cable ties all single conductor cable on each individual circuit in each junction box, or equipment at intervals not to exceed 6 feet.
3. Attach a cable identification tag to each cable.
   a. At each terminal to identify the circuit and cable.
   b. Attach fiber tags with cable ties.
   c. Use nylon ties and identification tabs color coded as follows:
      (1) 480V circuits – Red.
      (2) 277, 240, or 208Vac circuits – Orange.
      (3) 120V circuits – White.
      (4) Control cables – Natural Nylon.
4. Insulation Color Coding for Phase Identification:
   a. Color code 600-volt insulated, service entrance, feeder, and branch circuit conductors with factory-applied colored insulation for #8 AWG and smaller (except: #6 AWG and smaller for green ground wire); 1-inch band of colored tape at all splices and terminations for #6 AWG and larger (except: #4 AWG and larger for green ground wire) as follows:

Phase	240/120 Volts	480Y/277 Volts
A	Black (Line 1)	Brown
B	Red (Line 2)	Orange
C	N/A	Yellow
Neutral	White	Gray
Ground	Green	Green

   b. Tag each individual conductor or wire with wire markers as follows:
      (1) With terminal designation indicated on schematic diagrams or given on manufacturer's equipment drawings.
      (2) At each terminal.
      (3) In addition to specified circuit tags.

c. Terminate and ground, control, instrument, and specialty cable shields as indicated and recommended by the manufacturer of the equipment being connected. In general, ground the shields at the control panels.
d. Intermediate cable splices shall not be allowed when installing power, control, and instrument wiring except when spicing to lead wires provided with the equipment or device, or unless approved by the Engineer prior to cable installation.
e. Control and instrument and thermocouple cable splices shall be as follows:
(1) Made only in junction or terminal boxes.
(2) Made on terminal blocks with marking strips.
(3) Conductor color coding shall be maintained.
(4) For shielded cables, shield continuity and isolation shall be maintained.
(5) Thermocouple cable splices to be made only on terminal blocks which correspond to thermocouple type used.
f. Power cable (600V or below) splices and motor terminations shall be as follows:
(1) Made only in junction or terminal boxes.
(2) Splices shall be made using compression type connectors bolted together.
(3) Splice to be covered with a heat shrinkable connector insulator.
g. High-Temperature Wiring:
(1) Install from device to a terminal box for all devices which by their location have the body of the device or electrical connection subject to ambient temperatures in excess of 185°F. Typical locations are feed water heaters, burner fronts, boiler penthouse, and deaerator.
(2) Locate terminal box far enough from the source of heat so that the temperature does not exceed 175°F. This distance generally is between 3 and 5 feet.
(3) Replace with high-temperature wire any wiring installed by this Contract that is damaged by excessive heat.

5. Lighting Cable: Install as specified in DIVISION 26.
6. Ground Cable: Install as specified in DIVISION 26.
7. Control and Instrument Cable: Install as specified in this SECTION.
8. Communications Cable: Install as specified in this SECTION.

C. Cable Connections and Terminations:
1. Make up clean and tight to assure a low-resistance joint.
2. Make only in terminal boxes, equipment, or other accepted enclosures and not in conduit.
3. Install all connectors with tooling manufactured by the connector manufacturer and as specified.

3.02 FIELD QUALITY CONTROL:

A. Perform tests and inspections and prepare test reports. Submit test reports as specified.
B. General Requirements:
1. Test all wire, cable, and electrical equipment installed or connected by Contractor to assure proper installation, setting, connection, and functioning as indicated or to conform to Contract Documents and manufacturer's instructions.
2. Conduct all tests except megger insulation testing in the presence of Engineer and/or Owner and under the supervision of Equipment manufacturer's field engineer.
3. Include all tests recommended by the Equipment manufacturer unless specifically waived by Engineer.

4. Include all additional tests issued by Engineer that he deems necessary because of field conditions to determine that Equipment and Material and systems meet requirements of Contract Documents.
5. Include all tests recommended by the NETA Acceptance Testing Specifications.
6. The contractor shall be responsible for all damage to Equipment or Material due to improper test procedures or test apparatus handling.

C. Cable Testing Requirements:
1. Megger all 600V insulated power cable with a 1000Vdc megger for one minute, and values must not be less than 50 megohms per NETA ATS 7.3. Determine the values with all switchboards, panelboards, fuse holders, switches, and overcurrent devices in place. Do not connect motors and transformers during meggering. Megger wire and cable after installation and not on the cable reel.
2. Cables with conductors failing this test shall be removed and replaced.
3. Provide all phasing tests and make all changes necessary to assure proper rotation of all motors, the correct phasing and phase sequence of all circuits susceptible to being paralleled, the proper polarity on all instrument transformer wiring, and such other phasing tests as may be required for the equipment being connected under this Contract.

D. 600V Control Cable:
1. Check all control cable for rightness of terminal contacts.
2. Megger the specific control cables selected by Resident Project Representative, or Engineer. The quantity of cables required to be meggered will not exceed 10% of the control cable installed by this Contract. Megger as described for 600V power cable after installation, but with cables disconnected from control panels and other equipment.
3. All control cables shall have a continuity check performed on each conductor to ensure the conductance of each wire before the wires are terminated.
4. Cables with conductors failing this test shall be removed and replaced.

E. 300V Instrument Cable:
1. Megger the specific instrument cables selected by Resident Project Representative, or Engineer. The quantity of cables required to be meggered will not exceed 10% of the instrument cable installed by this Contract. Insulation resistance shall be a minimum of 1,000 megohms per 1,000 feet.
2. All instrument cables shall have a continuity check performed on each conductor and shield to ensure the conductance of each wire and shield before the wires are terminated.
3. Cables with conductors or shields failing this test shall be removed and replaced.

F. Quality Assurance:
1. Test Reports:
   a. Submit as specified in DIVISION 01.
   b. Maintain a written record of all tests showing date, personnel making tests, equipment used, Equipment or Material tested, tests performed, and results.
   c. Notify Engineer two weeks prior to commencement of all testing except for megger tests.

END OF SECTION 26 05 19

SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION specifies electrical grounding and bonding Work by this Contract.
B. Provide a grounding system as indicated on Drawings and schedules and as specified herein.
C. Ground each System specified in SECTION 26 00 00 PART 2 SYSTEMS. To protect the systems from lightning, line surges or high voltage to stabilize the systems.
D. Bond each conduit and electrical equipment enclosure with the source to create a low impedance ground-fault current path facilitating operation of the overcurrent protection devices.
E. Type of electrical grounding and bonding Work specified in this Section includes solidly grounded systems.
F. Applications of electrical grounding and bonding Work in this SECTION includes the following:
    1. Metal water piping.
    2. Electrical power systems.
    3. Grounding electrodes.
    4. Ground test wells.
    5. Counterpoise grounding ring.
    6. Separately derived systems.
    7. Raceways.
    8. Service equipment.
    9. Boxes and enclosures.
    10. Equipment.

1.03 RELATED REQUIREMENTS:

A. DIVISION 23 - Heating, Ventilating, and Air Conditioning (HVAC).
B. SECTION 26 00 00 - General Electrical Requirements
C. SECTION 26 05 19 - Low-Voltage Conductors and Cables
D. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
E. SECTION 26 05 29 - Hangers and Supports for Electrical Systems
F. SECTION 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems
G. SECTION 26 05 43 - Underground Duct Banks and Manholes
H. SECTION 26 05 44 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling
I. SECTION 26 05 53 - Identification for Electrical Systems
J. SECTION 26 22 13 - Low Voltage Distribution Transformers
K. SECTION 26 24 13 - Switchboards
L. SECTION 26 24 16 - Panelboards
M. SECTION 26 27 26 - Wiring Devices
N. SECTION 26 28 16 - Enclosed Switches and Circuit Breakers
O. SECTION 26 29 23 - Variable Frequency Motor Controllers
P. SECTION 26 32 13 - Engine Generator Sets
Q. SECTION 26 33 53 - Static Uninterruptible Power Supply
R. SECTION 26 41 00 Lightning Protection System
S. SECTION 26 43 13 - Surge Protective Devices

T. SECTION 26 50 00 - Lighting
U. DIVISION 28
V. SECTION 40 66 00 - Process Control Networks
W. SECTION 40 67 00 – Process Control Panels & Hardware
X. SECTION 40 70 00 - Instrumentation for Process Systems

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. ASTM International (ASTM):
   1. ASTM B3 - Soft or Annealed Copper Wire.
   2. ASTM B8 - Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. ASTM B33 - Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
C. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 80 - Guide for Safety in Substation Grounding.
   2. IEEE 81 - Guide for Measuring Ground Resistance, and Potential Gradient in the Earth.
   3. IEEE 3003.1 - Recommended Practice for the System Grounding of Industrial and Commercial Power Systems.
   4. IEEE 3003.2 - Recommended Practice for Equipment Grounding and Bonding in Industrial and Commercial Power Systems.
D. National Electrical Contractors Association (NECA) Installation Standards.
E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC)
F. Underwriters Laboratories (UL):
   1. UL 467 - Standard for Safety Grounding and Bonding Equipment.
   2. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   3. UL 869 - Electrical Service Equipment.
   4. UL 891 - Switchboards.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data: Submit manufacturer's data on all grounding and bonding components and associated accessories.
C. Qualification Data: For Qualified Testing Agency and testing agency's field Supervisor.
D. All field test reports.

1.06 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Must be a member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
C. Comply with UL 467 for grounding and bonding materials and equipment.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.

1.08 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.

1.09 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide grounding and bonding products of one of the following (for each type of product):
   1. Grounding Products:
      a. Anderson Electrical Products, Hubbell Inc.
      b. Burndy LLC.
      c. Cadweld, Erico, nVent Electric, plc.
      d. Crouse-Hinds, Eaton.
      e. Erico, nVent Electric, plc.
      f. Copperweld Bimetallics, LLC.
      g. Harger Lightning and Grounding.
      h. Ideal Industries, Inc.
      i. Joslyn, MacLean Power Systems.
      j. Myers, Crouse-Hinds, Eaton.
      k. O-Z/Gedney, Emerson Electric Company.
      l. Preferred Lightning Protection, Inc.
      m. Thomas & Betts, ABB Group.
      n. Engineer-approved equal.

2.02 GROUNDING AND BONDING:

A. Materials and Components:
   1. General: Except as otherwise indicated, provide electrical grounding and bonding systems indicated; with assembly of materials, including, but not limited to, cables/wires, connectors, solderless lug terminals, grounding electrodes, bonding jumper braid, surge arresters, and additional accessories needed for a complete installation. Where more than one type component product meets indicated requirements, selection is Contractor's code-compliance option. Where materials or components are not indicated, provide products which comply with NEC, UL, and IEEE requirements and with established industry standards for those applications.
   2. Conductors: as specified in SECTION 26 05 19.
      a. For buried and exposed grounding conductors as specified for Grounding Conductors.
      b. Bonding conductors shall be the same as specified for Power Cables.
      c. Equipment grounding conductors shall be as specified on the Drawings.
      d. Refer to Material Designation Table on Drawings for areas requiring tinned ground conductors.
   3. Separately derived systems: Ground each separately derived system as required by the NEC Article 250.
   4. Service Surge Protection: Refer to SECTION 26 43 13. Ground according to manufacturer’s installation requirements and recommendations.
   5. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches (6.3 by 100 mm) in cross section, with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600V. Lexan or PVC, impulse tested at 5,000V.

6. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.
    a. Bolted Connectors for Conductors and Pipes: Copper or copper-alloy, pressure type with at least two silicon bronze or stainless-steel bolts and lock washers.
    b. Bolted Service Connectors for Structural Steel: Shall have high-conductivity bronze alloy bolts and corrosion-resistant copper alloy nuts.
    c. Irreversible Compression Fittings: Pure wrought copper extrusion clamps and connectors, made to be held in the dies of an installation tool. Connectors must be factory filled with an oxide inhibitor.
    d. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
    e. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals and long-barrel, two-bolt connection to ground bus bar.
7. Ground Rods or Ground Electrodes:
    a. Ground Rods or Grounding Electrodes: Copper-clad steel or copper-alloy, sectional type rods. One end pointed to facilitate driving, 3/4-inch diameter by 10 feet.
8. Electrical Grounding Connection Accessories: Provide electrical insulating tape, heat-shrinkable insulating tubing, welding materials, bonding straps, as recommended by accessories manufacturers for type service required or indicated.
9. Mastic Coatings:
    a. Sonneborn-Sonoshield Mastics (BASF Construction Chemicals LLC).
    b. W.R. Meadows - Sealmastic.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install electrical grounding and bonding systems as indicated, in accordance with manufacturer's instructions and applicable portions of NEC, NECA's "Standards of Installation," and in accordance with recognized industry practices to ensure that products comply with requirements.

B. A grounding electrode shall be installed at each building or structure as indicated.
    1. Grounding electrodes shall consist of the following:
        a. Ground rod and cable system.
        b. Concrete-encased electrode.
        c. Grounded metal frame of the building or structure.
        d. Metal underground water pipe.
        e. Other systems or structures as indicated.

C. Ground Rods:
    1. Install rods as indicated by driving and not by drilling or jetting.
    2. Drive rods into unexcavated portion of the earth where possible.
    3. Where rods must be installed in excavated areas, drive rods into earth after compaction of backfill is completed.
    4. Drive to a depth such that top of rods will be approximately 18 inches below final grade or subgrade, and connect main grid ground cable thereto.
    5. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

6. Separation between ground rods shall be equal to or greater than the length of the rods.
7. The ground electrode conductor shall not contain splices between the ground electrode and the service entrance equipment.
8. For grounding electrode systems, where the grounding system shown on the plans do not meet the ground resistance requirement, install additional rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

D. Counterpoise Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column indicated, indicated item, extending around the perimeter of building or structure indicated.
1. Install a ground conductor for the ground ring and for taps to building steel.
2. Bury ground ring not less than 24 inches (600 mm) from building or structure foundation.

E. Test Wells: Test well handholes shall be at least 12 inches (300 mm) deep, with cover.
1. Ground rod driven through drilled hole in bottom of handhole.
2. Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance.
3. Set top of test well flush with finished floor, or for exterior locations no more than 1" above finished grade.

F. Grounding Conductors:
1. Install conductors meeting Specification 26 05 19 Low Voltage Conductors and Cables.
2. Install using as few joints as possible. Route along shortest and straightest paths possible unless otherwise indicated or required by Code.
3. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage. Suitably protect cable against damage during construction.
4. Replace or suitably repair cable if damaged by anyone before final acceptance.
5. In Exposed Installations:
   a. Route runs as indicated.
   b. Route along the webs of columns and beams, and in corners where possible for maximum physical protection.
   c. Where physical protection is required, install in PVC conduit unless indicated otherwise.
   d. Support at intervals of 3 feet or less with nonmagnetic clamp-type supports.
6. In Buried Installations:
   a. Conductor sizes shall be as indicated for specific connections. For required connections not indicated, use conductor size not less than ##4/0 AWG if buried in the earth or cast in concrete, or # 6 AWG at other locations.
   b. Lay in bottom of trench or in other excavations at the depth of the top of the ground rod.
   c. Bury at least 30 inches (600 mm) below grade.
   d. Maintain clearance of at least 12 inches from all underground metal piping or structures, except where connections thereto are specifically indicated.
   e. Ground cable shall enter the bottom of electrical gear or panels sitting on a slab through a PVC sleeve.
7. Backfill as specified in DIVISION 31.
8. Duct-Bank Grounding Conductor: Embed within duct bank when indicated as part of duct-bank installation. Tie embedded grounding cable to reinforcing steel at intervals not exceeding 20-feet.

G. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection,

with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

H. Ground Bonding Common with Lightning Protection System: Where a lightning protection system is present, comply with NFPA 780 and UL 96A when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

I. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
   1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
   2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors or irreversible compression fittings with appropriate anti-corrosion agent for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

J. Conductor Terminations and Connections:
   1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors with silicon bronze or stainless-steel bolts and lock washers.
   2. Use exothermic-welded connectors or irreversible compression fittings with appropriate anti-corrosion agent where grounding conductors connect to underground grounding conductors and underground grounding electrodes.
   3. Connections to Ground Rods at Test Wells: Bolted connectors.
   4. Connections to Structural Steel:
      a. Exothermically welded connectors, where allowed by the Structural Engineer.
      b. Bolted fittings where structural steel cannot be welded, but can be field drilled.
      c. Irreversible compression ground clamp with breakaway bolt head to building steel that cannot be altered.
   5. Clean metal contact surfaces of clamp-on connectors to ensure electrical conductivity and circuit integrity.
   6. Exothermic terminations:
      a. Conform to manufacturer’s instructions.
      b. Chemically degrease and dry completely before welding.
      c. Apply one coat of mastic coating to all exothermic-welded connections to be buried.

K. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70; use a minimum of 20 feet (6 m) of bare copper conductor not smaller than #3/0 AWG for a grounding conductor.
   1. If concrete foundation is less than 20 feet (6 m) long, route conductor along another direction, doubling back on opposite side, if necessary.
   2. Bond grounding conductor to reinforcing steel matte in at least four locations using compression fittings designed for the intended purpose.
   3. The grounding connection to the supplemental electrode shall be bonded by either exothermic welding or irreversible compression fittings.
   4. Extend a bonding conductor from concrete-encased electrode, below grade and out to building's grounding grid and bond.
   5. Extend a bonding conductor from at least one concrete-encased electrode out of the concrete and bond to the grounding electrode.

6. Welding Ufer grounding conductor directly to the structural steel is prohibited, unless approved by the Structural Engineer, in which case adhere to the following:
    a. A pig-tail of copper from the concrete-encased electrode shall penetrate the foundation and be exothermically welded to the structural steel.

L. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
1. Install bus horizontally, on insulated spacers 2 inches (50 mm) minimum from wall, 18 inches (150 mm) above finished floor unless otherwise indicated.
2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down to specified height above floor; connect to horizontal bus.
3. Insulate and support grounding bus at intervals not to exceed 2 feet on centers or as indicated.

M. Grounding and Bonding of Metal Underground Water Pipe:
1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes. Use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Gas Piping: If installed in, or attached to, a building or structure, bond each aboveground portion of gas piping system downstream from equipment shutoff valve. Metal underground gas piping systems shall NOT be used as a grounding electrode.
4. Metal Process Water Pipes:
    a. For a small or medium-sized pipe, connect the pipe to the ground system at an exposed location using a mechanical bolted clamp connector with silicon bronze hardware.
    b. Follow manufacturer’s instructions for cleaning pipe and applying oxide inhibiting compound around perimeter of connector.

N. Grounding at Handholes:
1. Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished/gravel floor.
2. If necessary, install ground rod before manhole is placed and provide #1/0 AWG minimum bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall.
3. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete.
4. Seal floor opening with waterproof, non-shrink grout.

O. All grounding system components shall be bonded to form one continuous grounding electrode.

P. Ground electrical service system neutral at service entrance equipment to grounding electrodes.

Q. Ground each separately derived system neutral to the main building ground system.

R. Bond the system neutral to service entrance equipment enclosures.

S. Ground all exposed noncurrent carrying metal parts of electrical equipment, metal raceway systems, grounding conductors in raceways and cables, receptacle ground conductors, and metallic plumbing systems.

T. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with tightening torque values specified in UL 486A to assure permanent and effective grounding.

U. Apply mastic coating to field connections, buried metallic grounding and bonding products, and places where factory applied protective coatings have been destroyed, which are subjected to corrosive action.

3.02 INSTALLATION - EQUIPMENT GROUNDING:

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Terminate feeder and branch circuit insulated equipment grounding conductors with grounding lug on substation, switchgear, switchboard, motor control center, or panelboard ground bus. When conduit enters from below and is not connected to the enclosure, ground equipment grounding conductor on conduit grounding bushing and then bond to ground bus (or grounded enclosure if there is no ground bus).

C. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
   1. Feeders and branch circuits.
   2. Lighting circuits.
   3. Receptacle circuits.
   4. Single-phase motor and appliance branch circuits.
   5. Three-phase motor and appliance branch circuits.
   6. Flexible raceway and power cords runs.
   7. Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
   8. Computer and Rack-Mounted Electronic Equipment circuits.

D. Ground wireway at least once and at 10-foot intervals.

E. Ground all continuous runs of metallic cable tray and all isolated sections of metallic cable tray at each end. Install NEC sized bare copper equipment ground conductor in all cable tray. Clamp equipment ground conductor to cable tray at 20-foot intervals.

F. Bond cable trays routed parallel to each other with an NEC sized, bare copper tray bonding jumper ground conductor (based on highest ampacity circuit) at 100 foot intervals.

G. Pad-Mounted Transformers and Switches: Install two ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than #2 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

H. Bonding Interior Metal Ducts: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners, heaters, blowers, fans, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping. Install tinned copper bonding jumper to bond across flexible duct connections to achieve continuity.

I. Water Heater and Heat-Tracing Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

J. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J STD-607-A.
   1. For telephone, alarm, voice and data, and other communication equipment, provide #4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
   2. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4- by 4- by 12-inch (6.3- by 100- by 300-mm) grounding bus.
   3. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

K. Ground fence enclosures at each post with Burndy Type GK and GAR connectors. Install flexible braid straps across all hinge points and gates for fence enclosures. Bond fence posts, gates, and fence material to ground where crossed above by a utility line.

L. Supplementally bond all motors and equipment 50 Hp or larger to the grounding electrode system with a minimum #6 AWG bare copper wire.

M. Bond all motors with “identified” equipment grounding conductor. Route in conduit with phase conductors.

N. Enclosure Grounds: Bond all enclosures by direct copper connection to the grounding electrode system.

O. Building Grounding Conductors: Support at intervals not to exceed 3 feet on center or as indicated.

P. Grounding electrode conductors shall not be installed through a ventilation opening of an enclosure.

3.03 LABELING:

A. Comply with requirements in Section 26 05 53 - Identification for Electrical Systems for instruction signs. The label or its text shall be green.

B. Install labels at the telecommunications bonding conductor, grounding equalizer, and at the grounding electrode conductor where exposed.
   1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.04 INSPECTION:

A. Do not cover up connections before they are inspected by Engineer.

B. Compression-type connections shall be inspected for embossment of proper die index per manufacturer’s instructions.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

D. Tests and Inspections:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
   2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
   3. All compression-type connections shall be inspected for proper die index number.

4. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
    a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
    b. Perform tests by fall-of-potential method according to IEEE 81 for the following:
        (1) Testing and commissioning of new grounds, not yet connected to the utility power supply.
        (2) Testing complex ground systems that include a metallic loop.
    c. A clamp-on ground tester may only be used if the Owner does not require strict adherence to IEEE 81 and for the following situations:
        (1) To test installed grounds without disconnecting them from the utility.
        (2) To test a grounding electrode configuration where the return path includes the earth. (This does not include a ground system that includes a metallic loop.)
        (3) To test the resistance of a single rod in a series or array.
        (4) To check errant current flow to ground for operator safety.
5. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

E. Prepare test and inspection reports.

F. Maximum grounding values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ohms.
2. Power and Lighting Equipment or System with Capacity of 500 to 1,000 kVA: 5 Ohms.
3. Power and Lighting Equipment or System with Capacity More Than 1,000 kVA: 3 Ohms.
4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 Ohms.
5. Substations and Pad-Mounted Equipment serving equipment less than 1,000 kVA: 5 Ohms.
6. Substations and Pad-Mounted Equipment serving equipment greater than 1,000 kVA: 3 Ohms.
7. Manhole Grounds: 10 Ohms.

G. Grounding system will be considered defective if any maximum grounding values are exceeded. Provide additional grounding, and grounding rods as necessary so that no maximum grounding value is exceeded.

END OF SECTION 26 05 26

SECTION 26 05 29 – HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies hangers, supports, anchors, sleeves, and seals for electrical equipment and systems as well as construction requirements for concrete bases as indicated by Drawings and schedules and/or specified in other Division 26 Sections.
B. Types of hangers, supports, anchors, sleeves, and seals specified in this Section include the following:
   1. Clevis hangers.
   2. Riser clamps.
   3. Steel rod coupling.
   4. C-clamps.
   5. I-beam clamps.
   6. One-hole conduit straps.
   7. Two-hole conduit straps.
   8. Hexagonal nuts.
   9. Round threaded steel rods.
   10. Conduit clamps.
   11. U-bolts.
   12. Lead expansion anchors.
   13. Toggle bolts.
   14. Wall, ceiling, roof and floor seals.
   15. Conduit cable supports.
   16. U-channel strut system.
   17. Fire and smoke stop compounds.

1.03 RELATED REQUIREMENTS:

A. Concrete materials, reinforcement, and placement requirements are specified in DIVISION 03 – Concrete.
B. SECTION 26 00 00 - General Electrical Requirements
C. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
D. SECTION 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. ASTM International (ASTM):
   1. ASTM-A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   2. ASTM-E814 REV A - Standard Test Method for Fire Tests of Penetration Firestop Systems, pertaining to fire stop components.
C. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.

D. National Fire Protection Association (NFPA):
   1. NFPA-70 - National Electrical Code (NEC).
E. National Electrical Contractors Association (NECA):
   1. NECA 1 – Standard Practice of Good Workmanship In Electrical Construction.
F. Society of Protective Coatings (SSPC):
   1. SSPC-PA 1 - Shop, Field and Maintenance Painting of Steel.
G. Underwriters Laboratories (UL):
   1. Provide electrical devices, components, and fire stops which are UL-listed and labeled.

1.05 PERFORMANCE/DESIGN CRITERIA:

A. Delegated Design:
   1. Design supports for multiple raceways including seismic bracing, where required, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated. Raceways to be capable of supporting combined weight of supported systems and its contents.
   2. Design for seismic anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
   3. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
   4. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.
B. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
C. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data:
   1. Submit manufacture's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.
C. Shop Drawings:
   1. Submit dimensioned drawings of fabricated products, indicating weights, strength, details of fabrication, and details of materials.

1.07 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
B. Comply with NEC.

1.08 COORDINATION:

A. Coordinate size and location of supports. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete specifications.
B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Anchor Manufacturers: Subject to compliance with requirements, provide anchors of one of the following manufacturers.
   1. Hilti, Inc.
   2. Ideal Industries, Inc.
   3. Joslyn Manufacturing Co., Inc.
   4. Eaton/Cooper; McGraw Edison Co.
   5. Unistrut; Atkore International.
B. Channel System Manufacturers: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
   1. Allied Tube & Conduit Corp.
   2. Eaton/Cooper; B-Line Systems, Industries.
   3. Erico International Corp.
   4. Kindorf; Thomas & Betts Corp.
   5. Power-Strut; Power Engineering Co.
   6. Unistrut; Atkore International.
C. Fire and Smoke Stop Compounds: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
   1. 3M Company.
   2. Hilti, Inc.

2.02 STEEL SUPPORT SYSTEMS:

A. General: Provide supporting devices which comply with manufacturer's standard materials, design, and construction in accordance with published product information, as required for complete installation, and as herein specified. All supports shall be designed for the support of the maximum number of conduits and their maximum conductor weights for maximum conduit loading. Where more than one type of supporting device meets indicated requirements, selection is Contractor's option. Do not use perforated metal straps for supports.
B. Provide as required to rigidly support all conduit runs, boxes, and equipment.
C. Support conduit within 12 inch of enclosures to which conduits are attached.
D. Do not exceed the manufacturers recommended distance between supports on horizontal or vertical runs.
E. Supports: Supporting devices of types, sizes, and materials indicated, and having the following construction features. Refer to Specification 26 00 00 for material requirements.
   1. Clevis Conduit Hangers: For supporting conduit;3/8-, 1/2-, 5/8- or 3/4-inch rod, size of clevis and rod as required.
   2. Riser Clamps: For supporting conduit, with two bolts and nuts.
   3. Steel Rod Couplings: Provide 3/8-, 1/2-, 5/8- or 3/4-inch straight rod couplings, size as required.
   4. C-Beam Clamps: 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required.

5. I-Beam Clamps: 3/8, 1/2-, 5/8-, or 3/4-inch rod, size as required; 3/8-inch horizontal "J" hook safety rod that bolts across the flange, flange width as required.
6. One-Hole Conduit Straps: For supporting conduit; size as required.
7. Two-Hole Conduit Straps: For supporting conduit, size as required.
8. Hexagonal Nuts, Flat Washers and Lock Washers: For 3/8-, 1/2-, 5/8-, or 3/4-inch rod, size as required.
9. Round Threaded Steel Rod: 3/8-, 1/2-, 5/8-, or 3/4-inch diameter, size as required. Minimum size is 3/8-inch diameter.
10. Conduit Clamps: For supporting conduit; size as required.
11. U-Bolts: For supporting conduit; size as required.

F. Fabricated supports:
1. From structural steel or manufactured framing members equal to "Unistrut" P1000 (1-5/8 inch by 1-5/8 inch) series as manufactured by Unistrut Corporation, Kindorf B-995 (1-1/2 inch by 1-1/2 inch) series as manufactured by Thomas and Betts, or Superstrut A-1200 (1-5/8 inch by 1-5/8 inch) series as manufactured by Thomas and Betts.
2. Minimum 12 gauge.

G. Coated Supports:
1. Channel shall be coated using an electro-deposition process with an epoxy or acrylic coating.
2. Unscribed samples shall exceed 600-hour salt spray when tested in accordance with ASTM B117.
3. Provide conduit clamps and hangers finished with the same process as the support and sized for the specific conduit size.
4. Provide zinc-plated anchors, inserts, bolts, washers, nuts, and support hardware.

H. Hot-Dipped Galvanized Supports:
1. Channel shall be hot-dipped galvanized after all manufacturing operations are complete.
2. Channel shall have a minimum of 2.5 mils or 1.5 ounces of coating per square foot on each side of the steel and conform to ASTM A123 and ASTM A153.
3. Provide conduit clamps and hangers finished with same process as the support and sized for the specific conduit size.
4. Provide stainless-steel rods, anchors, inserts, bolts, washers, nuts with all other support hardware hot-dipped galvanized.

I. Stainless-Steel Supports:
1. Channel Type 304 stainless steel conforming to ASTM A240.
2. Stainless-steel conduit clamps and hangers, sized for the specific conduit diameter.
3. Provide stainless-steel rods, anchors, inserts, bolts, washers, nuts, and support hardware.

J. Anchors: Anchors of types, sizes and materials indicated, with the following construction features.
1. Lead Expansion Anchors: 1/2, 5/8, or 3/4 inch as required.
2. Toggle Bolts: Springhead, 3/16 by 4 inch or larger size as required.

K. Conduit Cable Supports: Cable supports with insulating wedging plug for nonarmored type electrical cables in risers; construct for rigid metal conduit (size as required) number of wires as required, type wire as specified; construct body of malleable-iron casting with hot-dip galvanized finish.

L. U-Channel Strut Systems: Unless indicated otherwise, U-channel strut system for supporting electrical equipment, 12-gauge steel hot-dip galvanized after fabrication for wet and outdoor locations, 12-gauge standard green paint finish for dry and indoor locations, of types and sizes indicated; construct with 9/16-inch diameter holes, 8 inch o.c. on top surface, and with the fittings as required which mate and match with U-channel.

M. Fire and Smoke Stop Compounds: Provide one of the following:
   1. 3M Fire Barrier 2000+.
   2. Hilti, Inc. FS-ONE MAX.

PART 3 - EXECUTION

3.01 ERECTION, INSTALLATION, APPLICATION:

A. All conduits in pump rooms to be fed from below grade to avoid bridge crane operation.
B. Install hangers, anchors, sleeves, and seals as specified, required, indicated, in accordance with manufacturer's written instructions and with recognized industry practices to insure supporting devices comply with requirements. Comply with requirements of NECA and NFPA 70 for installation of supporting devices.
C. Install hangers, supports, clamps, and attachments to support conduit properly from building structure. Arrange for grouping of parallel runs of horizontal conduits to be supported together on trapeze type hangers where possible. Install supports with spacing indicated and as required by NFPA 70 or as indicated when less than NFPA 70 required spacing.
D. Torque sleeve seal nuts, complying with manufacturer's recommended values. Ensure that sealing grommets expand to form watertight seal.
E. Design trapeze type supports, including fasteners to the structure to carry the following loads:
   1. Outdoor supports shall have the following added to the calculated load:
      a. Ice weighing 57 pounds per cubic foot to a thickness of 0.25 inches over the projected area of the supports and conduit being supported.
      b. Snow weighing 8 pounds per square foot over the projected area of the conduit being supported.
      c. Wind at 25 pounds per square foot acting in a downward direction.
   2. The greater of the following:
      a. The total calculated load multiplied by a factor of 4.
      b. The total calculated load +200 pounds.
F. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
G. Repair damage to painted finishes with paint recommended by manufacturer.
H. Install fire and smoke stop compounds at all penetrations of fire rated walls, floors, ceilings and roofs. Install fire and smoke stop compounds in accordance with manufacturer's instructions to provide a fire seal rating equal to or greater than that of the surface penetrated.
   1. Testing shall be performed in accordance with ASTM-E814 REV A and applicable local codes.
I. Provide seismic support and bracing for all multiple conduit support trapezes plus individually supported conduit 2-1/2 inches and larger such that the supports shall resist the forces of a Seismic Factors event without collapse.
J. Provide seismic support and bracing for all busway and cable tray such that the support shall resist the forces of Seismic Factors event without collapse.

3.02 CONCRETE BASES:

A. Construct concrete bases of dimensions indicated but not less than 3.5 inches (100 mm) larger in both directions than supported unit, unless larger dimensions are required by the equipment manufacturer or delegated seismic design, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 – Concrete.

C. Anchor equipment to concrete base.
   1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   2. Install anchor bolts to elevations required for proper attachment to supported equipment.
   3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.03 SUPPORTS:

A. Construct with sufficient rigidity to hold all mounted equipment and material in permanent and neat alignment.
B. Design to provide ¼-inch space between equipment housings and walls or columns upon which they are mounted.
C. Do not exceed load requirements in NEC and NEMA standards.
D. Provide individual conduit hangers for supporting individual conduits.
E. Provide trapeze hangers to support multiple conduit runs. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and an additional 90 kg (200 lbs). Attach each conduit with U bolts or other approved fasteners.
F. Support conduit independently of junction boxes, pull-boxes, fixtures, suspended ceiling T bars, angle supports, and similar items.
G. Vertical Supports: Vertical conduit runs shall have riser clamps and supports in accordance with the NEC and as shown. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.
H. For galvanized members after Power Tool Cleaning SSPC-SP11, paint all welds, field cuts, and damaged areas with organic zinc-rich primer at 3-mils dry film thickness.
   1. Ameron – 68HS.
   2. Carboline – Carbozinc 859.
   3. International – Interzinc 52 HS.
   4. Tnemec – Tnemezinc 90-97.
I. For coated supports, paint all welds, field cuts, and damaged areas with manufacturer's recommended paint.
J. The following conduit types are to use support types as listed below. Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
   1. Use hot-dipped galvanized supports, clamps, and straps, and stainless-steel hardware to support steel conduit.
   2. Use stainless-steel or PVC-coated conduit straps to support PVC-coated rigid steel conduit. Use stainless-steel clamps for supporting PVC coated rigid steel conduit on stainless-steel supports.
   3. Use stainless steel conduit clamps and hardware to support nonmagnetic conduit.

3.04 PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).
B. Clean and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal as required.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 29

SECTION 26 05 33 – RACEWAYS, BOXES, SEALS, AND FITTINGS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies raceway Work for this Contract.
B. Provide raceway and material including:
   1. Conduit.
   2. Outlet and device boxes.
   3. Pull and junction boxes.
   4. Fittings.
   5. Bushings and ground bushings.
   6. Locknuts.
   7. Knockout closures.
   8. Grout.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 19 - Low Voltage Conductors and Cables
C. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
D. SECTION 26 05 29 - Hangers and Supports for Electrical Systems
E. SECTION 26 05 44 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling
F. SECTION 26 05 53 - Identification for Electrical Systems

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of the Issued For Construction (IFC) date of the Contract Documents unless otherwise indicated.
B. American National Standards Institute (ANSI):
   1. ANSI C80.1 - Electrical Rigid Steel Conduit (ERSC).
C. American Welding Society (AWS):
   1. AWS D1.1/D1.1M - Structural Welding Code - Steel.
D. ASTM International (ASTM):
   1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A153/A153M. - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   4. ASTM A780/A780M - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   5. ASTM B117 -Standard Practice for Operating Salt Spray (Fog) Apparatus.
   6. ASTM C1107/C1107M REV A - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   7. ASTM D3917 REV A - Standard Specification for Dimensional Tolerance of Thermosetting Glass-Reinforced Plastic Pultruded Shapes.

8. ASTM D4385 - Standard Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.
9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
10. ASTM F2160 - Standard Specification for Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).

E. Joint Industrial Council (J.I.C.):
1. Comply with standards for Oil and Dust Tight Lay-In Wireway.

F. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code (NEC).

G. National Electrical Contractor's Association (NECA):
1. NECA NEIS 1 - Standard for Good Workmanship in Electrical Construction.

H. National Electrical Manufacturers Association (NEMA):
1. NEMA RN 1 - Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
2. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit.
3. NEMA TC 3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
4. NEMA TC 6 and 8 - Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installation.
5. NEMA TC 14.AG - Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
6. NEMA TC 14.BG - Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
7. NEMA TC 14.XW - Extra Heavy Wall Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
8. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports.
9. NEMA OS 2 - Nonmetallic Outlet Boxes, Covers, and Box Supports.
10. NEMA 250 - Enclosures for Electrical Equipment (1,000V Maximum).

I. Society of Protective Coatings (SSPC):
1. SSPC-PA 1 - Shop, Field and Maintenance Painting of Steel.
2. SSPC-SP3 - Power Tool Cleaning.

J. Underwriters' Laboratories, Inc. (UL):
1. Provide all devices, components, and equipment that are UL listed and labeled.
2. UL 1 - UL Standard for Safety Flexible Metal Conduit.
3. UL 5 - UL Standard for Safety Surface Metal Raceways and Fittings.
4. UL 5C - UL Standard for Safety Surface Raceways and Fittings for Use with Data, Signal, and Control Circuits.
5. UL 6 - UL Standard for Safety Electrical Rigid Metal Conduit – Steel.
6. UL 50 - UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
7. UL 50E - UL Standard for Safety Enclosures for Electrical Equipment, Environmental Considerations.
8. UL 360 - UL Standard for Safety Liquid-Tight Flexible Metal Conduit.
9. UL 514A - UL Standard for Safety Metallic Outlet Boxes.
10. UL 514B - UL Standard for Safety Conduit, Tubing, and Cable Fittings.
11. UL 514C - UL Standard for Safety Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.

12. UL 651 - UL Standard for Safety Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
13. UL 651A - UL Standard for Safety Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
14. UL 1203 - UL Standard for Safety Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations
15. UL 2515 - UL Standard for Safety Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data:
   1. Submit manufacturer's technical product data, including conduit ratings, specifications, recommended installation applications (i.e. horizontal bore, direct burry, open trench) and installation instructions, for each type of product required. Include data substantiating that materials comply with the Contract Documents.
   2. Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.
C. Certifications:
   1. Submit certifications for personnel responsible for installing conduit and fittings with PVC coated jackets.

1.06 QUALITY ASSURANCE:

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, Structural Welding Code - Steel.
B. Comply with NEC.
C. Installations shall follow standard practices of NECA NEIS 1.
D. Installers of the PVC-coated galvanized rigid conduit system shall be certified by the manufacturer and be able to present a valid, unexpired certified installer card prior to starting installation. All clamping, cutting, threading, bending, and assembly instructions given during the manufacturer’s certified installation training shall be followed.

1.07 PERFORMANCE/DESIGN CRITERIA:

A. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Rigid Galvanized-Steel Conduit (RGS):
   1. Allied Tube and Conduit, Atkore International.
   2. Western Tube and Conduit Corporation.
   3. Wheatland Tube Company, JMC Steel Group.
   4. Republic Conduit, Tenaris.
B. Fittings for Rigid Steel Conduit:
   1. Heavy-Duty Cast Malleable Iron Fittings:
      a. Appleton, Emerson Electric Company.
      b. Crouse-Hinds, Eaton.

c. Thomas & Betts, ABB Group.
2. Conduit Expansion and Deflection Fittings:
a. O-Z/Gedney, Emerson Electric Company.
b. Thomas & Betts, ABB Group.

C. Rigid Steel Conduit and Fittings with Bonded Polyvinyl Chloride (PVC) Jacket:
1. OCAL, Thomas & Betts, ABB Group.
2. Robroy Industries.

D. Rigid Polyvinyl Chloride (PVC) Conduit and Fittings:
1. IPEX Inc.
2. North American Specialty Products.
3. Carlon, Thomas & Betts, ABB Group.
4. Cantex Inc.

E. Liquid-Tight Flexible Metal Conduit:
1. AFC Cable Systems, Atkore International.
2. Anamet Electrical, Inc.
3. Electri-Flex Company.
4. Southwire Company, LLC.
5. Thomas & Betts, ABB Group.

F. Outlet and Device Boxes:
1. Appleton, Emerson Electric Company.
2. Crouse-Hinds, Eaton.
3. Killark, Division of Hubbell, Inc.
4. Leviton Manufacturing Company, Inc.
5. O-Z/Gedney, Emerson Electric Company.
6. Thomas & Betts, ABB Group.

G. Pull and Junction Boxes:
1. Metallic Indoor and Outdoor Boxes:
a. B-Line, Eaton.
b. Hoffman, nVent Electric, plc.
c. Wiegmann, Hubbell Inc.

H. Conduit Hubs and Bodies:
1. Appleton, Emerson Electric Company.
2. Myers Industries, Inc. (ITT).
3. Crouse-Hinds, Eaton.
4. O-Z/Gedney, Emerson Electric Company.
5. Thomas & Betts, ABB Group.

I. Fittings:
1. Crouse-Hinds, Eaton.
2. Appleton, Emerson Electric Company.
3. Thomas & Betts, ABB Group.

J. Bushings, Grounding Bushings, and Locknuts:
1. Arrow Hart, Eaton.
2. Appleton, Emerson Electric Company.
3. O-Z/Gedney, Emerson Electric Company.
4. Raco, Hubbell, Inc.
5. Steel City, Thomas & Betts, ABB Group.

K. Electrical Enclosures:
1. Hoffman, nVent Electric, plc.

2. Saginaw Control and Engineering.
3. Wiegmann, Hubbell, Inc.

L. Anchor Manufacturers: Subject to compliance with requirements, provide anchors of one of the following manufacturers.
1. Hilti, Inc.
2. B-line, Eaton.
3. Powers, DeWalt.
4. Red Head, ITW.
5. Unistrut, Atkore International.

M. Metal Channel System Manufacturers: Subject to compliance with requirements, provide channel system of one of the following manufacturers.
1. B-line, Eaton
2. Erico, nVent Electric, plc.
3. Kindorf, Thomas & Betts, ABB Group.
4. Power-Strut, Atkore International.
5. Superstrut, Thomas & Betts, ABB Group.
6. Unistrut, Atkore International.

2.02 DESIGN REQUIREMENTS:

A. Conduit:
1. Each length of threaded conduit furnished with coupling on one end and metal or plastic thread protector on other end.
2. Provide UL listed and labeled conduit, on each length, fittings, and accessories.
3. Sizes of conduit, fittings, and accessories as indicated, specified, or as required by Electrical Codes and Standards.

B. Supports: refer to SECTION 26 05 29.

2.03 RIGID GALVANIZED STEEL CONDUIT:

A. Raceway:
1. For Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
2. Conform to ANSI C80.1, and UL 6.
3. Mild ductile steel, circular in cross section with uniform wall thickness sufficiently accurate to cut clean threads.
4. Each length threaded on both ends with threads protected.
5. All scale, grease, dirt, burrs, and other foreign matter removed from inside and outside prior to application of coating materials.
6. Galvanized by the hot-dip process as follows:
   a. Interior and exterior surfaces coated with a solid, unbroken layer of 99% virgin zinc by dipping.
   b. Coating not to show fixed deposits of copper after four 1-minute immersions in a standard copper sulfate solution.
   c. One coat of zinc-chromate finish on inside and outside surfaces to prevent oxidation and white rust.
7. Couplings and elbows fabricated, coated and finished by the same process as conduit.

B. Fittings:
1. Heavy-Duty Cast Malleable Iron Fittings:

a. For changes in direction on conduits 2" and larger, install pull boxes, rather than fittings.
b. Full-threaded hubs and rubber-gasketed covers.
c. Zinc, cadmium-plated, or bronze hardware bolts and screws for assembly.
d. Finished with cadmium plating or galvanizing.
e. Form 8 bodies and covers.
f. Standard and junction fittings.

2. Conduit Expansion Fittings:
   a. Line of Conduit Type:
      (1) Galvanized expansion fittings for rigid conduit movement up to 4 inches.
      (2) Insulated metal bushing on ends of the conduit, bonding jumper, and with expansion head sealed with a high-grade graphite packing.
      (3) O-Z/Gedney, Type AX with Type AJ bonding jumper or Thomas & Betts, Type XJG.
   b. End Type:
      (1) For conduit terminating in a junction box.
      (2) O-Z/Gedney, Type EXE with Type BJ-E bonding jumper.
3. Conduit Expansion and Deflection Fittings:
   a. Provide for movement of 3/4 inch from normal in all directions between two rigid conduits.
   b. Integral bonding jumper.
   c. O-Z/Gedney, Type DX.
4. Conform to NEMA Type 1 enclosure in all nonhazardous areas except as specified or indicated otherwise.
5.

2.04 RIGID POLYVINYL CHLORIDE (PVC) CONDUIT:

A. Fabricated from self-extinguishing high-impact polyvinyl chloride designed for aboveground and underground installations.
B. Shall meet NEMA TC2, TC6 and TC8, and UL 651.
C. Type EPC Schedule 80 heavy-wall rigid conduit.
D. Fittings and accessories fabricated from same material as conduit. Shall meet NEMA TC3.
E. Solvent-cement-type joints as recommended by manufacturer.

2.05 LIQUID-TIGHT FLEXIBLE METAL CONDUIT:

A. Liquid-tight conduit with flexible galvanized-steel or aluminum core and a synthetic rubber, polyvinyl chloride, or thermoplastic covering.
B. Shall comply with UL 360.
C. Spiral encased copper bonding conductors for conduit in sizes 1-1/4 inches and smaller.
D. External grounding jumper as required.
E. Provide hot-dipped galvanized fittings for connections to rigid steel conduit, and aluminum- or PVC-coated fittings for connections to aluminum and PVC-coated rigid steel conduit.
F. Fittings for liquid-tight flexible metal conduit shall comply with UL 514B.
G. Polyvinyl chloride (PVC) jacket, "Hi-Temp Liquatite Type H.T. Electri-Flex" where installed in a low or high temperature area, -40ºF, or high 220ºF, as specified or indicated.
H. Polyvinyl chloride (PVC) jacket, Type HA or Type O.R. "Seal-Tite" for oil-resistant applications.

2.06 OUTLET AND DEVICE BOXES:

A. Surface Mounted:
   1. Cast hub device boxes for receptacles and switches.
   2. Cast aluminum. Metallic boxes shall meet UL 514A and NEMA OS 1.
   3. PVC boxes for PVC conduit. PVC boxes shall meet UL 514C and NEMA OS 2.
   4. FS or FD single or multiple gang boxes as required.
   5. Outlet boxes intended for use in classified areas shall be UL 886 listed.

B. Flush Mounted in Plaster Walls:
   1. Galvanized, flat-rolled, sheet-steel nongangable device boxes.
   2. Conduit knockout openings in bottom and sides.
   3. Threaded screw holes for fastening devices and box covers.
   4. Corrosion-resistant screws for equipment grounding.
   5. Include mounting brackets, device extensions plaster ears, and plaster board expandable grip fasteners (for existing plaster walls) compatible with box.
   6. Shall meet UL 514A and NEMA OS 1.

2.07 PULL AND JUNCTION BOXES:

A. Steel Boxes - Indoors:
   1. Hot-dipped galvanized steel.
   2. Galvanized-steel covers.
   3. Cadmium-plated or bronze screws and bolts.
   4. For special boxes where it is not possible to provide hot-dip galvanizing, apply organic zinc-rich primer at 3-mils dry film thickness after SSPC-SP3 Power Tool Cleaning.
   5. Minimum gauge requirements:

No surface area exceeds	No single dimension exceeds	Gage steel
1,000 sq. inches	40 inches	14
1,500 sq. inches	60 inches	12
over 1,500 sq. inches	over 60 inches	10

   6. Minimum of 14-gauge steel.
   7. Conform to NEMA Type 1 enclosure in all nonhazardous areas except as specified or indicated otherwise.
      a. Junction boxes may be standard type with knock outs except as indicated otherwise.
   8. Include piano-hinged, gasketed cover and interior mounting panel where oil-tight J.I.C boxes are used for enclosing terminal blocks and control relays.
   9. Waterproof hubs in areas subject to moisture.

B. Steel Boxes - Outdoor:
   1. Type 304 or 316 stainless steel with stainless-steel cover and stainless-steel clamps and screws.
   2. Minimum 16 gauge for boxes with no dimension exceeding 6 inches and minimum 14 gauge for all other boxes.

3. Continuously welded seams shall be ground for a smooth finish.
4. Seamless gasket for cover.
5. Conform to NEMA Type 4X.
6. Provide continuous hinge, gasketed cover, and interior mounting plate when used for enclosing terminal blocks and control relays.
7. Provide rigid weatherproof conduit hubs for all boxes.

C. Metallic Barriers:
1. Designed not to separate phases of a power circuit.
2. Provide as indicated for the isolation of power circuits from other type circuits

D. Bushings: Provide threaded, nylon-insulated metallic bushings. Provide steel bushings for conduit sizes 1-1/2 inches and smaller. Provide malleable iron bushings for conduit sizes 2 inches and larger.

E. Grounding Bushings: Provided where indicated, specified and required by NEC. Provide threaded, insulated, malleable iron bushing with lay-in screw clamp lug.

F. Locknuts: Provide steel locknuts for conduit sizes 2 inches and smaller. Provide malleable iron aluminum for conduit sizes 2.5 inches and larger. Locknut material shall match conduit type.

G. Sealing Hub: Provide watertight, threaded, insulated sealing hub connectors for all outdoor and indoor wet locations where conduit enters into enclosures. Sealing hub threaded lengths shall be adequate to allow installation of bushing.

H. Knockout Closures: Provide steel press-in knockout seals for all unused punched out knockouts 2 inches and smaller. Provide steel two-piece bolt on knockout seals for all unused punched out knockouts 2-1/2 inches and larger.

I. Fittings: Provide all threaded nipples, insulated short elbows, offset nipples, offset connectors, enlargers and reducers as required.

J. Hinged-Cover Enclosures:
1. Comply with UL 50 and NEMA 250, Type 12 for indoor, and Type 4X for outdoor.
2. Provide with continuous-hinge cover with flush latch unless otherwise indicated.
3. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel, or Stainless-Steel per area requirements.
4. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
5. Metal barriers to separate wiring of different systems and voltage.
6. Gasketed enclosures shall meet UL 50E.

2.08 SUPPORT SYSTEM:

A. Provide as Specified in SECTION 26 05 29.

2.09 WALL AND DUCT SEAL:

A. Provide as specified in SECTION 26 05 44 for sleeves, seal fittings, silicone sealants and duct seal.

2.10 GROUT:

A. Description: Non-shrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

C. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

1.

PART 3 - EXECUTION

3.01 GENERAL

A. Comply with manufacturer's published instructions.
B. Follow the applicable NECA NEIS articles for installation of all conduits.
C. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Prior to pouring concrete plug coupling until conduit is extended above floor to destination or a minimum of 2 ft above finished floor.
D. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
E. Cut conduit perpendicular to the length. Use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
F. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound that maintains electrical conductivity to threads of duct raceway and fittings before making up joints. Follow compound manufacturer's published instructions.
G. Clean out all conduits before pulling wire.
H. Clean out all conduits immediately after concrete work is finished.
I. Install pull wires in empty duct raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inch of slack at both ends of pull wire. Cap underground duct raceways designated as spare above grade alongside duct raceways in use.
J. Expansion fittings required above grade for direct buried PVC conduit as required by NFPA 70 (NEC).

3.02 RACEWAYS INSTALLATION:

A. General Requirements:
    1. Location:
        a. Conduits routed through pump room to be installed below floor to avoid operation of bridge crane.
        b. When shown, install conduit as near as possible to the routing indicated.
        c. Shift locations as required to avoid interference with other equipment and piping being installed.
        d. Route raceway so stubs up are located according to the equipment submittals next to indicated equipment connections or motor terminal boxes.
        e. Where routing of conduit is not indicated, such as for lighting home run circuits and other systems requiring small conduit runs, route conduit as specified subject to approval by Engineer.
    2. Install horizontal runs as high above floor as possible, and in no case lower than 7 feet above floor, walkway, or platform in passage area.
    3. Run conduit parallel or perpendicular to walls, ceiling, beams, and columns unless indicated otherwise.
    4. Follow manufacturer's recommendations for field bending of conduit or use conduit fittings provided by manufacturer.
    5. Route to clear all doors, windows, access wells, and openings.

6. Group parallel runs in neatly aligned banks where possible with minimum of 1-inch clearance between exposed conduits and three conduits OD between concealed or encased conduits.
7. Do not install duct raceways or electrical items on "explosion-relief" walls or rotating equipment.
8. Do not install conduits within 2 inches of the bottom side of a metal deck roof.
9. Maintain 6-inch clearance between conduit and coverings on all hot lines; steam, hot water, and the like.
10. Do not use conduit in sizes smaller than 3/4 inch, except 1/2 inch may be used for connections to control devices and thermocouples where necessary.
11. Route the raceway through wall floor and ceiling penetrations, provide holes and sleeves as specified in SECTION 26 05 44.
12. Complete duct raceway installation before starting conductor installation.
13. Install no more than equivalent of three 90-degree bends in conduit run. Support within 12 inch of changes in direction.
14. Make bends in duct raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
15. Make connections to boxes, panels, and other equipment as follows:
    a. Indoor Dry Locations: Double locknuts, one inside and one outside.
    b. Outdoor and Damp Locations: Rigid weatherproof conduit hubs.
    c. Bushings:
        (1) Threaded malleable iron or steel.
        (2) Insulated with Bakelite, molded and bonded into the bushing.
        (3) Placed on end of conduit in addition to locknuts.
        (4) Install with integral grounding connector and conductor where all conduits pass through multiple concentric panel knockouts and where the conduit must be bonded to equipment it is not attached to.
16. Running threads will not be permitted.
17. Coat all field cut threads in galvanized conduit with cold galvanizing paint.
18. Comply with applicable requirements of NEC pertaining to installation of conduit systems.
19. Place drainage fittings or weep holes at unavoidable low points where moisture can collect.
20. Install an entire conduit system that is electrically continuous with bonding jumpers provided as necessary to conform to NEC.
21. Install expansion fittings at all building expansion joints and every 100 feet of continuous conduit.
22. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new conduits.
23. Provide identification of all raceways, including conduit and wireways as specified in Section 26 05 53.
24. Ground all raceways as specified in Section 26 05 26.

B. Rigid Steel Conduit:
1. For Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
2. Concealed:

a. Install conceal conduit for lighting, convenience outlets, and other circuits in walls, ceiling, and floors where possible.
b. Do not install conduit in concrete where conduit outside diameter exceeds one-third of concrete thickness.
c. Use expansion and deflection fitting with bonding jumpers at all concrete expansion joints.
d. Tie securely in place to prevent movement when concrete is poured.
e. Install in floor slabs in as straight a run as possible. Conduit crossovers are not permitted unless conduit total outside diameter is one-third of the concrete thickness or less.

C. Rigid PVC Conduit:
1. For Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
2. Make all joints watertight with cement compound furnished by the conduit manufacturer.
3. Buried:
a. Install in as straight a run as possible between termination points of exact routing to be determined in the field and subject to approval by Engineer.
b. Bury conduits a minimum of 30 inches below finish grade unless indicated otherwise.
c. Slope conduit away from building conduit risers down to handholes or manhole drains.
d. Maintain 6-inch separation from underground piping.
e. Use PVC-coated rigid steel elbows at all risers and at any bend greater than 45 degrees unless indicated otherwise.
f. All risers shall be PVC-coated rigid steel conduit.
g. After trench bottom has been finished to grade, lay conduit. Backfilling shall be as specified in Division 31.
h. Cap ends of all conduit risers before backfilling.

D. Liquid-Tight Flexible Metal Conduit.
1. For Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
2. Use between rigid conduit and motor terminal boxes except where conduit runs down from above and cannot be conveniently supported by a floor flange.
3. Place between rigid conduit or conduit box and control device cases where direct connection is not desirable for reasons of equipment movement, vibration, or for ease of maintenance.
4. Install at all points of connection to equipment mounted on supports to allow for expansion and contraction.
5. Conform to NEC with installation of conductors.
6. Install at locations where rigid conduit connections are impractical.
7. Use minimum length consistent with manufacturer's standard lengths, the acceptable bending radius, and with required movement of equipment.
8. Maximum length of 3 feet unless otherwise approved by Engineer.
9. Install an external bonding jumper to conform to NEC on conduit sized 1-1/2 inches and larger.
10. Install flex conduit with 15% extra length to allow the conductors and conduit room for vibration and expansion.

E. Conduit Fittings:

1. For Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
2. Installations of special fittings are indicated.
3. Use aluminum fittings for joining aluminum to steel conduit.
4. Install as required.

3.03 BOXES AND FITTINGS:

A. For Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
B. Install electrical boxes, bushings, locknuts, nipples, connectors, sealing hubs, and fittings as required, indicated, in accordance with applicable requirements of NEC and in accordance with recognized industry practices to fulfill Project requirements.
C. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.
   1. Where raceways containing 4 AWG or larger insulated circuit conductors have these conductors enter a cabinet, a box, an enclosure, or a raceway, protections , as required by NFPA 70 (NEC), must be installed prior to conductors.
D. Provide weatherproof boxes for interior and exterior locations exposed to weather or moisture.
E. All boxes containing emergency power and lighting circuits shall be identified as specified in Section 26 05 53 – Identification for Electrical Systems.
F. Provide (oil-tight) knockout closures to cap unused knockout holes where blanks have been removed.
G. Install electrical boxes in only those locations which ensure ready accessibility to enclosed electrical wiring.
H. Maximum box size in a fire-rated wall shall be 4 inches by 4 inches square. Do not install boxes back-to-back in walls. In walls that are not fire-rated or acoustic- rated, provide not less than 6 inches (150 mm) horizontal separation between boxes installed in opposite sides of wall. Provide not less than 24 inches (610 mm) horizontal separation between boxes installed in opposite sides of fire-rated and acoustic-rated walls.
I. Do not install aluminum products in concrete.
J. Position recessed outlet boxes accurately to allow for surface finish thickness.
K. Set floor boxes level and flush with finish flooring material.
L. Fasten electrical boxes firmly and rigidly to the surfaces to which attached, structural surfaces to which attached, or solidly embed them in concrete or masonry.
M. Provide electrical connections for installed boxes.
N. Properly ground metallic electrical boxes in compliance with the NEC. Bond all non-isolated equipment grounding conductors to all electrical boxes.
O. Subsequent to installation of boxes, protect boxes from construction debris and damage.
P. Install special boxes as indicated of size required for conduits and cables entering and leaving box.
   1. Boxes containing terminal blocks are sized to meet requirements of NFPA 70 (NEC).
Q. Explosionproof Fittings:
   1. Install explosionproof fittings in the conduit system as required by NEC.
   2. Install necessary fittings where not indicated but required by code.
R. Ground boxes and fittings per SECTION 26 05 26 – Grounding and Bonding for Electrical Systems.

3.04 PAINTING:

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
   1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 26 05 33

SECTION 26 05 43 – UNDERGROUND DUCT BANKS AND HANDHOLES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Complete underground duct systems consisting of banks of nonmetallic ducts encased in reinforced concrete, and precast concrete handholes.
   2. All necessary earth and rock excavation and backfill.
   3. Removal and disposal of all excess excavation material.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems
D. SECTION 26 05 44 - Sleeves and Sleeve Seals for Electrical Raceways and Cabling
E. SECTION 26 05 53 - Identification for Electrical Systems
F. DIVISION 31 - Earthwork

1.04 REFERENCE STANDARDS:

A. American Concrete Institute (ACI):
   1. 318-14 – Building Code Requirements for Structural Concrete.
B. American Society for Testing and Materials (ASTM):
   1. A48 – Standard Specification for Gray Iron Castings.
   2. C857 – Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   3. C858 – Standard Specification for Underground Precast Concrete Utility Structures.
   4. D3917 – Dimensional Tolerance of Thermosetting Glass Reinforced Plastic Pultruded Shapes.
   5. D4385 – Practice for Classifying Visual Defects in Thermosetting Reinforced Plastic Pultruded Products.
   6. F512 – Standard Specification for Smooth Wall Polyvinyl Chloride (PVC) Conduit and Fittings for Underground Installation.
C. Federal Specifications:
   1. W-C-1094A – Conduit and Conduit Fittings Plastic, Rigid.
D. National Electrical Manufacturer's Association (NEMA):
   1. TC-2 – Electrical Plastic Tubing (EPT) and Conduit (EPC-40 and EPC-80).
   2. TC 6 – PVC and ABS Plastic Utilities Duct for Underground Installation.
   3. TC 8 – Extra Strength PVC Plastic Utilities Duct for Underground Installation.
   4. TC-14 – Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
E. Underwriters Laboratories, Inc. (UL):
   1. 651 – Schedules 40, 80, Type EB and A Rigid PVC Conduit and Fittings
   2. 651A – Schedule 40 and 80 High Density Polyethylene (HDPE) Conduit.
   3. 1684 – Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.05 SUBMITTALS:

A. Product Data: Submit the following for each type of product specified and included as minimum:
   1. Data sheets for each product supplied.
B. Shop Drawings: Provide the following as minimum:
   1. Submit shop drawings for fabrication and installation of pre-cast concrete structures and cast-in-place concrete structures including the following:
      a. Steel reinforcement drawings.
      b. Elevation showing openings, pulling irons, cable supports, sump, steps, covers, frames and other details.
C. Closeout Submittals: Final documentation shall include the following as minimum:
   1. Certified "As-Built"/"As-Installed" drawings.
   2. Copies of all approved Product Data.

1.06 QUALITY ASSURANCE:

A. Manufacturer Qualifications:
   1. The manufacturer shall be by a company specializing in providing precast products and services normally associated with precast-concrete construction. Design of precast handholes shall be prepared by a professional engineer licensed in the state associated with the project to conform to the procedures set forth in ACI 318 and applicable standards of this specification and of the size, shape, and details indicated or specified.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Ducts:
   1. Carlon.
   2. Certain-Teed.
   3. Cantex.
B. Duct Spacers:
   1. Carlon.
   2. CertainTeed.
   3. Formex.
C. Concrete Inserts:
   1. Unistrut Corporation.
   2. B Line Systems, Inc.
D. Precast Handholes:
   1. Barbour Concrete Co.
   2. Champion Precast Inc.
   3. Old Castle.
   4. Engineer approved equal.

2.02 DUCTS:

A. Conduit Types for Concrete Encasement:
   1. Type EB:
      a. Tested to Underwriters' Laboratories, Inc. (UL) Standard UL 651A.
      b. Type EB35, Heavy Wall, Thickness conforming to NEMA TC-8 and ASTM F512.
B. Rated for use with 90°C conductors.

C. Provide with all necessary end bells, couplings, offset couplings, elbows, plugs, and other fittings.
D. Sizes as indicated.
E. Install PVC coated rigid galvanized steel elbows for all duct termination risers and all non-sweeping 90 degree bends.
F. Provide prefabricated, interlocking type plastic duct spacers for duct spacing as indicated.

2.03 REINFORCING STEEL:
A. Provide as specified in Division 03.

2.04 CONCRETE:
A. Provide as specified in Division 03.
B. Red colored concrete encasement, shall use a red pigment integrally mixed into the concrete. Dry shake or broadcast coloring agents are not to be used.
C. Concrete shall be red dyed utilizing red dye mixed into the concrete for a minimum of 5 minutes prior to pouring. Minimum of 1 bag of dye per 1 yd of concrete.

2.05 POLYMER CONCRETE HANDHOLES:
1. Provide polymer concrete handholes similar to Quazite, Old Castle, or approved equal.
2. Provide size as shown on drawings, or as necessary based on NEC Fill calculations. Contractor to verify size requirements.
3. Provide polymer concrete handholes with load ratings as necessary based on final location.
    a. Located within drives, parking areas, or other areas likely to receive heavy vehicle traffic, or loading from crane outriggers: HS20.

2.06 WARNING TAPE:
A. Standard detectable warning tape, 4-mil 3 inch wide tape, red with black letters imprinted with "CAUTION BURIED ELECTRIC CABLE BELOW".
B. Metallic marker tape and 12 awg uf single strand tin coated copper tracer

2.07 "PULLING IN" ROPE:
A. Nylon or nylon equivalent composite.
B. Minimum average breaking strength: 2000 pounds.

PART 3 - EXECUTION

3.01 EXCAVATION AND TRENCHING FOR DUCT BANKS AND HANDHOLES
A. Perform as specified in Division 31.
B. Work with extreme care near existing underground utilities to avoid damaging them.
C. Pitch the trench uniformly toward handholes or both ways from high points between handholes for required drainage.
D. Notify the Owner's representative for inspection prior to any duct bank installation and prior to concrete placement.

3.02 INSTALLATION:
A. Duct Banks:
1. Ducts:
    a. Assemble as follows:

(1) On spacers to maintain horizontal and vertical separation indicated.
(2) With joints in adjacent ducts staggered.
(3) All joints watertight by application of joint sealer compound furnished by duct manufacturer.
(4) No reinforcing steel or other ferrous material between individual ducts.

b. Securely tie overall at 5 foot or closer intervals as required.
c. Secure to anchors after assembling to prevent flotation when placing concrete.
d. Slope towards handholes with a minimum continuous slope of 1/2 percent.
e. Align ducts for each 100 feet not greater than 4 inches horizontal.
f. All risers and non-sweeping bends shall be PVC coated rigid galvanized steel as specified.
g. Install end bells flush with face of concrete at each handhole and termination point unless indicated otherwise.
h. Immediately after cleaning, install a "pulling in" rope in each duct, and plug each end of all ducts.

2. Install warning tape along the entire length of duct banks at a depth of 12 inches below grade or as indicated on drawings.
3. Run warning tape tracer wire to handhole with tracer wire test station.
4. Reinforcing: Place as specified in Division 03.
5. Concrete:
   a. Do not place prior to inspection and approval of duct and reinforcing installation by Engineer.
   b. Place as specified in Division 03.

B. Handholes:
1. Install a minimum of 6 inches of compacted granular material on undisturbed soil below handhole.
2. Place at location and alignment as indicated.
3. Top slab and handhole shall be set flush with finished grade when installed in paved areas, or 1” above finished grade in non-paved areas.
4. Install conduits as indicated.
5. Provide sufficient cable slack during installation to rack and secure cabling around the handhole walls.
6. Clearances

C. Duct and Conduit Sealing:
1. Seal the ducts and conduits at building entrances and at outdoor equipment with a suitable non-hardening compound to prevent the entrance of moisture and gases.

3.03 BACKFILLING:

A. Provide backfill and compaction as specified in Division 31.

3.04 ADJUSTING AND CLEANING:

A. Rod and clean all ducts with suitable cleaners, swabs and mandrels after completion of the duct bank.

END OF SECTION 26 05 43

SECTION 26 05 44 – SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This SECTION specifies the sleeves and seals Work by this Contract.
B. Provide raceway and duct seals including:
   1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
   2. Sleeve-seal fittings.
   3. Seal fittings.
   4. Silicone sealants.
   5. Duct seal.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 33 - Raceway, Boxes, Seals, and Fittings for Electrical Systems

1.04 REFERENCE STANDARDS:

A. ASTM International (ASTM):
   1. ASTM A 53/A 53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   2. ASTM D1785 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120
   3. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
B. Joint Industrial Council (J.I.C.):
C. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code (NEC).
D. National Electrical Contractors Association (NECA):
   1. NECA NEIS 1 - Standard for Good Workmanship in Electrical Construction.
E. National Electrical Manufacturers Association (NEMA):
   1. NEMA VE 2 - Cable Tray Installation Guidelines

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data:
   1. Submit manufacturer's technical product data, including specifications and installation instructions, for each type of product required. Include data substantiating that materials comply with requirements.
   2. Submit manufacturer's data on supporting devices including catalog cuts, specifications, and installation instructions, for each type of support, anchor, sleeve, and seal.
   3. Submit listed systems for penetrations expected to be encountered.

1.06 COORDINATION:

A. Coordinate size and location of sleeves. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Wall Entrance Seals: O.Z./Gedney, Emerson Electric Company.
B. Duct Seal:
   1. Ideal Industries, Inc.
   2. The 3M Company.
   3. Engineer-approved equal.

2.02 SLEEVES:

A. Round Sleeves:
   1. Steel Wall Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
   2. Cast-Iron Wall Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
   3. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.
   4. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
   5. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
B. Rectangular Sleeves:
   1. Rectangular, galvanized-steel, sheet metal sleeves.
   2. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter 50 inches or more and one or more sides larger than 16 inches, thickness shall be 0.138 inch.

2.03 SLEEVE-SEAL SYSTEMS

A. Options:
   1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   2. Pressure Plates: Stainless steel.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.
B. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.04 GROUT:

A. Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
B. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
C. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.
D. Packaging: Premixed and factory packaged.

2.05 POURABLE SEALANTS

A. Single-component, neutral-curing elastomeric sealants of grade indicated below.
B. Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

2.06 FOAM SEALANTS

A. Multicomponent, liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam. Foam expansion must not damage cables or crack penetrated structure.

2.07 CONDUIT WALL ENTRANCE SEALS:

A. Provide where required or indicated.
B. Use O.Z./Gedney Company Type FSK for new walls.
C. Use O.Z./Gedney Company Type CSM for penetration in existing walls.

2.08 SEAL FITTINGS AND COUPLINGS FOR RIGID STEEL, AND PVC-JACKETED RIGID STEEL CONDUIT:

A. Fittings:
   1. Cast malleable iron fittings (for rigid steel conduit).
   2. Explosionproof.
   3. Cast malleable iron.
   4. Threaded cover to conform to NEC.
   5. Full thread hubs.
   6. Seal compound well for seal.
   7. Drain seals as indicated or required to provide a continuous automatic drain of water.
   8. "Chico" compound for all sealing fittings.
   9. PVC jacketed in corrosive areas where PVC-jacketed conduit is used.
   10. Oversized to allow full cross section matching raceway and not reduce fill ratio.
B. Couplings:
   1. Explosionproof.
   2. Flexible.
   3. Conform to NEC.
   4. Threaded steel end fittings, matching conduit type, securely fastened to the core and braided to ensure electrical continuity.
   5. PVC jacketed in corrosive areas where PVC-jacketed conduit is used.

2.09 DUCT SEAL:

A. Duct Seal:
   1. Noncorrosive, permanently soft compound.
   2. Nontoxic.
   3. Provide flexible re-enterable and repairable seal around cables in conduits.
   4. Prevent air movement and drafts through conduits.
   5. Provide Ideal Industries Duct Seal, 3M® Moldable Putty, or Engineer-approved equal.

2.10 SILICONE SEALANTS:

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.01 SEAL FITTINGS:

A. Comply with NECA 1.

B. For sealing conduits within or leaving hazardous areas, provide seal fittings sized large enough to full use of the NEC allowed conduit capacity.

C. Install duct sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed duct raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install duct sealing fittings in accordance with NFPA 70.

D. Install devices to seal duct raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of duct raceways at the following:
1. Conduits pass from warm to cold locations.
2. Underground service duct raceway enters a building or structure.
3. Conduit extending from interior to exterior of building.
4. Around cables at all conduit terminations at control panels
5. Boxes containing terminations and splices.
6. Where otherwise required by NFPA 70
7. Install necessary fittings in locations indicated and as required by code.

E. Wall, Roof and Floor Seals: Provide sleeves for conduit which penetrate foundation walls below grade, floors, ceilings, or exterior walls. Caulk between sleeve and conduit with nontoxic, UL-classified caulking material to ensure watertight seal.

F. Sleeve Seals: Provide modular mechanical type seals, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation. Seal fire rating shall equal or exceed that of the wall or floor penetrated.

G. Provide a fire-rated sleeve and seal equal to or exceeding the fire rating of the ceiling, floor or wall being penetrated. Fire-rated Sleeve and seal systems provided are to comply with engineer approved UL Listed systems. Coordinate with Engineer to gain approval of new penetration types requiring fire-rated sleeve and seal systems not yet approved.

H. Provide through floors, walls, and roofs as necessary for conduit or cable tray runs, including approved flashing and weather proofing at outside walls and on roofs.

I. Install sleeves or forms for all openings in new Work.

J. Provide the required inserts and holes, completely sleeved, bonded, curbed, flashed, and finished off in an approved manner, whether in concrete, steel grating, metal panels, or roofs.

K. Core-drill all holes required in existing building work using a dustless method.

L. Place non-shrinking grout or Dow Corning 3-6548 Silicone RTV or equivalent General Electric RTF 762 sealant as specified, in the following locations:

M. All holes in concrete, walls, floor, and roof slabs after installation of conduit.

N. All unused holes and sleeves as approved by Engineer.

O. Install wall entrance seals where conduit enters the building or vaults from exterior underground.
P. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
    1. Size pipe sleeves to provide 1/4 inch annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed, or seismic criteria require different clearance.
    2. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
Q. Aboveground, Exterior-Wall Penetrations: Seal penetrations using galvanized steel or cast-iron pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
R. Underground, Exterior-Wall and Floor Penetrations:
    1. Install cast-iron pipe sleeves with integral waterstops. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.
    2. Install steel pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Grout sleeve into wall or floor opening.

END OF SECTION 26 05 44

SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies electrical identification work including the following:
   1.
   2. Electrical power, control, and communication conductors (and raceways).
   3. Operational instructions and warnings.
   4. Danger, caution and warning signs.
   5. Equipment/system identification nameplates.

1.03 RELATED REQUIREMENTS:

A. Section 26 05 19 – Low Voltage Conductors and Cables
B. Section 26 05 73 – Overcurrent Protective Device Coordination Study.

1.04 REFERENCE STANDARDS:

A. Applicable Standards: Comply with the applicable requirements of the following standards.
   1. American Society of Mechanical Engineers (ASME):
      a. A13.1 - Scheme for the Identification of Piping Systems.
   2. Federal Specifications (FS):
      a. FS L-P-387 - Polyethylene Low and Medium Density – Molding Material (for designation plates).
   3. National Electrical Manufacturers Association (NEMA):
      a. Z535.1 - Safety Colors.
      b. Z535.4 - Product Safety Signs and Labels.
   4. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC), as applicable to installation of identifying labels and markers for wiring and equipment.
      b. 70E - Electrical Safety in the Workplace.
      c. 72 - National Electric Safety Code (NESC) – IEEE C2.
   5. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910.144 - Safety Color Code for Marking Physical Hazards.
      b. 29 CFR 1910.145 - Specifications for Accident Prevention Signs and Tags.
   6. Underwriters Laboratories (UL), pertaining to electrical identification systems:
      a. 969 - Standards for Marking and Labeling Systems.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data: Submit manufacturer's data on electrical identification materials and products.
C. Samples: Submit samples of each color, lettering style, and other graphic representation required for each identification material or system.

1.06 QUALITY ASSURANCE:

A. Comply with ASME A13.1.
B. Comply with NFPA 70.
C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
D. Comply with NEMA Z535.4 for safety signs and labels.
E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.07 COORDINATION:

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
C. Coordinate installation of identifying devices with location of access panels and doors.
D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide electrical identification products of one of the following (for each type of marker):
   1. Brady Worldwide, Inc.
   2. Panduit Corp.
   3. Seton Identification Products.
   4. Thomas & Betts Corp.

2.02 ELECTRICAL IDENTIFICATION MATERIALS:

A. General: Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, selection is Installer's option; but provide single selection for each application.
B. Orange "Emergency" and “( )-VOLT" Conduit, Equipment, Box Markers:
   1. General: Self-adhesive vinyl tape marker not less than 3 mils thick. Provide 1-1/8 inch wide by 4-1/2 inch long marker for 2 inch and smaller conduit. Provide 2-1/4 inch wide by 9 inch long marker for 2-1/2 inch and larger conduit. Except as otherwise indicated, provide black lettering which indicates highest voltage of cables(s) in. Provide black lettering that indicates "Emergency" power circuit is in conduit.
   2. Colors: Unless otherwise indicated or required by governing regulations, provide orange background tape marker.
C. Underground Type Plastic Line Marker:
   1. General: Permanent, bright-colored, continuous-printed plastic tape marker, intended for direct-burial service; not less than 6 inches wide by 4 mils thick. Provide tape marker with printing which most accurately indicates type of service of buried cable or duct bank. (Provide embedded continuous metallic strip or core when used with non-metallic conduit and fiber optic cable to enable locating.)
D. Conduit, wireway identification tags:

1. Instrument, 600V Control, and Power: Use labels with 2-inch black letters identifying.
2. Label adhesive to be able to hold on curved surfaces and withstand temperatures up to 150ºF, in indoor or outdoor environments.
3. Labels to be resistant to oil, dirt, and abrasion.
4. Made by Brady Corporation:
    a. Numbers generated with the BBP31 or BBP33 printer, with each raceway number on a continuous white background strip.
    b. Text size of 2 inches high with 1 character per inch on white background.
    c. Label size of 2.25 inches high.
    d. Utilize B-595 indoor/outdoor vinyl.
5. Made by Electromark Company:
    a. Each label generated on a continuous white background strip.
    b. C-1003 series.
    c. Label size of 2.5 inch high.
    d. Text size of 2 inches high with 1 character per inch on a white background of 6-mil polyester film.
    e. Suitable for outdoor installation in all environments.
        (1) Long lasting performance in all environments.
        (2) Permanent adhesive for cold weather installation.
        (3) UV resistant ink.
        (4) Furnish with wrap around bands to insure that the identification tags will not lift off.
6. Engineer approved equal.

E. Wire/Cable Identification Bands:
1. Allen Marking Products.
2. Panduit.
3. Specialty Products Company.
4. Thomas and Betts.
5. Brady Corporation.
6. General: Vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, print-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification number indicated on Drawings or Shop Drawings.

F. Plasticized Tags:
1. General: Preprinted or partially preprinted accident-prevention and operational tags, on plasticized card stock with matt finish suitable for writing, approximately 3-1/4 inches by 5-5/8 inches, with brass grommets and wire fasteners, and with appropriate preprinted wording, including large-size primary wording, e.g., "DANGER, DO NOT OPERATE." Tags shall comply with OSHA requirements.

G. Self-Adhesive Plastic Signs:
1. General: Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application, e.g., "EXHAUST FAN."
    a. Colors: Unless otherwise indicated or required by governing regulations, provide white signs with black lettering.

H. Baked Enamel "Danger" Signs:
1. "DANGER" signs of baked enamel finish on 20-gauge steel (unless specified otherwise); of standard safety red, safety black, and safety white as defined by NEMA Z535.1; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision;

with recognized standard explanation wording, e.g., "_____VOLTS, KEEP AWAY." Sign shall conform to OSHA and NEMA Z535.4.

I. Baked Enamel "Caution" Signs:
   1. "CAUTION" signs of baked enamel finish on 20-gauge steel (unless specified otherwise); of standard safety yellow with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording, e.g., "Caution for Ear Protection Required in this Area."

J. Based Enamel "WARNING" Signs:
   1. "WARNING" signs of baked enamel finish on 20-gauge steel (unless specified otherwise); of standard safety orange with safety black letters; 14 inches by 10 inches size, except where 10 inches by 7 inches is largest size that can be applied where needed and except where larger size is needed for adequate vision; with recognized standard explanation wording. Sign shall conform to OSHA and NEMA Z535.4.

K. Engraved Plastic-Laminate Nameplates:
   1. General: Engraving stock melamine plastic laminate nameplates, in sizes (minimum height of characters shall be 1/8 inch) and thicknesses specified or indicated, engraved with engraver's standard letter style of sizes and wording indicated, white face and black core plies (letter color) except as otherwise indicated, specified or required. Colors shall comply with OSHA and NEMA Z535.1. Nameplate shall be punched for mechanical fastening except where adhesive mounting is necessary because of the surface type it is mounted to, or where mechanical fastening will compromise the enclosure protection ratings.
      a. Thickness: 1/16-inch, for units up to 20 square inches or 8 inch length; 1/8-inch for larger units.
      b. Fasteners: Self-tapping stainless-steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate surface it is mounted to.
   2. Lettering and Graphics:
      a. Coordinate names, abbreviations, and other designations used in electric identification work with corresponding designations shown, specified, or scheduled. Provide numbers, lettering, and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ASME A13.1 pertaining to minimum sizes for letters and numbers. Comply with OSHA requirements. Comply with design requirements of NEMA Z535.4.

PART 3 - EXECUTION

3.01 APPLICATION AND INSTALLATION:

A. General Installation Requirements:
   1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions and requirements of NEC.
   2. Coordination: Where identification is to be applied to surfaces which require finish painting, install identification after completion of painting.
   3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit, wireway identification tags:

1. General: Where exposed, apply identification markers at 20-foot intervals (visible from the floor) and within 3 feet of all panelboards, switchboards, switchgear, automatic transfer switches, emergency generators, substations, switches, devices, and circuit breakers (readily visible when standing in front of equipment). Identification on wireway shall be on outside of both sidewalls at 20-foot intervals.

C. Underground Cable, Conduit, and Duct Bank Identification Marker:
1. General: During back-filling/top-soiling of each exterior underground direct buried electrical, signal or communication cable, conduit and duct bank, install continuous underground-type plastic line marker, located directly over the direct buried cable, conduit or duct bank at 12 inches below finished grade. Where multiple small direct buried cables are buried in a common trench and do not exceed an overall width of 16 inches, install a single line marker.
2. Install line marker for every cable below grade, regardless of whether direct-buried, protected in conduit, or conduit in duct bank.

D. Wire/Cable Identification Bands:
1. General: Apply cable/conductor identification bands, including circuit number, on each wire/cable in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.

E. Wire/Cable Identification Bands:
1. General: Apply cable/conductor identification bands, including circuit number, on each wire/cable in each box/enclosure/cabinet where wires of more than one circuit or communication/signal system are present. Match identification with marking system used in panelboards, shop drawings, contract documents, and similar previously established identification for project's electrical work.
2. Refer to Interconnect Wiring Diagrams provided by System Integrator. Refer to SECTION 40 60 00 – Process Control and Instrumentation General Requirements.
3. Wire labels to adhere to the following wire labeling format:
    a. AAAABBBBCCCC-DDDEEEEFF, where
        (1) AAAA = Drawing number of interconnect wiring diagram provided by System Integrator.
        (2) BBBB = Control Panel name.
        (3) CCCC = Terminal number of wire in control panel.
        (4) DDD = Field instrument designation type
        (5) EEEE = Instrument loop number
        (6) FF = Optional Indicator
        (7) Example: 0205MAIN0405-HS2400ES
            (a) 0205 - would be the wire label indicating sheet 0205 in the interconnect wiring diagram package provided by the System Integrator.
            (b) MAIN is the name of the enclosure/panel the wire terminates
            (c) 0405 is the terminal number the wire lands on
            (d) HS is a hand switch as designated by the P&ID symbol sheets.
            (e) 2400 is the equipment id/loop number as identified on the P&IDs and located on the electrical Drawings.
            (f) ES defines the HS device type, specifically as an E-Stop push button as identified by the P&ID symbol sheets.

F. Operational Identification and Warning Plasticized Tags and Metal Signs and Plastic Signs:

1. General: Wherever reasonably required to ensure safe and efficient operation and maintenance of electrical systems, and electrically connected mechanical systems and general systems and equipment, including prevention of misuse of electrical facilities by unauthorized personnel, install signs with instruction or warnings. When signs are installed on switches, outlets, controls, devices and covers of electrical enclosures they may be self-adhesive vinyl or plastic. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.
2. Where switchboards, switchgear, motor control centers, and panelboard are supplied by a feeder, provide an informational sign indicating each device or piece of equipment from where the power originates.

G. Danger Signs:
1. General: In addition to installation of danger signs specified, indicated, and required by governing regulations and authorities, install appropriate danger signs at locations indicated and at locations subsequently identified by Installer of electrical work as constituting similar dangers for persons in or about Project.
2. Install danger signs (with actual circuit voltage) on all building doors, substations, switchgear, switchboards, panelboards switches, circuit breakers, etc., wherever it is possible (under any circumstances) for persons to come into contact with electrical voltages to ground greater than 277V.
3. Critical Switches/Controls: Install danger signs on switches and similar controls, regardless of whether concealed or locked up, where untimely or inadvertent operation (by anyone) could result in significant danger to persons or damage to or loss of property.
4. Provide the following danger sign on the equipment indicated:
   a. "Danger This Machine Starts Automatically" on all fire pumps, air compressors and emergency generators.
5. Provide the following danger signs on the doors leading to the equipment indicated:
   a. "Danger Hearing Protection Required" on all emergency generator room doors.
   b. "Danger: No Smoking, Matches or Open Flames" on all emergency generator room doors (, personnel doors opening into aircraft hangar,) and battery room doors.

H. Warning Signs:
1. Provide an orange background sign with black letters reading "WARNING: LOAD SIDE OF SWITCH MAY BE ENERGIZED BY BACKFEED" on all tie switches and tie circuit breakers.
2. Provide Arc Flash Warning signs on electrical equipment such as switchboards, switchgear, panelboards, industrial control panels, motor control centers and meter socket enclosures that are likely to require examination, adjustment, servicing, or maintenance while energized. Marking shall be permanently affixed and of a durable nature to withstand the environment within which it is installed. Marking is to include date of Electrical Study confirming the stated values.
3. Provide Available Fault Current Warning signs on electrical equipment as specified in Section 26 05 73. Label shall include possible incident energy exposure within arc flash boundary in front of equipment as well as meet NFPA 70E for additional content.

I. Caution Signs:
1. Provide yellow background caution signs with black letters on the doors leading to the equipment indicated:
   a. "Caution Ear Protection Required in this Area" on all emergency generator room doors.

2. Provide the following yellow background caution sign with black letters on all panelboards, substations, switches, circuit breakers, and switchboards where turning off a circuit will automatically start an emergency generator:
   a. "Caution Turning Off this Circuit will Automatically Start Emergency Generator AAA-GEN-XXX"
3. Provide the following yellow background caution sign with black letters on all automatic transfer switches, switches, circuit breakers, equipment, and emergency panelboards that are energized by the emergency power system:
   a. "Caution Automatically Energized by the Emergency Power System."

J. Equipment/System Identification Nameplates:
1. General: Install engraved plastic-laminated nameplates on each major unit of electrical equipment in the building; including central or master unit of each electrical system including communication/control/signal/alarm systems, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2-inch high lettering on 1-1/2-inch high sign (2 inches high were two lines are required), black lettering on white field. Provide text matching terminology and numbering of the contract documents and shop drawings. Nameplate shall include unit designation, normal source circuit number ("Fed from..."), circuit voltage, and other data specifically indicated. Nameplate shall indicate normal source circuit number ("Fed from..."), and emergency source circuit number ("Fed from..."), when the equipment is a transfer switch or fed directly from a transfer switch. Provide nameplates for each unit of the following categories of electrical work:
   a. Switchboards, panelboards, electrical cabinets, and enclosures. (Include main bus ampacity on the nameplate.)
   b. Access panel/doors to electrical facilities.
   c. Major electrical switchgear (Include main bus ampacity on the nameplate.)
   d. Electrical substations (Include main bus ampacity on the nameplate.)
   e. Motor control centers, (Include main bus ampacity on the nameplate.) and individual motor starters.
   f. Disconnect switches.
   g. Push buttons, selector switches, indicating lights. (Circuit number and voltage not required on nameplate).
   h. Power transfer equipment: Contactors and transfer switches.
   i. Lighting control equipment and contactors.
   j. Remote controlled switches, dimmer modules, and control devices.
   k. Transformers (Include primary voltage, secondary voltage, number of phases, feeder, and panelboards or equipment supplied by the secondary.)
   l. Inverters. (Include input voltage, output voltage, number of input phases.)
   m. Rectifiers. (Include input voltage, output voltage, and number of phases.)
   n. Frequency converters. (Include input and output frequency.)
   o. Battery racks.
   p. Power generating units.
   q. Telephone cabinets and switching equipment. (Circuit number and voltage not required on nameplate.)
   r. Clock/program master equipment.
   s. Fire alarm and mass notification systems master station.
   t. Security monitoring master station.
   u. Public address system.
   v. Uninterruptible power supplies (UPS).

w. Wireway used as auxiliary gutter tap locations with circuit number of circuit being tapped. Provide on outside of wireway.
x. Provide voltage identifying conduit markers on all conduit and pull boxes that contain medium voltage conductors.
y. Provide "EMERGENCY" conduit markers on all conduit and pull boxes that contain emergency power conductors.
z. Switchboard main switches and circuit breakers.

2. Install markers, tags, nameplates, and signs at locations indicated or, where not otherwise indicated, at location for best convenience of viewing without interference with operation and maintenance of equipment. Secure the identification with fasteners, except use adhesive where fasteners should not or cannot penetrate surface.

END OF SECTION 26 05 53

SECTION 26 05 73 – ELECTRICAL STUDIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This SECTION includes computer-based fault-current (short circuit) analysis, overcurrent protective device coordination, and arc flash hazard studies.
B. Perform field data collection include cable length and enclosure size types and electrode configuration.
C. Perform fault-current (short circuit) analysis, overcurrent protective device coordination, and arc flash hazard studies.
D. The study shall be provided for the electrical distribution system components provided and include all power sources (normal and emergency) down to the branch circuit overcurrent protective device and equipment.

1.02 RELATED REQUIREMENTS:

A. SECTION 26 05 53 – Identification for Electrical Systems.

1.03 REFERENCE STANDARDS:

A. The short circuit study shall be completed in accordance with the latest edition of the following standard:
   1. IEEE 3002.3 - Recommended Practice for Short-Circuit Calculations in Industrial and Commercial Power Systems.
B. The short circuit study and overcurrent protective device coordination and settings shall be completed in accordance with the latest edition of the following standards:
   1. IEEE 3001.5 - IEEE Recommended Practice for the Application of Power Distribution Apparatus in Industrial and Commercial Power Systems
   2. IEEE 3004.5 - Recommended Practice for the Application of Low-Voltage Circuit Breakers in Industrial and Commercial Power Systems.
   3. IEEE 3004.11 - Recommended Practice for Bus and Switchgear Protection in Industrial and Commercial Power Systems.
C. The arc flash hazard analysis and labels shall be completed in accordance with latest editions of the following standards:
   1. IEEE Standard 1584 - Guide for Performing Arc-Flash Hazard Calculations.
   2. NFPA70E – Standard for Electrical Safety Requirements for Employee Workplaces.

1.04 PERFORMANCE/DESIGN CRITERIA:

A. The short circuit study shall calculate the available short-circuit current at each bus in the electrical distribution system.
B. All overcurrent protective devices provided shall have an interrupting rating equal to or greater than the available short-circuit current at the point of application.
C. The study shall examine proper protection of electrical system components and utilization equipment such that the equipment has a sufficient short-circuit current rating.
D. The overcurrent protective device study shall analyze the system for selective coordination. This analysis shall identify any potential selective coordination problems including fault currents up to the available short-circuit current. Any areas where the overcurrent protective devices are not selectively coordinated shall be explicitly noted and recommendations shall be made to achieve selective coordination.
E. The study shall include an arc flash hazard analysis for electrical distribution equipment. The analysis shall determine the flash protection boundary, incident energy, and required level of personal protective equipment (PPE) for workers at the electrical distribution equipment. The

electrical distribution equipment shall be labeled with this information in accordance with codes, and standards; study must also coordinate with the Owners existing arc flash hazard system, if available and less than 5 years old.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Product Data:

1. Computer analysis software application name, provider and version.

C. The results of the studies shall be summarized in report format with explanation of how to interpret the data.

D. As a minimum the report shall include the following:

1. Short-Circuit Study:
    a. Printout of input data and calculated results.
    b. One-line diagram identifying all bus locations and the maximum available three-phase and line-to-ground short-circuit currents at each bus.
    c. Bus-to-bus listing of the maximum available short-circuit current expressed in RMS symmetrical amperes and the X over R ratio of that fault current.
    d. A table of specified equipment short-circuit ratings versus calculated short-circuit current values with notations of locations where are specified equipment short-circuit ratings are less or greater than required at the point of application.
    e. An analysis of the results in which any overrating or inadequacies shall be called to the attention of the Engineer and recommendations made for improvements.
2. Protective Device Coordination Study:
    a. Time-current characteristic curve drawings on log-log printouts which illustrate:
        (1) The recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices provided for the project.
        (2) The key or limiting overcurrent device characteristics, load characteristics, and protection requirements affecting the settings or ratings of the overcurrent protective devices supplied.
        (3) The degree of selective coordination achieved with the overcurrent protective devices supplied.
    b. Tabulation of the recommended settings for all adjustable relays, overcurrent protective devices and ground fault protective devices and type selections for fuse protective devices supplied.
    c. An analysis of the results in which any inadequacies related to selective coordination shall be called to the attention of the Engineer with recommendations for improved coordination.
3. Arc Flash Hazard Analysis Study:
    a. Include the following for each piece of switchgear, switchboard, motor control center, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker, disconnect switch, and equipment control panel installed on the project:
        (1) Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Incident Energy Level (cal/cm2).
        (2) Risk of personnel injury as a result of exposure to incident energy released during an arc flash event.
        (3) Appropriate ratings of personal protective equipment (PPE).
        (4) The Flash Protection Boundary (approach limit distance).
        (5) Information for equipment specific arc-flash hazard warning labels.

b. Recommendations and methods to mitigate the hazard risk, where applicable, to reduce PPE requirements.

4. Cut sheets and label specification information on the Arc Flash warning labels being provided.
5. Closeout Submittal: Provide complete set of calculation files (SKM PTW, ETAP, etc.) to customer.

1.06 QUALITY ASSURANCE:

A. The company and individual(s) performing the study shall have a minimum 5 years documented experience in power system analysis and completed projects of similar size and scope. The individual(s) performing the study shall be a registered Professional Engineer in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of Professional Engineer.
B. The company performing the study shall have the capability and experience to aid during system start up.
C. Comply with IEEE 3002.3-2 for short-circuit currents and coordination time intervals.
D. Comply with IEEE 3001.5 for general study procedures.
E. Comply with IEEE 1584 or NFPA 70E for arc flash hazard analysis.

1.07 SEQUENCING AND SCHEDULING:

A. The selection of the company and the individual performing the study shall be submitted and approved by the design Engineer prior to the start of the study.
B. Short Circuit study is to be submitted based on equipment intended to be provided but not yet approved. Study is to be approved prior to purchase orders for equipment being issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve selective coordination.
C. The final study shall be completed and submitted and approved prior to the facility startup.

PART 2 - PRODUCTS

2.01 GENERAL:

A. The short circuit, protective device coordination, and flash hazard analysis study shall be completed with the aid of a computer software program such as ETAP, SKM Power Tools, or Engineer approved equal.
B. The Contractor shall provide all lengths of cable for use in the studies.
C. All equipment ratings, make, and model information shall be obtained by the Contractor from the equipment manufacturers and/or suppliers and provided for use in the studies.
D. Information on the electrical service including available fault current, transformer impedance, primary fuse ratings, primary cable size, and any other required information shall be obtained from the local utility for inclusion in the studies.
E. The study shall be inclusive of the entire electrical distribution system from all power sources (normal and emergency) down to the branch circuit overcurrent protective device and equipment.
F. Separate calculations shall be performed for both the normal and emergency sources. Device settings shall be based upon the normal (utility) source study.
G. The Arc Flash Study shall be based on the source, normal or emergency, that results in the highest incident energy.

2.02 SHORT CIRCUIT COORDINATION STUDY:

A. The short circuit study shall as minimum include the following:

1. A schematic one-line drawing of the entire electrical system included in the study, from the electrical utility source including the point of delivery, to each primary transformer, and including all main secondary buses of each transformer included in the study. Secondary buses shall include multiple secondary transformations within the scope of the study. Each device shall be identified by the Engineer assigned equipment tag number indicated on the Contract Documents. Each motor greater than 1 hp shall be shown and identified. Each bus shall be identified by the Engineer assigned equipment tag number indicated on the Contract Documents.
2. Source voltage and impedance data shall be given in the analysis, including reactance and resistance in OHMS to the source, and available symmetrical and asymmetrical short circuit amperes at the point of delivery of electrical power. Short circuit amperes shall be based on utility provided information assuming a bolted three-phase and line-to-ground short circuits.
3. At each bus, including buses of all primary protective and switching devices, primary and secondary of all transformers, all secondary main and feeder breakers, and all secondary devices and panelboards within the scope of the study, the following shall be calculated:
    a. Symmetrical RMS short circuit amperes calculated using total source and motor contribution reactance and resistance values.
    b. Asymmetrical average 3 phase RMS amperes at 1/2 cycle, calculated using actual total source and motor contribution X/R ratio.
    c. Reactance ("X") and Resistance ("R") in OHMS at the voltage of the device being examined, including both electrical utility source and all motor contributions.
4. Calculation sheets for cable sections shall indicate voltage, wire size, cable length, reactance and resistance of the section in OHMS and total "X" and "R" to the source.
5. Calculation sheets for transformer sections shall indicate transformer kVA, secondary voltage, percent impedance, percent reactance, percent resistance, and total "X" and "R" value in OHMS at the secondary voltage to source, including the electrical utility source impedance plus any primary motor contribution.
6. Calculation sheets for busway and miscellaneous devices shall provide all pertinent parameters including operating voltage, section "X" and "R" values in OHMS, and total "X" and "R" values in OHMS to the source, based on source impedance plus any motor contribution.
7. Bus summary sheets shall be provided giving consecutive bus numbers, description, voltage, "X" and "R" values in OHMS including The electrical utility source plus all motor contributions, symmetrical and asymmetrical short circuit amperes, X/R ration, and asymmetrical factor.
8. Motor summary sheets shall provide motor description and all pertinent motor data including subtransient reactance for each motor greater than 1 hp. Symmetrical short circuit amperes shall be given for each motor at the motor terminals.

2.03 PROTECTIVE DEVICE COORDINATION STUDY:

A. The protective device coordination study shall as a minimum include the following:

1. Time-current coordination plots shall be made on log-log software generated plots and shall graphically indicate the coordination proposed for all of the key systems. The plots shall include complete titles, one-line diagram and legend.
2. The electrical utility source relay, fuse, or protective device shall be plotted with all load protective devices at the same voltage.

3. Transformer primary protective device, transformer magnetic inrush, transformer ANSI withstand points, secondary voltage fuse or circuit breaker and largest feeder fuse or circuit breaker shall be plotted at the secondary voltage. Circuit breaker curves shall include complete operating bands, terminating with the appropriate available short circuit current. Fuse curves shall be identified as either total clearing time or damage time as applicable.
4. Low voltage circuit breakers shall have instantaneous, short delay, long-time pick-up and ground fault trip settings and ground fault ampere and time delay settings identified as plotted. Sensor or monitor rating shall be stated for each circuit breaker. All regions of the circuit breaker curve shall be identified.
5. The coordination plots shall include significant motor starting characteristics and large motor protective devices.
6. Feeder circuit breakers shall have the time-damage curve of the feeder conductors plotted to indicate protection of the conductor insulation at the total clearing time of the circuit breaker or fuse. The time-damage point shall be calculated for the specific parameters of conductor insulation used, with average 3 phase RMS asymmetrical amperes as 1/2 cycle calculated using actual resistance and reactance values of the source plus all motor contributions which exist at the load end of the feeder conductors.
7. A determination of settings or ratings for the overcurrent and ground fault protective devices supplied. Where necessary, an appropriate compromise shall be made between selective coordination and service continuity with selective coordination considered more important than system service continuity.
8. A summary tabulation shall be provided listing manufacturer and type for all overcurrent protective devices and all recommended settings of each adjustable band included in each device.
9. Settings of protective devices shall minimize the arc flash hazard while maintaining selective coordination.

2.04 ARC FLASH HAZARD ANALYSIS STUDY:

A. The arc flash hazard analysis study shall as minimum include the following:
   1. Calculate incident energy levels and flash protection boundaries at all relevant equipment busses based on available short-circuit current, protective device clearing time, field data and other applicable one-line diagram information in accordance with IEEE - 1584.
   2. As a minimum, the following shall be calculated for each piece of switchgear, switchboard, motor control center, distribution panel, panelboard, automatic transfer switch, enclosed circuit breaker, disconnect switch, and equipment control panel to be installed on the project:
      a. Minimum Arc Fault Current, Arc Flash Boundary and Arc Fault Rating (cal/cm2).
      b. Risk of personnel injury from exposure to incident energy released during an arc flash event.
      c. The appropriate ratings of personal protective equipment (PPE).
      d. The Flash Protection Boundary (approach limit distance) as required by NFPA 70E.
   3. Provide equipment specific arc-flash hazard warning label requirements per NFPA 70E, including all information specified to be provided on individual equipment warning labels.
   4. Provide recommendations and incorporate with the protective coordination study methods to mitigate the hazard risk, where applicable, in order to reduce PPE requirements.

B. Provide self-adhesive or plastic arc flash and available fault current labels for all electrical equipment in accordance with NFPA 70E.
   1. Self-adhesive or pressure-sensitive, preprinted, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility.
   2. Refer to SECTION 26 05 53 for label specifications.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are as indicated on Drawings.

B. Proceed with coordination study only after relevant equipment submittals have been approved and assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

C. Prior to final electrical equipment selection Contractor shall review the short circuit study recommendations for the electrical Equipment ratings and provide Equipment that meets or exceeds those recommendations.

3.02 SETTINGS AND SELECTION:

A. Prior to project Substantial Completion, the Contractor shall:
   1. Provide all current limiting fuses, and fused disconnects as required to for equipment to meet the short circuit ratings of the system.
   2. Set all relays, overcurrent devices and ground fault protection devices:
      a. Relays: Reset all adjustable relay settings from the factory default settings to the settings recommended in the studies specified in this SECTION.
      b. Circuit Breakers and Motor Circuit Protectors: Reset all adjustable trip settings from the factory default settings to the settings recommended in the studies specified in this SECTION.
      c. Ground Fault Protection Devices: Reset all adjustable device settings from the factory default settings to the settings recommended in the studies specified in this SECTION.
   3. all fuses that do not meet the recommendations of the studies specified in this SECTION with fuses that are recommended.

B. Certification: Prior to project Substantial Completion, the Contractor shall submit a document certifying that the Contractor has completed the settings and selection scope specified to the Engineer.

3.03 INSTALLATION:

A. Provide Arc Flash Warning signs on electrical equipment such as switchboards, switchgear, panelboards, industrial control panels, motor control centers and meter socket enclosures. Marking shall be permanently affixed and of a durable nature to withstand the environment within which it is installed. Thoroughly clean equipment surfaces prior to installation of labels.

END OF SECTION 26 05 73

SECTION 26 22 13 – LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION specifies transformer work as indicated by Drawings and Schedules.
B. Types of transformers specified in this SECTION include the following:
   1. Dry-type transformers.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 53 - Identification for Electrical Systems
D. SECTION 26 05 73 - Electrical Studies

1.04 REFERENCE STANDARDS:

A. ASTM International (ASTM):
   1. ASTM D877/D877M - Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids using Disk Electrodes.
B. Code of Federal Regulations (CFR):
   1. 10 CRF Part 429 - Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment.
      a. 429.47 - Distribution Transformers.
   2. 10 CFR Part 431 - Energy Efficiency Program for Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers.
      a. 431.193 - Test procedures for measuring energy consumption of distribution transformers.
      b. 431.196 - Energy Conservation Standards.
C. Institute of Electrical and Electronics Engineers (IEEE):
   1. IEEE C2 - National Electric Safety Code.
   2. IEEE C57.12.01 - General Requirements for Dry-Type Distribution and Power Transformers.
   3. IEEE C57.12.91 - Test Code for Dry-Type Distribution and Power Transformers.
D. National Electrical Manufacturers Association (NEMA):
   1. NEMA ST 20 - Dry-type Transformers for General Applications.
   2. NEMA TR 1 - Transformers, Regulators, and Reactors. (Supplements IEEE C57 - Series Standards.)
   3. NEMA 250 - Enclosures for Electrical Equipment.
E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC). Comply with NEC as applicable to installation and construction of electrical power/distribution transformers.
F. Underwriters Laboratories (UL):
   1. Comply with applicable requirements of UL 506 Safety Standard for Specialty Transformers. Provide transformers and components which are UL-listed and labeled.
   2. UL 1561 - Large General Purpose Transformers.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design for seismic bracing and anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Product Data: Submit for each type of product specified and included, with the following as a minimum:

1. Technical product data: Includes, but not limited to, rated kVA, frequency, primary and secondary voltages, wiring diagram, percent taps, polarity, impedance and certification of transformer performance efficiency at 100% load, percentage voltage regulation at 100% load at 75ºC, full-load losses in watts, percent impedance at 75ºC, hot-spot and average temperature rise above 40ºC ambient temperature, sound level in decibels, and standard published data.

C. Shop Drawings: Submit the following as a minimum:

1. Manufacturer's drawings indicating dimensions and weight loadings for transformers and wall brackets.
2. Transformer nameplate data. Include center of gravity information in seismic zones.
3. Wiring Diagrams: Submit wiring and control diagrams for transformers. Clearly differentiate between portions of wiring that are manufacturer factory installed and portions to be field-installed.

D. Submit all field test data.

E. Closeout Submittals: Final documentation shall include:

1. Operation and Maintenance manuals.
2. Certified “As-Built” drawings.
3. Copies of all approved Product Data.
4. Copies of all approved Test Reports.
5. Warranty information.

1.07 QUALITY ASSURANCE:

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.
D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
E. Comply with IEEE C2, National Electric Safety Code.
F. Testing procedures shall comply with 10 CFR 429.47 - Distribution Transformers and 10 CFR 431.193 - Test procedures for measuring energy consumption of distribution transformers.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Transformers shall be stored according to the manufacturer's instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.
B. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.
C. Handle and prepare transformers for installation according to NEMA ST 20 and manufacturer's instructions.

1.09 PROJECT SITE CONDITIONS:

A. Environmental Limitations:
   1. Do not deliver or install transformers until spaces are enclosed and weather tight, any wet work is complete and dry, work above transformers is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
   2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
B. Service Conditions:
   1. NEMA ST 20, usual service conditions.
   2. Refer to Specification 26 00 00 for site conditions.

1.10 WARRANTY:

A. All equipment furnished under this SECTION shall be warranted by the Contractor and the equipment manufacturer(s) for a minimum period of one year after substantial completion.
B. Warranty shall include all parts, labor, and expenses to perform necessary work.

1.11 COORDINATION:

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.
B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide products of one of the following (for each type of transformer):
   1. Eaton.

2. General Electric Company.
3. Sola/Hevi-Duty, Emerson Electric Co.
4. Siemens.
5. Square D, Schneider Electric.

2.02 TRANSFORMERS:

A. General:
1. Except as otherwise specified or indicated, provide manufacturer's standard materials and components as indicated by published product information, designed and constructed as recommended by manufacturer, and as required for complete installation.
2. Comply with DOE energy efficiency standards as defined by 10 CFR Part 431.196 – Energy Conservation Standards for all transformers 15 kVA and larger.
3. Core material shall be grain-oriented, non-aging silicon steel. Coils shall be continuous windings without splices except for taps. Internal coil connections shall be brazed or pressure type. Provide transformers that are constructed to withstand seismic forces specified by the Structural design.
4. Enclosure ratings shall comply with NEMA 250 – Enclosures for Electrical Equipment.

B. Dry-Type Transformers (45 kVA or less):
1. Factory-assembled and tested, general-purpose, air-cooled, dry-type transformers; of sizes, characteristics, and rated capacities indicated.
2. Three-phase transformer: 480V delta connected primary and 208/120V wye-connected secondary with grounded neutral, 60-hertz, 10 kV BIL.
3. Copper primary and secondary windings. Manufacturer’s standard impedance.
4. Provide primary winding with 4 full-capacity taps; two 2-1/2% increments below and above full-rated voltage for de-energized tap-changing operation.
5. Insulate with 220ºC, UL-component-recognized insulation system with a maximum of 115ºC rise above 40ºC ambient temperature.
6. Rate transformer for continuous operation at rated kVA.
7. Limit transformer surface temperature rise to maximum of 65ºC.
8. Provide terminal enclosure, with cover, to accommodate primary and secondary winding connections and raceway connectors.
9. Equip terminal leads with connectors installed. Limit terminal compartment temperature to 75ºC when transformer is operating continuously at rated load with ambient temperature of 40ºC. Provide wiring connectors suitable for copper wiring.
10. Cushion-mount transformers with external vibration isolation supports.
11. Sound-level ratings shall not exceed IEEE/NEMA standards. Conform to NEMA ST 20.
12. Electrically ground core and coils to transformer enclosure by means of flexible metal grounding strap.
13. Provide transformers with ventilated or fully enclosed sheet steel enclosures. Apply manufacturer's standard light gray indoor enamel over cleaned and phosphatized steel enclosure.
14. All transformers shall be suitable for floor mounting unless noted otherwise.
15. Provide wall mounting brackets for wall- or column-mounted transformers.
16. Must comply with IEEE C57.12.01 and/or IEEE C57.12.50.
17. Must comply with UL 1561.

C. Final equipment selection: Review the short circuit equipment study. Provide only equipment that meets or exceeds the recommendation of that short circuit study specified in SECTION 26 05 73.

D. Equipment/System Identification: Provide equipment/system identification nameplates complying with SECTION 26 05 53.
E. Finishes: Coat interior and exterior surfaces of transformer, including bolted joints, with manufacturer's standard color baked-on enamel.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.
B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.
C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
D. Verify that ground connections are in place and requirements in SECTION 26 05 26.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Transformers to be installed in switchboards. Refer to Section 26 24 13.

3.03 CONNECTIONS:

A. Provide equipment grounding connections for transformers as specified, indicated, and as required. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounding. Provide grounding in accordance with SECTION 26 05 26.

3.04 IDENTIFICATION:

A. Provide all warning signs, nameplates, labels and markers as specified in SECTION 26 05 53.
B. Label field-installed conductors, interconnecting wiring, and components;
C. Provide Equipment and conduit warning signs.
D. Provide Equipment nameplates.
E. Place arc flash label on equipment.

3.05 FIELD QUALITY CONTROL:

A. Tests and Inspections:
   1. Prior to energization of transformers, check all accessible connections for compliance with manufacturer's torque tightening specifications. Clean out any dust and dirt.
   2. Prior to energization, check circuitry for electrical continuity and for short circuits.
   3. Perform insulation resistance test: Megger between high-voltage winding to low-voltage winding, low-voltage winding to ground, and high-voltage winding to ground. Record and submit test results. If readings are below 50 megohms (at 77°F), notify Engineer before energizing transformer.
   4. Perform transformer turns ratio test (TTR) on the full winding and all taps. Record and submit test results.
   5. On liquid-filled transformers, perform insulating liquid dielectric test in accordance with ASTM D923 and ASTM D877.
   6. Check cooling fans and controls, where provided, for proper operation.
   7. Upon completion of installation of transformers and testing, energize primary circuitry at rated voltage and frequency from normal power source, and test transformers, including,

but not limited to, audible sound levels, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at the Site then retest to demonstrate compliance; otherwise, remove and replace with new units or components and proceed with retesting.

8. Adjust transformer primary taps for nominal system voltage at initial installation and again when the transformer reaches its designed "full" load condition after occupancy by the Owner. Schedule all required electrical outages with the Owner.
9. Infrared Scanning:
    a. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
    b. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
    d. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
    e. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

3.06 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
    1. Touch Up:
        a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
        b. Field painting shall be performed based on manufacturer’s recommended procedures.
        c. Transformer manufacturer shall furnish Contractor with an adequate quantity of touch-up paint to match the factory applied finish.

3.07 ADJUSTING AND CLEANING:

A. Upon completion of installation, clean interior and exterior of transformers. Remove paint splatters, spots, dirt and debris.

3.08 PROTECTION:

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until unit is placed into service.

3.09 MAINTENANCE

A. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
C. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
D. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 22 13

SECTION 26 24 13 – SWITCHBOARDS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This SECTION specifies switchboard work that is indicated by drawings and schedules.
B. Types of switchboards specified in this SECTION include the following:
   1. Dead-Front Distribution:
      a. Circuit-breaker switchboards.
C. The low-voltage switchboard shall be furnished with the paired diesel-powered generator set as a part of a complete Emergency Power System (EPS) by a single EPS supplier. The EPS supplier shall be a factory-authorized dealer with complete Emergency Power System parts and service available on a 24-hour emergency basis within a 2.5 hour drive of the project site. Refer to SECTION 26 32 13.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 53 - Identification for Electrical Systems
D. SECTION 26 05 73 - Electrical Studies
E. SECTION 26 24 16 – Panelboards
F. SECTION 26 22 13 – Low Voltage Distribution Transformers
G. SECTION 26 32 13 - Engine Generator Sets
H. SECTION 26 43 13 - Surge Protective Devices
I. SECTION 40 61 96 - Process Control System Programming and Reports

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE):
   1. ANSI/IEEE C37.13 – Low-Voltage AC Power Circuit Breakers Used in Enclosures.
   2. ANSI/IEEE C37.14 – Low-Voltage DC Power Circuit Breakers Used in Enclosures.
   3. ANSI/IEEE C36.16 – Related Requirements and Application Recommendations for Low-Voltage Power Circuit Breakers and AC Power Protectors, Preferred Ratings.
C. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 241 – Recommended Practice for Electric Power Systems in Commercial Buildings, Pertaining to Switchboards.
D. National Electrical Manufacturers' Association (NEMA):
   1. NEMA PB2 – Dead-Front Distribution Switchboards.
   2. NEMA PB 2.1 – General Instruction for Proper Handling, Installation, Operation, and Maintenance of Dead-Front Distribution Switchboards Rated 600V or Less.
   3. NEMA SG 3 – Low-Voltage Power Circuit Breakers.
E. National Fire Protection Association (NFPA): Comply with applicable local code requirements of the authority having jurisdiction and that portion of the NEC which pertains to installation and construction of switchboards.
   1. NFPA 70 – National Electrical Code (NEC).

2. NFPA 70E – Standard for Electrical Safety in the Workplaces.

F. Underwriters Laboratories (UL) Compliance: Provide switchboards and components which are UL-listed and labeled.
1. UL 98 – Enclosed and Dead Front Switches.
2. UL 486A – Wire Connections and Soldering Lugs for Use in Copper Conductors.
3. UL 489 – Molded Case Circuit Breakers and Circuit Breaker Enclosures.
4. UL 891 – Dead Front Electrical Switchboards.
5. UL 977 – Fused Power Circuit Devices.
6. UL 1054 – Ground-Fault Sensing and Relaying Equipment.
7. UL 1449 – Surge Protective Devices.

G. Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE):
1. SEI/ASCE 7-2002 – Minimum Design Loads for Buildings and other Structures.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design for seismic anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, site conditions, environmental ratings & hazardous locations.

1.06 SUBMITTALS:

A. Product Data: Submit for each type of product specified and included, with the following as minimum:
1. Data sheets for all components furnished as part of the equipment package. Indicate voltages, number of phases, frequency, short-circuit, and continuous current ratings.
2. Provide application data and time-current trip curves for main and branch circuit-breakers and fuses. Provide time-current curves for fuse melting and clearing.
3. Instrument transformer performance curves and data.

B. Shop Drawings: Provide the following as minimum:
1. Submit dimensioned drawings of switchboards showing accurately dimensioned equipment sections, including auxiliary compartments, section components, and combination sections.
2. Indicate shipping splits and weight of each section. Complete loading diagrams covering static and dynamic loadings for all conditions of operation and structural steel details. Provide center of gravity information for all seismic rated switchboards. Indicate all required access points for all terminations.
3. Wiring Diagrams: Submit a wiring diagram for the complete switchboard unit showing connections to electrical power feeders, distribution branches, and associated auxiliaries. All external power and control connections shall be clearly identified.
a. Differentiate between portions of wiring that are manufacturer factory-installed and portions that are field-installed.
4. Nameplate schedule.
5. Surge Protective Device data and testing laboratory reports.
6. Coordination Study: As specified in SECTION 26 05 73.

7. Provide documentation on communication system interface along with a complete list of all available parameters and associated addresses.
8. Provide paper documentation of the programmable logic controller program.

C. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces at the site. Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assemble components or on calculation.
2. Dimensioned Outline Drawing of Equipment Unit: Identify center of gravity and locate describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

D. Submit paint manufacturer's certification of VOC compliance and MSDS sheets. Submit certification of paint VOC level compliance as required by local or regional governing authorities.

E. Special Procedure Submittals:
1. Start-up and commissioning instructions.
2. Syllabus for Owner training.

F. Test and Evaluation Reports:
1. Qualification Data: For qualified Installer and Testing Agency.
2. Factory test reports.
3. Commissioning and Field test reports, including infrared scanning report.

G. Closeout Submittals: Final documentation shall include the following as minimum:
1. Operation and Maintenance Manuals including the following:
   a. Operation and maintenance manuals for all components furnished.
   b. Certified “As-Built” drawings of all equipment with information listed above.
   c. Copies of all approved Product Data.
   d. Copies of all approved Test Reports.
   e. Spare parts and supply list with supplier names and part numbers.
   f. Warranty Information.
   g. Manufacturer’s service and repair support during and after warranty including contact information.
   h. Training Materials. Includes final edited training videos.

H. Maintenance Material Submittals:
1. Spare Parts:
   a. Three spare LED indicating lamps for each type and color used.
   b. Three spare indicating light assemblies.
   c. Three spare power and control fuses of each voltage and current rating used.
   d. One 12oz aerosol cans of manufacturer’s touch-up paint for each color used. Color shall match the original factory applied color.
   e. All parts supplied with the equipment shall be properly labeled for ease of identification and to permit the shortest possible time to repair.
2. Software:
   a. Soft copy of PLC programs including all programming comments.
   b. Organize and submit software on a USB flash drive.

1.07 QUALITY ASSURANCE:

A. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least five years prior to Bid opening.

B. Factory Tests:

1. The switchboard assembly shall be completely and functionally tested in the manufacturer's facility prior to shipment. For systems shipped in multiple sections, the switchboard shall be quality tested utilizing the plug-together wiring system which shall be unplugged prior to shipment and plugged together again when the equipment is installed in order to maintain the integrity of the manufacturer's quality assurance testing.
2. Conduct tests on all system components and subassemblies to assure that all devices and systems are in proper working order before delivery to jobsite.
3. Automatic Throw-Over System: Simulate actual system operation. Includes simulations of power failure, transfer to emergency source, and re-transfer to normal source.
4. Submit test reports as specified in Division 01.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Deliver switchboards and components properly packaged and mounted on pallets or skids to facilitate handling of heavy items. Utilize factory-fabricated type containers or wrappings for switchboard and components which protect equipment from damage. Install impact measuring meters in containers which will indicate whether the container has been bumped or dropped. Return impact meters to the manufacturer for reuse upon delivery of switchboards. Inspect equipment to ensure that no damage has occurred during shipment.

B. All necessary hardware for reconnecting shipping splits shall be provided.

C. Store switchboard equipment in original packaging and protect from weather and construction traffic and according to the manufacturer's instructions. Store in a conditioned space to avoid condensation, dust, and other environmental contaminants. Do not store outdoors, wrapped or otherwise.

D. Handle switchboard equipment carefully to prevent physical damage to equipment and components. Remove packaging, including the opening of crates and containers, avoiding the use of excessive hammering and jarring which would damage the electrical equipment contained therein. Do not install damaged equipment; remove damaged equipment from the site and replace with new.

1.09 SEQUENCING AND SCHEDULING:

A. Schedule delivery of switchboard equipment which permits ready building ingress for large equipment components to their designated installation spaces. Coordinate delivery of equipment with the installation of other building components.

B. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into concrete pad. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 PROJECT SITE CONDITIONS:

A. Refer to SECTION 26 00 00 for Site Conditions.

B. Do not install the switchboard equipment specified herein until designated installation spaces are suitable for intended service.

C. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing the switchboard and shall be maintained for the remainder of the construction period.

1.11 WARRANTY:

A. All equipment furnished under this SECTION shall be warranted by the Contractor and the equipment manufacturer(s) for a minimum period of one year after completion of startup.

B. Warranty shall include all parts, labor, and expenses to perform necessary work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide switchboard units of one of the following (for each type, and rating of switchboard):

1. Eaton Corporation.
2. Siemens Corporation.
3. Schneider Electric.

2.02 EQUIPMENT SECTIONS AND COMPONENTS:

A. General: Except as otherwise indicated, provide switchboards and ancillary components of types, sizes, characteristics, and ratings indicated which comply with manufacturer's standard design, materials, components, and construction, in accordance with published product information, and as required for complete installation. Provide terminals UL rated for 75ºC (minimum) conductors.

B. Final equipment selection: Review the short circuit equipment study. Provide only equipment that meets or exceeds the recommendation of that short circuit study specified in SECTION 26 05 73.

C. Seismic Performance: Switchboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

D. AC Dead-Front Distribution Switchboards:

1. Factory-assembled, dead-front, metal-enclosed, self-supporting secondary power switchboards, of types, sizes, electrical ratings, and characteristics indicated.
2. Assemblies consisting of vertical panel units and containing circuit-breakers assemblies of quantities, ratings, and types indicated.
3. Provide switchboard with main bus rating as shown on the Drawings.
4. Provide main bus with connections to switching devices and circuit-breaker branches of sufficient capacity to limit rated continuous current operating temperature rise to no greater than 65ºC above average ambient temperature of 30ºC.
5. Main bus and tap connections shall be plated and bolted tightly according to manufacturer's torquing requirements for maximum conductivity.
6. Copper bus current density shall not exceed 1,000 amperes per square inch.
7. Brace bus for short-circuit stresses greater than or equal to the minimum interrupting capacity indicated.
8. Provide accessibility of line and load terminations from front of switchboard. Rear access is not available.
9. Provide equipment with built-in lifting eyes and yokes.
10. Provide vertical individual panel units, suitable for bolting together at project site.
11. Construct switchboard enclosures suitable for the following environment:
    a. Installation: Indoors, NEMA Type 12.

E. Enclosures: Construct dead-front switchboards suitable for floor mounting, with front cabling/wiring accessibility and conduit accessibility as indicated. Provide welded steel channel framework; hinge front wireway covers to permit ready access to branch circuit-

breaker load side terminals. Enclosure shall be suitable for being rolled or pushed into final location. Coat enclosures with manufacturer's standard corrosive-resistant finish.

F. Finish:
   1. Paint system with manufacturer's standard coating system suitable for intended service.
   2. Coating systems shall not contain any lead (0.00%), zinc or strontium chromates, mercury or mercury compounds, or asbestos. Coatings shall also be VOC compliant to meet the VOC level as required by the local or regional governing authorities. Equipment Manufacturers shall submit certification by coating manufacturers, including MSDS sheets, verifying these requirements.
   3. Exterior paint color shall be light gray.
   4. Provide factory-painted white mimic bus on front of each switchboard.

G. Circuit Breakers: Except as otherwise indicated, provide circuit breakers and ancillary components, of types, sizes, ratings and electrical characteristics indicated, which comply with manufacturer's standard design, materials, components, and construction in accordance with published product information and as required for a complete installation.
   1. Power Circuit Breakers (Mains and Ties):
      a. Shall be Draw-out low-voltage power circuit breakers.
      b. Frame ratings shall be as indicated on drawings.
      c. Breaker shall be 100% rated.
      d. Breaker shall be electrically operated.
      e. Breaker shall allow draw-out operation.
      f. Shall be provided with 120Vac motor operators.
      g. Control power for the circuit breaker shall be taken from a control power transformer internal to the switchboard assembly. Control power transformers shall be provided with primary and secondary fuse protection.
      h. The breaker control interface shall have color-coded visual indicators to indicate contact open or closed positions as well as mechanism charged and discharged positions. Manual control pushbuttons on the breaker face shall be provided for opening and closing the breaker. The power circuit breaker shall have a "Positive On" feature. The breaker flag will read "Closed" if the contacts are welded and the breaker is tripped or opened.
      i. Circuit breaker shall be furnished with minimum four (4) "a" contacts and four (4) "b" auxiliary contacts for remote indication of breaker open/close status. In addition, there shall be an overcurrent trip switch which consists of one (1) set of normally open and normally closed contacts for remote indication of breaker trip.
      j. Trip Units:
         (1) Each circuit breaker shall be equipped with a solid-state trip unit. The trip unit shall use microprocessor-based technology to provide advanced adjustable time-current protection functions.
         (2) Shall measure true rms current.
         (3) Trip unit shall signal the circuit breaker to trip actuators when predetermined trip levels and time delay settings are reached.
         (4) Interchangeable current sensors with their associated rating plug shall establish the continuous trip rating of each circuit breaker. The trip rating shall be indicated on the front of the trip unit.
         (5) The trip unit shall have an information system that provides LEDs to indicate mode of trip following an automatic trip operation. The indication of the mode of trip shall be retained after an automatic trip. A reset button shall be provided to turn off the LED indication after an automatic trip.

(6) Shall have a trip button to test the function of the trip unit in opening of the breaker.
(7) The trip unit shall be provided with a display panel, including a representation of the time/current curve that will indicate the protection functions. The unit shall be continuously self-checking and provide a visual indication that the internal circuitry is being monitored and is fully operational.
(8) The trip units shall be capable of the following protective functions.
(a) Adjustable long time pickup.
(b) Adjustable long time delay.
(c) Adjustable short time pickup.
(d) Adjustable short time delay.
(e) Adjustable instantaneous time pickup.
(f) Adjustable instantaneous time delay.
(g) Adjustable ground fault time pickup.
(h) Adjustable ground fault time delay.
(i) I^2t settings for instantaneous and ground fault.
(9) The trip unit shall be capable of basic power monitoring and metering functions. Metering functions shall include the following:
(a) AC Amps of each phase, accurate to ± 0.3%.
(b) AC Voltage, L-L and L-N, accurate to ± 0.3%.
(c) Real Power (Watts), accurate to ± 0.6%.
(d) Reactive Power (VAR), accurate to ± 0.6%.
(e) Apparent Power (VA), accurate to ± 0.6%.
(f) Power factor, accurate to ± 1%.
(g) Watt-hours meter, accurate to ± 0.6%.
(h) VAR-hours meter, accurate to ± 0.6%.
(i) VA-hours, accurate to ± 0.6%.
(j) Demand monitoring of current, watts, and VA with an adjustable time interval from 5 minutes up to 60 minutes.
(k) Frequency, accurate to ± 0.1 Hz.
(10) Provide Modbus communication interface to switchboard mounted automatic transfer controller PLC.

k. Provide necessary interlocks for automatic transfer control scheme as specified.

2. Molded-Case Circuit Breakers (Feeders):
a. Factory-assembled, molded-case, manually-operated.
b. Frame sizes and ampere rating as indicated, 600V, 60 Hz, 3 poles with RMS symmetrical interrupting ratings indicated.
c. Provide breakers with permanent thermal and instantaneous magnetic trips in each pole with fault-current limiting protection and ampere ratings as indicated.
d. Construct with overcenter, trip-free, toggle-type operating mechanisms with quick-make, quick-break action and positive handle trip indication.
e. External handle clearly indicates when breaker is "ON," "OFF," or "TRIPPED," and lockable in the "OFF" position.
f. Provide push-to-trip button on enclosure cover for mechanical tripping circuit breakers.
g. Construct breakers for mounting in any physical position and operating in an ambient temperature of 40ºC.
h. Provide breakers with mechanical screw type removable connector lugs, AL/CU rated.

i. Breaker Accessories: Provide the following molded-case breaker accessories:
   (1) Auxiliary contacts.
   (2) Alarm switch.
   (3) Undervoltage trip.

3. Solid-State Trip Circuit Breakers:
   a. Factory Assembled, Solid-state trip circuit breakers
   b. Ampere rating indicated, 480V, 60 Hz, 3 poles, with RMS symmetrical ampere interrupting rating as indicated.
   c. Construct breakers with ampere setting adjustment knobs for changing current carrying capability of units and with ground-fault protection components with external neutral current transformer (CT).
   d. Provide electronic components for timing and monitoring internal currents and for initiating automatic tripping action.
   e. Construct with trip-free mechanisms and with positive handle indication.
   f. Provide push-to-trip button on cover for mechanical tripping circuit breakers.
   g. Construct breakers for mounting in any physical position and operating in an ambient temperature of 40ºC.
   h. Provide breakers with mechanical screw type removable connectors, AL/CU rated.
   i. Solid-state trip circuit breakers shall have the following functions:
      (1) Adjustable current, long time delay.
      (2) Adjustable current, intermediate delay.
      (3) Ground-Fault current pickup and delay.
      (4) Adjustable current, instantaneous pickup.
      (5) Short time current pickup and delay.
4. Adjustable trip overcurrent devices must have local restricted access as required by NFPA 70 (NEC).

H. Where shown, provide an arc energy-reducing maintenance switch with a local status indicator for main circuit breakers with a rating of 1200A or greater to meet requirements of the NEC.

I. Switchboard Bus: Provide switchboard busing with sufficient cross-sectional area to fulfill UL 891 pertaining to temperature rise. Buses shall be continuous rated as indicated on the drawings. Construct through-bus of copper (with silver-plated connections), with ampacity rating indicated, and with short-circuit current rating indicated. Provide fully rated main bus (tapered bus is not acceptable). Provide full capacity neutral bus when neutral bus is indicated. Provide ground bus full length of switchboard, firmly connected to each vertical section of the switchboard.

J. Metering and Protective Relays:
   1. For Utility metering compartments shown, coordinate with local serving utility to provide compartments meeting Utility specifications.
   2. For customer owned metering compartments, provide metering compartments, CTs, PTs, kWh meter, and instrument phase selector switches. Mount meters semi-recessed in front doors and install meter wiring and lacing with sufficient flexibility at hinged edge of meter front mounting plates to prevent damage. Provide the following metering devices where indicated.
      a. Instrument Transformers: IEEE C57.13, NEMA EI 21.1, and the following:
      b. Potential Transformers: IEEE C57.13; 120 V, 60 Hz, single secondary; disconnecting type with integral fuse mountings. Burden and accuracy shall be consistent with connected metering and relay devices.

(1) Current Transformers: IEEE C57.13; 5 A, 60 Hz, secondary; bar type; single secondary winding and secondary shorting device. Burden and accuracy shall be consistent with connected metering and relay devices.
(2) Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kVA.
(3) Current Transformers for Neutral and Ground-Fault Current Sensing: Connect secondary wiring to ground overcurrent relays, via shorting terminals, to provide selective tripping of main and tie circuit breaker. Coordinate with feeder circuit-breaker, ground-fault protection.

c. Digital Multi-function Meter (power monitor):
(1) Provide three-phase, multi-function, solid-state digital metering devices as indicated.
(2) Meter shall have an LED display and touch-pad that selects meter function, phase, minimum, maximum, and alarm mode of each meter function.
(3) Meter shall either be self-powered from voltage inputs or a control power transformer shall be provided to derive proper operating voltage.
(4) Meter shall accept 5 Amp current inputs.
(5) Meter shall accept 480 Vac inputs.
(6) Meter shall be capable of displaying and communicating the following parameters:
(a) AC Amps of each phase, accurate to +/- 0.3%.
(b) AC Voltage, phase-to-phase and phase to neutral, accurate to +/- 0.3%.
(c) Watts, accurate to ± 0.6%.
(d) Vars, accurate to ± 0.6%.
(e) VA, accurate to ± 0.6%.
(f) Power factor, accurate to ± 1%.
(g) Watt-hours meter, accurate to ± 0.6%.
(h) Var-hours meter, accurate to ± 0.6%.
(i) VA-hours, accurate to ± 0.6%.
(j) Demand monitoring of current, watts, and VA with an adjustable time interval up to 60 minutes.
(k) Frequency, accurate to ± 0.1 Hz.
(l) Percent of Total Harmonic Distortion accurate to the 31st harmonic.
(7) Shall be capable of communicating metered parameters over a Modbus TCP communication network.

K. Ground-Fault Protectors: Solid-state, ground-fault protection units for breakers rated 1000A and above of types and ratings indicated: equip with static relays, sensors, pilot lights, and push-buttons for fault indication, test, and reset; include fuse blocks, fuses, and control power transformers. Provide system which operates at 120Vac.
L. System Coordination: Provide settings for all adjustable trips such that the electrical system and switchboard devices are all selectively coordinated. Coordinate with SECTION 26 05 73.
M. Provide one of the manufacturer's standard solid-state trip programming and test devices to the Owner.

2.03 SURGE PROTECTIVE DEVICES (SPD):
A. Switchboard shall be provided with an integral Surge Protective Device (SPD) as specified in SECTION 26 43 13.

2.04 PANELBOARDS:

A. Switchboard shall be provided with integral panelboards where shown on the one-line diagrams as specified in SECTION 26 24 16.

2.05 TRANSFORMERS:

A. Switchboard shall be provided with integral step-down transformers where shown on the one-line diagrams as specified in SECTION 26 22 13.

2.06 UTILITY METERING

A. Where required on the One-Line Drawings, provide vertical section and all necessary components meeting the requirements of Xcel Energy (Colorado) for utility metering. Coordinate with Xcel Energy for requirements.

2.07 AUTOMATIC TRANSFER CONTROLS:

A. A service entrance rated automatic throw-over system shall be provided in the switchboard assembly and serve as the main switching device for the switchboard line-up.

B. The automatic throw-over system shall be rated as follows:
   1. Designed for 480V, 3-phase, 4 wire, amp rating as indicated.
   2. Shall be 100% equipment rated for continuous duty.
   3. Shall be listed as service entrance equipment.

C. Construction:
   1. The throw-over system shall consist of completely enclosed circuit breaker assemblies and a separate logic controller mounted in the switchboard assembly.
   2. Switchboard shall be provided with a redundant, 24Vdc power system to power network equipment, communications, control boards, and logic controllers.
      a. A minimum of two full capacity 120Vac to 24Vdc power supplies shall be provided for each switchboard. Each power supply shall be provided with a dedicated input circuit breaker and shall each be powered from a dedicated control power transformer with backup battery supply.
      b. Each power supply shall be sized to accommodate all connected components plus a minimum of 20% spare capacity.
      c. A failure contact shall be provided from each power supply and wired to the switchgear PLC. Contact shall be rated a minimum of 3 Amps at 120Vac. Provide interposing relay if required.
   3. Each transfer switch shall be electrically interlocked to prevent simultaneous closing of both sources under either automatic or manual operation. Main contacts shall be locked in position in both normal and emergency positions.
   4. A redundant relay shall be provided to open one source, coordinated with the utility, to ensure the closed transition does not persist longer than 1 second, or as allowed by the serving Utility.
   5. The transfer switch shall be capable of being operated manually under full rated load conditions. Manual operation shall be accomplished by a permanently attached manual operator, or by integrally mounted pushbuttons. Removable manual operating handles, and handles that may move in the event of an electrical operation during the manual operation, are not acceptable. Manual operators requiring source or load disconnection prior to manual operation are not acceptable.
   6. The transfer switches shall be applied as service entrance switches and shall be provided with overcurrent trip units and a service entrance listing. An external key-operated selector switch shall be provided to provide disconnect and lock-out functionality of the

Utility and Generator main breakers. Indicators shall be provided to show the availability of each source as well as breakers in a tripped or disconnected position.

7. Provide neutral disconnect link for three-pole solid neutral-to-ground main bonding jumper for all switches to meet UL service entrance requirements. Ground fault protection shall be provided in accordance with NFPA 70 Article 230-95.
8. The transfer switch shall be controlled by a microprocessor-based logic controller. The controller shall be hardened against potential problems from transients and surges. Operation of the transfer switch, monitoring of both sources, input and output functions, and communications to the plant control system shall be managed by the controller.

D. Programmable Logic Controller (PLC):
   1. The PLC shall be mounted in the switchboard instrument section and shall provide the operator with an overview of the transfer switch stats, parameters, and diagnostic data.
   2. The PLC based control system shall include an HMI touchscreen mounted on the face of the switchboard instrument section for operator interface. The touchscreen shall be color, 12” inch (minimum diagonal) TFT LCD industrial display capable of displaying both text and graphics. The display shall support a minimum resolution of 800x600 pixels, 16 million colors. The HMI shall display the following as minimum:
      a. Main Menu Screen with a complete listing of major screens.
      b. System Overview Screen with a dynamic graphic display of the electrical one-line.
      c. System Control and Metering Screens with graphical presentations of all functions specified and minimum metered points as follows.
         (1) Line-to-line and line-to-neutral voltages for each source and the load.
         (2) Line frequency for each source and the load.
         (3) Load indication in kW and kVA.
         (4) Power factor.
         (5) Load current (per phase).
      d. Utility and Generator Settings Screen that contains all of the adjustments and delays specified.
      e. Annunciation Screen that contains all of the status and alarm points for the system.
      f. Alarm Summary Screen that contains a time/date stamped system alarm summary.
      g. Password Entry Screen that contains a soft keyboard/keypad for password entry.
      h. Timer countdown for each time delay while functioning.
      i. Real-time clock.
   3. The transfer switch interfaces shall include individual LED indicators and touchscreen indication of the following:
      a. Source 1 available.
      b. Source 1 connected.
      c. Source 2 available.
      d. Source 2 connected.
      e. System status.

E. The automatic throw-over system shall contain the following features:
   1. Password programming protection.
   2. Set points shall be stored in Non-Volatile memory, and use of an external battery source to maintain operation during "dead" periods shall not be required.
   3. Provision shall be made for manual transfer capabilities in the event of a PLC/HMI display failure.
   4. The voltage of each phase of the normal source and the alternate source shall be monitored, with undervoltage dropout adjustable from 50% to 97% of nominal and pickup adjustable from dropout setting ±2% to 99% of nominal.

5. The voltage of each phase of the normal source and the alternate source shall be monitored, with overvoltage dropout adjustable from 105% to 120% of nominal and pickup adjustable from dropout setting +2% to 103% of nominal.
6. The frequency of the normal source and the alternate source shall be monitored, with underfrequency dropout adjustable from 90% to 97% of nominal and pickup adjustable from dropout setting +1 Hz to 99% of nominal.
7. The frequency of the normal source and the alternate source shall be monitored, with overfrequency dropout adjustable from 103% to 110% of nominal and pickup adjustable from dropout setting +1 Hz to 101% of nominal.
8. A time delay shall be provided to override a momentary power outage or voltage fluctuation, adjustable from 0 to 120 seconds.
9. A time delay shall be provided on transfer to alternate source, adjustable from 1 to 1800 seconds.
10. A time delay shall be provided on retransfer from alternate source to normal source, adjustable from 0 to 1800 seconds. This time delay shall be bypassed if emergency source fails and normal source is available.
11. A time delay shall be provided after retransfer that allows the generator to run unloaded prior to shutdown, adjustable from 0 to 1800 seconds.
12. A time delay shall be provided for the neutral position, adjustable from 0 to 60 seconds.
13. A time delay shall be provided for engine failure to start, adjustable from 0 to 10 seconds.
14. All delays shall be field adjustable from the operator touchscreen interface without the use of special software or tools.
15. Plant exerciser, selectable - disabled, daily, or 7, 14, 28 day interval, 0-600 minutes load or no load.
16. Retransfer mode, selectable - manual or automatic.
17. Generator test mode selection - disabled, load, or no load.

F. The automatic transfer controller shall contain the following input/outputs:
1. Minimum of two (2) SPDT contact outputs for generator start, rated 5A, 250Vac.
2. Minimum of six (6) SPDT contact outputs for control functions, rated 5A, 250Vac.
3. The logic controller input/output contacts shall function as specified and described as follows:
    a. Output contact for transfer switch fail alarm.
    b. Output contact for Breaker in Utility position.
    c. Output contact for Utility source available.
    d. Output contact for Breaker in Generator position.
    e. Output contact for Generator source available.
    f. Output contact for control power failure (Energized open, fail closed).

G. Annunciation
1. The system shall be provided with HMI annunciation in accordance with NFPA 110 requirements.
2. The annunciation system shall be equipped with a fast pulse horn (rated 80-95 dbA at three feet), a horn silence push-button, and acknowledge push-button. Any system alarm conditions shall cause the horn to sound until the horn silence button is depressed. Any subsequent alarms shall re-sound the alarm horn. The display shall operate such that any alarm point shall “flash” until acknowledged.
3. As minimum the following annunciation points shall be provided.
    a. Utility control not in Auto.
    b. Generator control not in Auto.
    c. Utility Circuit Breaker Failed to Close/Open.

d. Generator Circuit Breaker Failed to Close/Open.
e. Utility Circuit Breaker Tripped.
f. Generator Circuit Breaker Tripped.
g. Controller Fault.

2.08 PROCESS CONTROL SYSTEM (PCS) INTERFACE:

A. The switchboard system shall provide a network interface for the process control system (PCS).
B. The interface shall be designed such that the PCS or external user interface can in no way compromise the integrity or interfere with the critical operations of the Automatic Throw-over System.
C. The communications protocol to the PCS shall be via Modbus TCP.
   1. A single Category 6 cable connection shall be used for this interface.
D. Refer to SECTION 40 61 96 for a control description of the PCS interface. Refer to the I/O list at the end of that section for a complete list of required I/O points communicated with the PCS.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine areas and conditions under which switchboards and components are to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected.
B. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing the switchboard and shall be maintained for the remainder of the construction period.

3.02 INSTALLATION OF SWITCHBOARDS:

A. Install switchboards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices.
B. Comply with applicable requirements of NEC, NEMA PB 2.1, and NECA's "Standard of Installation." Provide seismic support and bracing to resist the forces of a Seismic event without damage.
C. Provide all openings in floors, walls, roofs, and other structures necessary for complete equipment installation, unless such openings are specifically indicated as being provided by others. Include openings through floors for future cables to connect to spare breakers and to spaces provided in equipment for future expansion.
D. Install a 3.5-inch high, nominal, concrete equipment pad 4 inches wider and 4 inches deeper than the switchboard.
E. Level, shim, and anchor to floor or wall with bolts or concrete anchors.
F. Install all necessary wiring or interconnections as required.
G. Make all internal and external connections as indicated and as required by manufacturer's wiring diagrams.
H. Check all internal and external connections, especially current transformer secondary short circuiting jumpers, and tighten as required.
I. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and the National Electrical Code.
J. Grounding:

1. Provide equipment grounding connections for switchboards as indicated. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds.
2. Test for ground continuity. Test neutral continuity to grounded point of derived system.

K. Place Dow Corning 3-6548 Silicone RTV or General Electric RTF762 sealant in the following locations:
1. All holes in concrete walls, floors and roof slabs after installation of conduit.
2. All unused holes and sleeves as approved by Resident Project Representative.

3.03 IDENTIFICATION:

A. Provide all warning signs, nameplates, labels and markers as specified in SECTION 26 05 53.
B. Label field-installed conductors, interconnecting wiring, and components;
C. Provide Equipment and conduit warning signs.
D. Provide Equipment nameplates.
E. Place arc flash label on equipment.
F. Create a directory to indicate installed circuit loads; incorporate equipment served and room designations as indicated on the Drawings. Use a computer printer to create directory; handwritten directories are not acceptable. Directory shall be subject to approval by the Engineer.
G. Provide each overcurrent device with a corresponding adhesive label with associated number and load served as indicated.

3.04 FIELD QUALITY CONTROL:

A. Manufacturer’s Field Services:
1. Manufacturer's field service shall be provided as specified in this SECTION and in Division 01.
2. Switchboard manufacturer shall provide the field services of a factory technician for a minimum of 3 day(s) on 2 separate occasions to supervise/inspect installation, test and start-up all equipment provided. All travel and living expenses shall be included. All equipment required for testing, start-up and performance verification shall be provided by the start-up technician.
3. Additional days and trips shall be provided as required to fully complete field testing, startup, and training as specified.
4. The switchboard manufacturer shall provide a factory technician specializing in Modbus TCP communication as part of the start-up field services. All equipment required for setup and configuration shall be provided by the technician. The technician shall be available to assist the Systems Integrator in setup and configuration of the plant control system network connections to the switchboard and associated network connected devices.

B. Field Testing:
1. Perform “start-up” tests as recommended by manufacturer.
2. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specifications.
3. Prior to energization, check for electrical continuity of circuits and for short-circuits.
4. Prior to energization check with an insulation resistance tester: phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled. Record and submit field test data.
5. Configure networked equipment for proper communication on the Modbus TCP PCS network.

6. Test network communication to all network connected electronic meters, trip units, and logic controllers and verify the overload device is responding to commands and reporting statuses properly to the plant control system.
7. The manufacturer's representative shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved Short-Circuit, Coordination and Arc-Flash Hazard Analysis Studies.
8. Automatic Throw-Over System Tests: Simulate actual system operation. Includes, but is not limited to, simulations of power failure, transfer to emergency source, and re-transfer to normal source.
9. Infrared Scanning:
    a. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
    b. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
    d. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
    e. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

C. Additional Field Testing:
    1. Provide additional field testing as required by switchboard manufacturer.
D. Submit field testing and commissioning reports as specified in Division 01.

3.05 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
    1. Touch Up:
        a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
        b. Field painting shall be performed based on manufacturer's recommended procedures.
        c. MCC manufacturer shall furnish Contractor with an adequate quantity of touch-up paint to match the factory applied finish.

3.06 ADJUSTING AND CLEANING:

A. Adjust operating mechanisms for free mechanical movement.
B. After field installation and final wiring terminations are completed the field connected power and control wiring and cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.

C. Prior to final acceptance the switchboard interior and exterior shall be wiped clean and free from dust and debris.

3.07 DEMONSTRATIONS:

A. Subsequent to installation of switchboard and all main, feeder, and branch circuit wire and cable hook-ups, energize switchboards and demonstrate functioning in accordance with requirements.
B. Demonstrate the automatic throw-over system in both automatic and manual mode.
C. Where necessary, correct malfunctioning units and then retest to demonstrate compliance.

3.08 TRAINING:

A. The switchboard manufacturer shall provide a qualified representative for a minimum of 1.5 (one and one half) day(s) of training at the customer's facility for operations, maintenance and service personnel.
    1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
    2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, programming, setup, configuration, operational indicators, faults, diagnostic tools, troubleshooting, and preventive maintenance.
    3. Hands-on training shall be provided on the equipment.
    4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.
B. The Owner at their option shall be allowed to video record all training sessions for future reference.
C. Contractor shall record the training sessions and provide a final edited version to the Owner on electronic video file format.

END OF SECTION 26 24 13

SECTION 26 24 16 - PANELBOARDS

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies panelboards and mini-power centers, including cabinets and boxes, as indicated by Drawings and Schedules, and as specified herein.

B. Types of panelboards and enclosures required for the Project include the following:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.
3. Load centers.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 53 - Identification for Electrical Systems
D. SECTION 26 05 73 - Electrical Studies
E. SECTION 26 43 13 - Surge Protective Devices

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with the latest standards revision in effect as of the date of the Contract Documents unless otherwise indicated.

B. Code of Federal Regulations (CFR):

1. 10 CRF Part 429 – Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment.
   a. 429.47 – Distribution Transformers.
2. 10 CFR Part 431 – Energy Efficiency program For Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers.
   a. 431.193 – Test procedures for measuring energy consumption of distribution transformers.
   b. 431.196 – Energy Conservation Standards.

C. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE C62.41.1 – Surge Environment in Low-Voltage (1000V and less) AC Power Circuits.
2. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
3. IEEE C62.45 – Surge Testing on Equipment Connected to Low Voltage (1000V and less) AC Power Circuits.
4. IEEE C62.62 – Test Specification for Surge Protective Devices for Low Voltage AC Power Circuitry.

D. National Electrical Manufacturers Association (NEMA):

1. NEMA 250 – Enclosures for Electrical Equipment (1,000V Maximum).
2. NEMA PB 1 – Panelboards.
3. NEMA PB 1.1 – General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600V or Less.
4. NEMA PB 2.2 – Application Guide for Ground-Fault Protective Devices for Equipment.
5. NEMA ST 20 – Dry Type Transformers for General Applications.

E. National Fire Protection Association (NFPA):
   1. NFPA 70 - National Electrical Code (NEC): Comply with applicable local code requirements of the authority having jurisdiction and NEC as applicable to installation and construction of electrical panelboards and enclosures.

F. Underwriters Laboratories (UL): Provide panelboard units which are UL listed and labeled.
   1. UL 50 - Electrical Cabinets and Boxes.
   2. UL 67 - Electrical Panelboards.
   3. UL 486A - Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   4. UL 489 - Molded-Case Circuit Breakers and Circuit Breaker Enclosures.
   5. UL 869A - Electrical Service Equipment.
   6. UL 1053 - Ground-Fault Sensing and Relaying Equipment.
   7. 1283 – Electromagnetic Interference Filters.
   8. 1449 – Safety for Surge Protective Devices.
   9. Special Use Markings: Provide panelboards constructed for special use with appropriate UL markings which indicate that they are "Suitable for Use as Service Equipment" where applicable.

G. Federal Specification (FS) Compliance: Comply with applicable requirements of the following standards.
   1. FS W-C-375 Series – Molded-Case Circuit-Breakers, Branch Service and Circuit.
   2. FS W-P-115C – Panel, Power Distribution.
   3. FS W-C-375 – Circuit Breakers, Molded Case; Branch Circuit and Service.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design for seismic bracing and anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, site conditions, environmental ratings & hazardous locations.

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Short Circuit study is to be submitted based on equipment intended to be provided. Study is to be approved prior to purchase orders for equipment being issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve selective coordination.

C. Submittals shall be custom prepared by the panelboard manufacturer for this specific application.

D. Product Data: Submit for each type of product specified and included, with the following as a minimum:
   1. Data sheets for all components furnished as part of the system package.

E. Shop Drawings: Provide the following as a minimum:
   1. Panelboard dimensions and weight. Provide center-of-gravity information for each seismic rated panelboard.

2. Complete data on circuit breakers. Submit time - current characteristic curves of all devices.
3. Panelboard short-circuit interrupting capacity, and information on buses: Phase, neutral, and ground.
4. Information on whether panelboard is fed from top, bottom, or both.
5. Data on maximum and minimum incoming and outgoing feeder and branch circuit wire size.
6. Data on door, locks, and mounting: Surface or flush.
7. Data on total number of poles and number of unused poles that is available for future use.

F. Closeout Submittals: Final documentation shall include the following as minimum:
1. Operation and Maintenance Manuals including the following:
a. Operation and maintenance manuals for all components furnished.
b. Certified “As-Built” drawings of all equipment with information listed above.
c. Copies of all approved Product Data.
d. Copies of all approved Test Reports.
e. Warranty Information.

G. Maintenance Material Submittals:
1. Furnish extra materials and spare parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
a. Keys: Two spares for each type of panelboard cabinet lock.
b. Circuit Breakers, including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
c. Provide a minimum of 3 spare breaker handle locking devices.

1.07 QUALITY ASSURANCE:

A. Testing Agency Qualifications: Member company of NETA or a NRTL.
1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer’s latest standard design that has been in satisfactory use for at least one year prior to Bid opening.

C. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

F. Panelboards shall comply with NEMA PB 1.

G. Comply with NFPA 70.

H. Mini-power centers shall conform to the applicable requirements of 10 CFR 429.47 – Distribution Transformers and 10 CFR 431.193 – Test procedures for measuring energy consumption of distribution transformers.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Panelboards shall be stored according to the manufacturer’s instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.

B. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (Approximately 250 watts per panelboard for average conditions) to prevent condensation.
C. Handle and prepare panelboards for installation according to NEMA PB 1 and manufacturer's instructions.
D. Environmental Limitations:
   1. Do not deliver or install panelboards until spaces are enclosed, weathertight, dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.09 COORDINATION:
A. Coordinate the layout and installation of panelboards and components with other types of equipment including raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY:
A. All equipment furnished under this Section shall be warranted by the Contractor and the equipment manufacturer(s) for a minimum period of one year after substantial completion.
B. Warranty shall include all parts, labor, and expenses to perform necessary work.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Subject to compliance with requirements, provide panelboard and mini-power center products of one of the following (for each type and rating of panelboard and enclosure):
   1. Eaton.
   2. General Electric Company.
   3. Siemens.
   4. Square D, Schneider Electric.

2.02 GENERAL REQUIREMENTS FOR PANELBOARDS:
A. Except as otherwise indicated, provide panelboards, enclosures, and ancillary components of types, size, and ratings indicated, which comply with manufacturer's standard materials and with the design and construction in accordance with published product information.
B. Where types, sizes, or ratings are not indicated, comply with NEC, UL, and established industry standards for those applications indicated.
C. Equip with proper number of panelboard switching and protective devices as required for complete installation.
D. Provide ground fault circuit interrupter type circuit breakers where indicated.
E. Enclosures: Flush- and surface-mounted cabinets as indicated.
   1. Provide enclosures fabricated by same manufacturer as panelboards which mate and match properly with panelboards.
   2. Suitable ratings for environmental conditions at installed location. Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.

3. Materials: Galvanized sheet steel cabinet type enclosures, in sizes required. Provide code gage (minimum 16-gage) thickness steel.
4. Must be UL 50 listed.
5. Front: Secured to box with adjustable, concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
6. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Front doors shall have flush locks with three keys per panelboard, all panelboard enclosures keyed alike.
7. Finishes:
    a. Color: Baked gray enamel finish over a rust inhibitor coating.
    b. Panels and Trim: Galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    c. Back Boxes: Galvanized steel. Stainless Steel for NEMA 4X panelboards.
    d. Fungus Proofing: Permanent fungicidal treatment for overcurrent protective devices and other components.
8. Directory Card: Inside panelboard door, equip with interior circuit directory frame and removable card with clear plastic covering.

F. Phase, Neutral, and Ground Buses:
1. Bus shall be braced to withstand available short-circuit currents as indicated.
2. Provide suitable lugs on neutral bus for incoming and outgoing feeders requiring neutral connections.
3. Equipment Ground Bus: Bare, uninsulated, adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
4. Full-Capacity Neutral Bus and Lugs: Neutral bus and lugs rated 100% of phase bus and UL listed as suitable for nonlinear loads. Provide as indicated.
5. Material: Tin-plated, Hard-drawn copper, 98% conductivity.

G. Conductor Connectors: Suitable for use with conductor material and sizes indicated and specified.
1. Material: Hard-drawn copper, 98% conductivity.
2. Main and Neutral Lugs: Mechanical type rated for AL/CU (aluminum/copper) conductors.
3. Ground Lugs and Bus-Configured Terminators.
4. Feed-Through Lugs: As indicated, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. All lugs shall be mechanical type.
6. Provide terminals UL rated for 75ºC (minimum) conductors.

H. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with one or more main service disconnecting and overcurrent protective devices.

I. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

J. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals as indicated.

K. Final equipment selection: Review the short circuit equipment study. Provide only equipment that meets or exceeds the recommendation of that short circuit study specified in SECTION 26 05 73.

L. Surge Protection Devices: Provide an integral surge protection device for each panelboard as specified. Refer to Section 26 43 13 – Surge Protection Devices.

M. Provide panelboard nameplate as indicated.

2.03 POWER DISTRIBUTION PANELBOARDS:

A. Panelboards: NEMA PB 1, dead front, safety type, power and feeder distribution type, voltage and other ratings as indicated on the drawings.
B. Panelboard switching and protective devices in quantities, ratings, types, and with arrangements shown.
C. Anti-turn, solderless, pressure-type main lug connectors approved for use with copper conductors.
D. Where required, provide panelboards with UL markings which indicate "suitable for use as service entrance equipment". Shall meet UL 869A.
E. Incoming Mains Location: Top or bottom, as indicated.
F. Mains: Circuit breaker or lugs only, as indicated.
G. Branch Overcurrent Protective Devices:
    1. Bolt-on, molded-case circuit breakers.
    2. Molded-case circuit breakers shall have toggle handles that indicate when tripped.
    3. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously.
    4. Circuit breakers shall be replaceable without disturbing adjacent units.
H. Where necessary, furnish an integral metal locking device for each circuit breaker indicated on the drawings or listed below. Locking device shall be pad lockable and allow breakers to be individually locked in the OFF position. Adjustable trip overcurrent devices must have local restricted access as required by NFPA 70 (NEC).
I. Provide an integral surge protection device to protect the panelboard Refer to SECTION 26 43 13.
J. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
    1. For doors more than 36 inches high, provide two latches, keyed alike.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS AND LOAD CENTERS:

A. Panelboards: NEMA PB 1, dead front, safety type, power and feeder distribution type, voltage and other ratings as indicated on the drawings.
B. Lighting and appliance branch-circuit type as indicated with switching and protective devices in quantities, ratings, types, and arrangements shown.
C. Incoming Mains Location: Top or bottom, as required.
D. Mains: Circuit breaker or lugs only, as indicated.
E. Branch Overcurrent Protective Devices:
    1. Bolt-on, molded-case circuit breakers.
    2. Molded-case circuit breakers shall have toggle handles that indicate when tripped.
    3. Where multiple pole breakers are indicated, provide with common trip so overload on one pole will trip all poles simultaneously.
    4. Circuit breakers shall be replaceable without disturbing adjacent units.
F. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.
G. Unless indicated otherwise on the Drawings, provide a minimum of 5-spare 20A and 3-spare 30A single pole breakers mounted within the panelboard.
H. Provide an integral surge protection device to protect the panelboard as specified in SECTION 26 43 13 – Surge Protection Devices.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
C. Verify Site conditions are suitable for installation of equipment.
D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the work.
E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF PANELBOARDS:

A. Refer to Section 26 24 13 for installation of panelboards in switchboards.

3.03 GROUNDING:

A. Provide equipment grounding connections for panelboard enclosures as indicated and as required by NEC. Tighten connections to comply with tightening torques specified in UL 486A to assure permanent and effective grounds. Provide grounding as specified in SECTION 26 05 26.

3.04 IDENTIFICATION:

A. Provide all warning signs, nameplates, labels and markers as specified in SECTION 26 05 53.
B. Label field-installed conductors, interconnecting wiring, and components;
C. Provide Equipment and conduit warning signs.
D. Provide Equipment nameplates.
E. Create a directory to indicate installed circuit loads; incorporate equipment served and room designations as indicated on the Drawings. Use a computer printer to create directory; handwritten directories are not acceptable. Directory shall be subject to approval by the Engineer.

3.05 FIELD QUALITY CONTROL:

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
C. Perform tests and inspections as specified and as recommended by the equipment manufacturer.
    1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
D. Acceptance Testing Preparation:
    1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
    2. Test continuity of each circuit.
E. Tests and Inspections:
    1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
    2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3. Prior to energization of electrical circuitry, check all accessible connections to manufacturer's tightening torque specifications.
4. Prior to energization, check panelboard circuits for short circuits, electrical continuity of circuits, enclosure grounding and neutral grounding at service entrance and at incoming derived source transformer.
5. Prior to energization of panelboards, check with insulation resistance tester the phase-to-phase and phase-to-ground insulation resistance levels of each phase bus to ensure requirements are fulfilled. Record and submit test results.
6. Panelboards will be considered defective if they do not pass tests and inspections.
7. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
8. Infrared Scanning:
    a. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
    b. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    c. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
    d. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
    e. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

3.06 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
    1. Touch Up:
        a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
        b. Field painting shall be performed based on manufacturer’s recommended procedures.
        c. Panelboard manufacturer shall furnish Contractor with an adequate quantity of touch-up paint to match the factory applied finish.

3.07 ADJUSTING AND CLEANING:

A. Once loads are finalized, Contractor to adjust panel circuiting to provide optimal load balancing.
B. Adjust moving parts and operable components to ensure normal function as recommended by manufacturer.
C. Upon completion of installation, clean interior and exterior of panelboards. Remove paint splatters, spots, dirt and debris.

D. Touch-up scratched or marred surfaces to match original finishes.
E. Adjust transformer taps of mini-power centers as required.

3.08 PROTECTION:
A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

3.09 DEMONSTRATION:
A. Subsequent to final wire and cable hook-ups, energize panelboards and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

3.10 MAINTENANCE
A. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
B. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
C. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
D. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 24 16

SECTION 26 24 19 – MOTOR CONTROL CENTERS

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Motor control center and all necessary parts for complete assembly.
   2. Network components mounted within the motor control center.

B. Coordination of motor horsepower, short circuit rating, motor controller size, including overload protection, as recommended by the final Short-Circuit, Coordination and Arc-Flash Hazard Analysis Studies.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 53 - Identification for Electrical Systems
D. SECTION 26 05 73 - Electrical Studies
E. SECTION 26 35 36 – Harmonic Filters
F. SECTION 26 43 13 - Surge Protective Devices
G. SECTION 40 60 00 - Process Control and Instrumentation General Requirements
H. SECTION 40 66 00 - Process Control Networks
I. SECTION 46 05 13 - Common Motor Requirements for Water and Wastewater Equipment

1.04 REFERENCE STANDARDS:

A. American National Standards Institute/National Electrical Manufacturers Association (ANSI/NEMA):
   1. ANSI/NEMA C37.50 – Low Voltage AC Power Circuit Breakers Used in Enclosures - Test Procedures.
   2. ANSI/NEMA C37.51 – Metal-Enclosed Low Voltage AC Power Circuit Breaker Switchgear Assemblies - Conformance Test Procedures.

B. American Society for Testing and Materials (ASTM):
   1. ASTM A123 – Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A153 – Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   3. ASTM B5 – High Conductivity Tough Pitch Copper Refinery Shapes.
   4. ASTM B187 – Copper Bus Bar, Rod and Shapes and General Purpose Rod, Bar and Shapes.
   5. ASTM B188 – Seamless Copper Bus Pipe and Tube.
   6. ASTM B211 – Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod and Wire.
   7. ASTM B236 – Aluminum Bars for Electrical Purposes (Bus Bars).
   8. ASTM B317 – Aluminum-Alloy Extruded Bar, Rod, Pipe, Structural Profiles, and Profiles for Electrical Purposes (Bus Conductor).

C. Code of Federal Regulations (CFR):
   1. 10 CRF Part 429 – Certification, Compliance, and Enforcement for Consumer Products and Commercial and Industrial Equipment.
      a. 429.47 – Distribution Transformers.
   2. 10 CFR Part 431 – Energy Efficiency program For Certain Commercial and Industrial Equipment, Subpart K – Distribution Transformers.

a. 431.193 – Test procedures for measuring energy consumption of distribution transformers.
b. 431.196 – Energy Conservation Standards.

D. Institute of Electrical and Electronic Engineers (IEEE):
1. IEEE C37.13 – Low-Voltage AC Power Circuit-Breakers Used in Enclosures.
2. IEEE C37.16 – Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
3. IEEE C37.20 – Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
4. IEEE C57.13 – Standard Requirements for Instrument Transformers.

E. National Electrical Manufacturers Association (NEMA):
1. NEMA ICS Complete Set – Industrial Controls and Systems.
2. NEMA PB 1 – Panelboards.
3. NEMA PB 2 – Deadfront Distribution Switchboards.
4. NEMA ST 20 – Dry-Type Transformers for General Application.

F. National Fire Protection Association (NFPA):
1. NFPA 70 - National Electrical Code (NEC): Comply with requirements of NEC as applicable to motor control center equipment and components.

G. Underwriters' Laboratories, Inc. (UL):
1. UL 50 – Enclosures for Electrical Equipment, Non-Environmental Considerations.
2. UL 489 – Molded Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
3. UL 508 – Industrial Control Equipment.
4. UL 845 – Motor Control Centers.
5. UL 857 – Busways.
6. UL 1449 – Surge Protective Devices.

1.05 DEFINITIONS:

A. CPT: Control power transformer.
B. MCCB: Molded-case circuit breaker.
C. MCP: Motor circuit protector.
D. N.C.: Normally closed.
E. N.O.: Normally open.
F. OCPD: Overcurrent protective device.
G. SCR: Silicon-controlled rectifier.

1.06 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design for seismic bracing and anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements, design criteria indicated, and related product information for equipment to be supplied.
B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."
C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, site conditions, environmental ratings & hazardous locations.
D.

1.07 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Short Circuit study is to be submitted based on equipment intended to be provided. Study is to be approved prior to purchase orders for equipment being issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve selective coordination.

C. Refer to each Section of this Division for specific Product Data, Shop drawing and additional Submittal requirements.

D. Product Data: Submit for each type of product specified and included, with the following as minimum:
   1. Data sheets for all components furnished as part of the system package.

E. Shop Drawings: Provide the following as minimum.
   1. Fabrication and erection drawings.
   2. Equipment dimensions, including stub-up locations, shipping splits and shipping weights.
   3. Equipment ratings.
   4. General outline drawing.
   5. Detailed equipment installation drawings.
   6. Schematic diagrams.
   7. Bill of materials.
   8. Nameplate schedule.
   9. Surge Protective Device data and testing laboratory reports.
   10. Sizing calculations for active harmonic filters.
   11. Complete loading diagrams covering static and dynamic loadings for all conditions of operation and structural steel details.
   12. Complete unit and internal wiring diagrams.
   13. External connection diagrams.
   14. Instrument transformer performance curves and data.
   15. Time-current characteristic curves for overcurrent protective devices.
   16. Configuration sheet for each intelligent overload relay that indicates all available settings for the relay along with recommended settings for each parameter. Any settings which require field adjustment or Engineer input shall be clearly indicated.
   17. Complete list of available parameters from intelligent components including overload relays, variable frequency drives, and power meters. List shall include I/O addresses.

F. Special Procedure Submittals:
   1. Start-up and commissioning instructions.
   2. Syllabus for Owner training.

G. Test and Evaluation Reports:
   1. Factory acceptance test reports.
   2. Commissioning test reports.

H. Closeout Submittals: Final documentation shall include the following as minimum:
   1. Operation and Maintenance Manuals including the following:
      a. Operation and maintenance manuals for all components furnished.
      b. Certified “As-Built” drawings of all equipment with information listed above.
      c. Copies of all approved Product Data.
      d. Copies of all approved Test Reports.
      e. Spare parts and supply list with supplier names and part numbers.
      f. Warranty Information.
      g. Manufacturer’s service and repair support during and after warranty including contact information.

h. Configuration sheet for each intelligent overload relay indicating as installed settings for each relay.
i. Training Materials. Includes final edited training videos.
j. Infrared scan report.

I. Maintenance Material Submittals:
1. Spare Parts:
a. Three spare LED indicating lamps for each type and color used.
b. Three spare indicating light assemblies.
c. Ten spare power and control fuses of each voltage and current rating used.
d. One 12oz aerosol cans of manufacturer's touch-up paint for each color used. Color shall match the original factory applied color.
e. One spare 24Vdc power supply.
f. All parts supplied with the equipment shall be properly labeled for ease of identification and to permit the shortest possible time to repair.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.
B. The MCC shall be delivered to the site pre-assembled and wired with all specified interconnecting wiring and cable. Cabling for connection across shipping splits shall be neatly coiled and identified. Exposed sections of equipment shall be fully protected from damage during shipment. All necessary hardware for reconnecting shipping splits shall be provided.
C. The MCC manufacturer shall be responsible for all system interconnections across shipping splits at the project site.
D. Complete instructions for handling and storage shall be provided by the manufacturer prior to delivery of the equipment. All equipment shall have adequate provisions for handling by overhead crane or forklift truck.
E. MCCs shall be stored according to the manufacturer's instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.

1.09 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.
B. Factory Tests:
1. The manufacturer shall conduct tests according to industry standard requirements.
2. Perform factory tests on all motor controller assemblies to assure that all devices and systems are in proper working order before delivery to jobsite.
3. Test all power, control and communication systems for proper operation.
4. Simulate actual system operation.
5. Submit test reports as specified in Division 01.

1.10 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Allen-Bradley, Rockwell Automation, Inc.
B. Eaton.
C. Schneider Electric.
D. Siemens.

2.02 MOTOR CONTROL CENTER ASSEMBLY:

A. Conform to ANSI/IEEE C37.20 and applicable ASTM, IEEE, NEMA and UL standards specified in PART 1, REFERENCES.
B. Rated 480Y/277-volt, bus ratings as shown, 3-phase, 4-wire and 60 Hz.
C. The motor control center assembly including bus bracing and overcurrent devices shall have a minimum symmetrical interrupting rating as indicated.
D. Main horizontal bus of tin-plated copper with minimum rating as indicated, continuous.
E. Vertical bus shall be tin-plated copper and shall be rated a minimum of 300 Amps.
F. Provisions shall be provided for splicing additional sections to either end of the motor control center.
G. All copper bus bars shall be composed of 98% IACS copper with a current density of 1000-A per square inch and be plated as specified.
H. The dimensions (width, length and height) of the motor control center shall not be larger than the floor space allocated for the motor control center as indicated.
I. Provide transition sections for thru-the-back or back-to-back installation at locations indicated.

2.03 ENCLOSURE:

A. Assemblies of vertical metal-enclosed sections, each nominally 20 inches wide, 20 inches deep, and 90 inches high, joined together to form totally enclosed freestanding units, designed to permit easy addition and removal of sections in the field.
B. NEMA Class II, Type B wiring construction.
C. NEMA Type 1A, gasketed, enclosure construction.
D. Ground bus provided for full length of the motor control center with lug for grounding the unit, located toward the bottom front of the MCC.
E. Section Arrangement:
    1. Minimum individual motor starter height: 12 inches.
    2. Minimum individual feeder device height: 6 inches.
    3. Front-mounted or arranged for back-to-back mounting as indicated.
    4. Arrange units to obtain best fill of each vertical section for minimum overall length, including spare spaces.
    5. Mount larger starters and transformers at bottom of each section.
    6. Locate metering components and other operator interface devices at a convenient operating height.
F. Construction:
    1. Horizontal wiring tray at top and bottom of unit.
    2. Vertical wireway with hinged door. Wireway shall have provisions for cable supports.
    3. Complete accessibility from front to all buses, starters, control devices, and all other components for wiring and maintenance.
    4. Front-mounted starter units, circuit breaker units, and other equipment in separate compartments isolated by steel barriers.
    5. Guide rails, separator bars, cover plates, and other provisions necessary for installation of a future starter unit in all future spaces and blank spaces remaining in the units after all required components are installed.
    6. Permanent base channel sills having closure strip at each end of units.
    7. Each unit compartment shall be provided with an individual hinged front door.
    8. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access, unless the disconnect is in the OFF position. A mechanical means shall be provided to bypass this

interlock. Padlocking capability shall be provided to positively lock the disconnect in the OFF position.

G. Finish:
1. Paint system with manufacturer's standard coating system suitable for intended service.
2. Exterior paint color shall be light gray.
3. Interior surfaces shall be painted white.

H. Nameplates:
1. Wording and equipment tags as indicated.
2. Engraved phenolic nameplates for each starter unit, fused disconnect and circuit breaker unit and other items of equipment.
3. Engraved phenolic "master" nameplate for each motor control center.

2.04 INTELLIGENT SYSTEMS:

A. General:
1. Where motor starters and power monitors require, each motor control center shall be provided with a factory installed Ethernet network that utilizes Modbus TCP communication protocol.
2. Each intelligent overload relay, reduced voltage solid-state starter, and power meter shall be supplied with a communication card to communicate directly to the network, and have the capability of controlling and monitoring input and output points as specified.
3. Each intelligent overload relay, reduced voltage solid-state starter and power meter shall be provided with an integral web page that allows for viewing and setting parameters utilizing standard web browser software.
4. Modbus TCP shall be the native communication language of the device and the use of protocol converter modules to allow devices to communicate on the specified network is not allowed.

B. Control Power:
1. Each combination motor starter, variable frequency drive, reduced voltage solid-state starter and contactor shall be provided with a unit mounted control power transformer to power control relays, indicating lights, motor space heaters, cooling fans and other equipment as indicated and specified.
a. Provide an additional 150VA spare capacity for control power transformers.
2. Each MCC shall be provided with a redundant, 24Vdc power system to power network equipment, motor controller communication and control boards, and intelligent overloads.
a. A minimum of two full capacity 120Vac to 24Vdc power supplies shall be provided for each MCC. Each power supply shall be provided with a dedicated input circuit breaker and shall each be powered from a dedicated control power transformer.
b. Each power supply shall be sized to accommodate all connected components plus a minimum of 20% spare capacity.
c. A failure contact shall be provided from each power supply. Contact shall be rated a minimum of 3 Amps at 120Vac. Provide interposing relay if required. Contacts shall be factory wired to field terminal blocks.

C. Communication Network:
1. The motor control center shall have Category 6 Ethernet cabling installed from each intelligent unit back to the associated unit mounted Ethernet switch as indicated.
2. Refer to Section 40 66 00 – Process Control Networks for Ethernet switch requirements. Provide a minimum of 20% spare ports for each motor control center.

3. Ethernet cabling shall be routed through the MCC line-up, behind barriers, rated 600V, that isolate the cabling from the unit space and wireways to prevent damage during installation.
4. Spare cables shall be routed to sections containing spare space. A minimum of one cable per 12-inches of spare space shall be provided.
5. The addition or removal of a unit from the network shall not interrupt the operation of other units within the system.
6. The manufacturer shall factory program the IP address, Subnet, and Default Gateway for all intelligent components. Coordinate with the Systems Integrator for IP Address assignments.

2.05 INCOMING LINE SECTION:

A. Incoming Power Feeder:
1. Cables entering as shown on the drawings, or as required by building construction; contractor to coordinate.
2. Necessary lugs, clamps, supports, space and all items to terminate cables as indicated.
3. Main lug only or main circuit breaker, as indicated.

2.06 MAIN AND FEEDER CIRCUIT DEVICES:

A. Molded Case Circuit Breakers:
1. Provide for circuit breakers rated less than 1200 Amps, unless identified otherwise directly or by necessary features.
2. Molded-case, manually-operated, 3 pole.
3. Trip-free from handle.
4. Inverse time thermal element overload protection.
5. Instantaneous magnetic short-circuit protection on all poles.
6. External handle which clearly indicates when breaker is "ON," "OFF," or "TRIPPED," and lockable in the "OFF" position.

B. Molded-Case Circuit Breakers With Solid State Trip Unit:
1. Provide for circuit breakers rated 1200 Amps and above.
2. Molded-case, manually-operated, 3 pole circuit breaker with solid state trip unit.
3. Trip-free from handle.
4. Solid state trip unit shall have the following features:
   a. Adjustable long time pickup.
   b. Adjustable long time delay.
   c. Adjustable short time pickup.
   d. Adjustable short time delay.
   e. Adjustable instantaneous time pickup.
   f. Adjustable instantaneous time delay.
   g. Adjustable ground fault time pickup.
   h. Adjustable ground fault time delay.
   i. I^2t settings for instantaneous and ground fault.
5. External handle which clearly indicates when breaker is "ON," "OFF," or "TRIPPED," and lockable in the "OFF" position.
6. Adjustable trip overcurrent devices must have local restricted access as required by NFPA 70 (NEC).
7. Accessories:
   a. Auxiliary contacts as indicated.
   b. Shunt trip.

c. Arc reduction maintenance switch

2.07 OUTGOING/LOAD SECTIONS:

A. Incoming Power Feeder:
1. Cables entering as shown on the drawings, or as required by building construction; contractor to coordinate.
2. Necessary lugs, clamps, supports, space and all items to terminate cables, as indicated.

2.08 FEEDER DEVICES:

A. Molded Case Circuit Breakers:
1. Provide for circuit breakers rated less than 1200 Amps, unless identified otherwise directly or by necessary features.
2. Molded-case, manually-operated, 3 pole.
3. Trip-free from handle.
4. Inverse time thermal element overload protection.
5. Instantaneous magnetic short-circuit protection on all poles.
6. External handle which clearly indicates when breaker is "ON," "OFF," or "TRIPPED," and lockable in the "OFF" position.

B. Molded-Case Circuit Breakers With Solid State Trip Unit:
1. Provide for circuit breakers rated 1200 Amps and above.
2. Molded-case, manually-operated, 3 pole circuit breaker with solid state trip unit.
3. Trip-free from handle.
4. Solid state trip unit shall have the following features:
a. Adjustable long-time pickup.
b. Adjustable long-time delay.
c. Adjustable short-time pickup.
d. Adjustable short-time delay.
e. Adjustable instantaneous time pickup.
f. Adjustable instantaneous time delay.
g. Adjustable ground fault time pickup.
h. Adjustable ground fault time delay.
i. I^2t settings for instantaneous and ground fault.
5. External handle which clearly indicates when breaker is "ON," "OFF," or "TRIPPED," and lockable in the "OFF" position.
6. Adjustable trip overcurrent devices must have local restricted access as required by NFPA 70 (NEC).
7. Accessories:
a. Auxiliary contacts as indicated.
b. Shunt trip.

2.09 COMBINATION STARTERS:

A. General:
1. Factory-mounted interchangeable-type 12 inches or larger vertical modular units, with hinged doors.
2. Each combination starter shall be provided with a motor circuit protector (MCP) type disconnect.
a. Shall be provided with an external handle that clearly indicates when the MCP is "ON," "OFF," or "TRIPPED" and be lockable in the "OFF" position.
b. Molded-case, manually-operated, 3-pole.

c. Adjustable, instantaneous-trip, magnetic-only-type circuit breaker.
d. Coordinated unit rating for circuit protector and starter.

3. Suitable sized, fused, individual control transformers for supplying 120Vac control power to each motor starter coil, and its associated equipment as indicated.
4. Starters and starter spare spaces as indicated.
5. Each starter sized according to horsepower rating of motor furnished. One-line diagrams show approximate motor horsepower ratings and sizes of spare starters and spare starter spaces.
6. Auxiliary contacts as required by Contract Drawings.
7. Spare auxiliary contacts: One normally open and one normally closed, unless indicated otherwise.
8. Momentary or maintained start-stop push buttons, selector switches, control switches, time delay relays, and indicating lights for motor starters as indicated.

B. Full-Voltage Starters:
1. Provide full voltage NEMA type reversing and non-reversing starters as indicated.
2. Minimum starter size NEMA Size 1.
3. Provide voltage snubbers in parallel with contactor coil.
4. Provide with solid-state, self-powered overload relay sized for and adjustable to full load current of the motor being protected. Overload relay shall be manually reset and provide phase loss protection. Overload trip class shall be selectable between 5, 10, 20 and 30.
5. External manual reset of overload relay from outside of the unit enclosure.

C. Variable Frequency Drive
1. Refer to SECTION 26 29 23.

2.10 SURGE PROTECTIVE DEVICE (SPD):

A. Each MCC shall be provided with an integral Surge Protective Device (SPD) as indicated. Refer to Section 26 43 13 – Surge Protection Devices.

2.11 METERS AND PROTECTIVE RELAYS:

A. Provide motor thermal protection relays for motors shown on the Drawings. Including thermal sensor type and quantity of inputs identified in the motor specification, SECTION 46 05 13 - Common Motor Requirements for Water and Wastewater Equipment.

B. Current Transformers:
1. Dry-type, torodial bushing or wound-type.
2. Ratio as indicated or required by application.
3. Accuracy conforming to ANSI/IEEE C57.13 Classification 2.5H or 2.5L for relaying and 0.3 for metering.
4. Thermal and mechanical ratings corresponding to equipment with which applied.
5. Secondary terminals connected to short-circuiting-type terminal blocks.

2.12 CONTACTORS:

A. Rated 600 volts.
B. 3 pole.
C. Coil designed to operate at 120Vac, 60 Hz.
D. Correct NEMA size with contacts rated for the specific load.

2.13 ACTIVE HARMONIC FILTERS:

A. Motor Control Center shall be provided with integral active harmonic filter where shown on the one-line diagrams as specified in SECTION 26 35 26.

2.14 MISCELLANEOUS:

A. Push Buttons and Selector Switches:
   1. Heavy duty, 30 mm units with contacts rated 10A continuous at 120Vac.
   2. NEMA 4/12 rated.
   3. Provide the number of contacts and contact development as indicated.
   4. Start push buttons shall have green operators.
   5. Stop push buttons shall have red operators.
   6. Emergency Stop push buttons shall have red mushroom head operators.

B. Pilot Lights:
   1. Heavy duty, 30 mm units.
   2. NEMA 4/12 rated.
   3. 120Vac cluster LED type.
   4. Red lights shall indicate equipment OFF.
   5. Green lights shall indicate equipment ON.
   6. Amber lights shall indicate equipment failure.
   7. Push-to-test type.

C. Control Relays:
   1. Industrial type rated 600-volt, 60-Hz, with convertible contacts.
   2. Plug-in type, rated 240-volt, 60-Hz with indicator light and mounting socket.
   3. Minimum 10 Amp contact rating.
   4. Coil voltage: 120-volt, 60-Hz.
   5. Number of normally open and normally closed contacts as required.
   6. Provide a minimum of one spare normally open and normally closed contact.

D. Space Heaters:
   1. Provide differential thermostat-controlled space heaters in each section.
   2. Space heaters shall be sized to prevent condensation within the enclosure.
   3. Power space heaters from internal source, or from panelboard where indicated.
   4. Provide required control power transformer and overcurrent protection for space heaters.

E. Control Wiring:
   1. Small wiring, necessary fuse blocks and terminal blocks within the motor control center shall be furnished as required.
   2. Numbered terminal blocks shall be provided for field wiring and shall be suitable for copper cable rated for 75°C of the size as indicated on the drawings.
   3. Terminal blocks shall be rated for 600 Vac.
   4. Provide a minimum of 20% spare terminal blocks in each unit.
   5. All internal control wire shall be type MTW, bundled and secured with nylon ties.
   6. All current transformer secondary leads shall first be connected to conveniently accessible shorting terminal blocks before connecting to any other device.
   7. Wire markers shall be installed at each end of all control wiring.

F. Control components mounted within the assembly, such as fuse blocks, relays, push buttons, switches, etc., shall be suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.

2.15 IDENTIFICATION:

A. Provide all warning signs, nameplates, labels and markers as specified in SECTION 26 05 53.
B. Label field-installed conductors, interconnecting wiring, and components;
C. Provide Equipment and conduit warning signs.
D. Provide Equipment nameplates.
E. Place arc flash label on equipment.

F. Create a directory to indicate installed circuit loads; incorporate equipment served and room designations as indicated on the Drawings. Use a computer printer to create directory; handwritten directories are not acceptable. Directory shall be subject to approval by the Engineer and Owner.
G. Provide each overcurrent device with a corresponding adhesive label with associated number and load served as indicated.

2.16 SOFTWARE:
A. Provide one licensed copy of all required software to program, configure, control (for testing purposes) and monitor the intelligent overload relays, solid-state soft starters, variable frequency drives and power monitors. Software shall allow configuration files to be saved.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Verify site conditions are suitable for installation of equipment.
B. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing MCCs and shall be maintained for the remainder of the construction period.

3.02 INSTALLATION:
A. Install shall conform to manufacturer's instructions.
B. Completely install as specified, indicated, or required for operation and continuous service at the locations indicated.
C. Provide all openings in floors, walls, roofs, and other structures necessary for complete equipment installation, unless such openings are specifically indicated as being provided by others. Include openings through floors for future cables to connect to spare breakers, starters, and the like and to spaces provided in equipment for future expansion.
D. Place Dow Corning 3-6548 Silicone RTV or General Electric RTF762 sealant in the following locations:
    1. All holes in concrete walls, floors and roof slabs after installation of conduit.
    2. All unused holes and sleeves as approved by Resident Project Representative.
E. For freestanding enclosures install a 3.5-inch high concrete equipment (housekeeping) pad 3-inches wider and 3-inches deeper than the MCC. Clear dimension to anchor bolts to be a minimum of 4-inches.
F. Level, shim, and anchor to floor or wall with bolts or concrete anchors, and grout all floor-mounted equipment.
G. Install all necessary wiring or interconnections as required.
H. Make all internal and external connections as indicated and as required by manufacturer's wiring diagrams.
I. Check all internal and external connections, especially current transformer secondary short circuiting jumpers, and tighten as required.
J. Place arc flash label on equipment.

3.03 FIELD QUALITY CONTROL:
A. Manufacturer’s Field Services:
    1. Manufacturer's field service shall be provided as specified in this Section and in Division 01.

2. MCC manufacturer shall provide the field services of a factory technician for a minimum of 2 day(s), over separate occasions, if necessary, to supervise/inspect installation, test and start-up all equipment provided. All travel and living expenses shall be included. All equipment required for testing, start-up and performance verification shall be provided by the start-up technician.
3. Additional days and trips shall be provided as required to fully complete field testing, startup, and training as specified.
4. The MCC manufacturer shall provide a factory technician specializing in Modbus TCP communication as part of the start-up field services. All equipment required for setup and configuration shall be provided by the technician. The technician shall be available to assist the Systems Integrator in setup and configuration of the plant control system network connections to the MCC and associated network connected devices.

B. Field Testing:
1. Perform “start-up” tests as recommended by manufacturer.
2. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specifications.
3. Prior to energization, check for electrical continuity of circuits and for short-circuits.
4. Prior to energization check with an insulation resistance tester: phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled. Record and submit field test data.
5. Configure intelligent devices for proper communication on the Modbus TCP network.
6. Configure intelligent device to maintain current state if network communication is lost unless specified or indicated otherwise. All devices shall be controllable locally at the motor starter or variable frequency drive if the communication system fails. Configure as required.
7. Set all parameters associated with intelligent overload devices for proper motor protection and system performance. Settings shall be recorded and included with final documentation as specified.
8. Test network communication to all network connected solid-state overload devices and verify the overload device is responding to commands and reporting statuses properly to the plant control system.
9. The manufacturer’s representative shall perform field adjustments of the protective devices as required to place the equipment in final operating condition. The settings shall be in accordance with the approved short-circuit study, protective device evaluation study, and protective device coordination study.

C. Additional Field Testing:
1. Provide additional field testing as required by motor control center manufacturer.

D. Submit field testing and commissioning reports as specified in Division 01.

E. Infrared Scanning:
1. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
2. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.

4. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
5. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

3.04 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
   1. Touch Up:
      a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
      b. Field painting shall be performed based on manufacturer's recommended procedures.
      c. MCC manufacturer shall furnish Contractor with an adequate quantity of touch-up paint to match the factory applied finish.

3.05 ADJUSTING AND CLEANING:

A. After field installation and final wiring terminations are completed the field connected power and control wiring and cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.
B. Prior to final acceptance the MCC interior and exterior shall be wiped clean and free from dust and debris.

3.06 TRAINING:

A. The MCC supplier shall provide a minimum of one day of training at the customer's facility for operations, maintenance and service personnel.
   1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
   2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, software mapping, programming, setup, configuration, control loop tuning, operational indicators, faults, diagnostic tools, troubleshooting, and preventive maintenance.
   3. Hands-on training shall be provided on equipment.
   4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.
B. The Owner at their option shall be allowed to video record all training sessions for future reference.
C. Contractor shall record the training sessions and provide a final edited version to the Owner on electronic video file format.

3.07 MAINTENANCE

A. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
B. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
C. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.

D. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 24 19

SECTION 26 27 26 –WIRING DEVICES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers wiring devices for lighting and utilization equipment including but not limited to the following:
   1. Receptacles.
   2. Switches.
   3. Wall Plates.
   4. Plugs.

1.03 RELATED REQUIREMENTS:

A. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
B. Section 26 05 33 – Raceways, Boxes, Seals and Fittings for Electrical Systems.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. National Electrical Manufacturers Association (NEMA):
   1. NEMA WD 1 – General Color Requirements for Wiring Devices.
   2. NEMA WD 6 – Wiring Devices - Dimensional Specifications.
   3. NEMA 410 – Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
C. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC).
D. Underwriters Laboratories (UL):
   1. UL 20 – General-Use Snap Switches.
   2. UL 486A-486B – Wire Connectors.
   3. UL 498 – Attachment Plugs and Receptacles.
   4. UL 514D – Cover Plates for Flush-Mounted Wiring Devices.
   5. UL 943 – Ground-Fault Circuit-Interrupters.
   6. UL 1310 – Class 2 Power Units.
   7. UL 1472 – Solid State Dimming Controls.
   8. UL 1682 – UL Standard for Safety Plugs, Receptacles, and Cable Connectors of the Pin and Sleeve Type.
   9. UL 1686 – UL Standard for Safety Pin and Sleeve Configurations.
E. Federal Specification (Fed. Spec.):
   1. Fed. Spec. W-C-596 – Connector, Electrical, Power, General Specifications.
   2. Fed. Spec. W-S-896 – Switches, Toggles (Toggle and Lock), Flush-Mounted.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data for each product specified.

1.06 QUALITY ASSURANCE:

A. Conform to the requirements of NFPA 70.

B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Wiring devices shall be packaged and shipped to the project site to avoid damage.
B. Store in a clean, dry space in original manufacturer's packing to avoid condensation, dust, and other environmental contaminants until ready for installation.

1.08 SEQUENCE AND SCHEDULING:

A. Schedule installation of wiring devices and associated wall plates after the surface upon which they are installed has received the final finish.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Appleton, Emerson Electric Co.
B. Cooper, Crouse-Hinds, Division of Eaton.
C. Hubbell, Inc.
D. Leviton Manufacturing Co., Inc.
E. Pass & Seymour, Legrand North America, Inc.
F. Russellstoll, Thomas & Betts.
G. Woodhead, Molex.
H. Source Limitation: Wiring device and associated wall plate shall be supplied from a single manufacturer for each type of device for consistency throughout project.

2.02 RECEPTACLES:

A. General:
   1. All receptacles shall be heavy-duty type and shall bear a UL 498 label and comply with NEMA WD 1 and WD 6 as applicable.
   2. Provide all necessary wiring and accessories as required for complete installation.
B. Flush-Mounted and Surface-Mounted Receptacles:
   1. Rated 20A at 125Vac.
   2. Duplex, arc-resistant, back and side-wired, 3-wire grounding type. NEMA reference 5-20R.
   3. Receptacle and wall plates shall be as follows:
      a. Flush mounted white receptacle and grade stainless steel wall plate with matching screws in finished areas.
      b. Surface-mounted receptacles shall be white and have cast copper-free aluminum FS or FD single or multiple gang boxes with stainless steel cover plate.
   4. "Specification" grade type 5362, Fed. Spec. W-C-596 compliant, NEMA reference 5-20R.
   5. When indicated provide GFCI type as specified in this Section.
C. Ground Fault Circuit Interrupter (GFCI) Receptacles:
   1. Flush or surface mounted as indicated.
   2. Rated 20A at 125Vac, Fed. Spec. W-C-596.
   3. Back and side wired terminals with feed-through design.
      a. Terminal installation unless indicated otherwise.
   4. UL Standard 943 Class A, Group 1.
   5. Leakage current sensitivity: 5 mA ±1 mA.

a. Opens circuit within 25 milliseconds of reaching 5 mA.
6. Duplex, arc resistant and prewired.
7. Cover plate materials and colors shall match standard receptacles as specified this Section.
8. FD box.

D. Weatherproof Receptacles:
1. Flush or surface mounted as indicated.
2. Rated 20A at 125Vac, Fed. Spec. W-C-596. NEMA reference 5-20R.
3. GFCI receptacle as specified in this Section when indicated.
4. Provide a white receptacle with a cast aluminum weather-proof cover.
a. Provide while in use cover for outdoor locations in addition to locations indicated.
b. Provide hinged self-closing, gasketed type covers for indoor damp locations.
5. FS or FD boxes.
6. Locations as indicated.

2.03 SWITCHES:

A. General:
1. All switches and associated materials shall bear a UL 20 label and comply with NEMA WD 1.
2. Provide all necessary wiring and accessories as required for complete installation.

B. All single-pole, double-pole, three-way, and four-way switches as indicated.

C. Flush-Mounted, Tumbler, Self-Grounding, Heavy-Duty Switches:
1. Rated 20A at 120 or 277Vac.
2. Quiet type.
3. "Specification" grade, Fed. Spec. W-S-896.
4. White toggle and stainless-steel wall plate with matching screws.
5. Back and side wired design.
a. Screw terminal installation unless indicated otherwise.
6. With grounding lug.

D. Surface-Mounted, Tumbler, Self-Grounding, Heavy-Duty Switches:
1. Rated 20A at 120V or 277Vac.
2. "Specification" grade (Fed. Spec. W-S-896) switch with gray toggle.
3. FS and FD single or multiple gang cast boxes.
4. Cast aluminum cover plates and matching countersunk screws.
5. Locations indicated.

E. Weatherproof, Self-Grounding, Heavy-Duty Switches:
1. Rated 20A at 120V or 277Vac.
2. Gray toggle.
3. Flush or surface mounted as indicated.
4. FS or FD boxes with PVC gasketing.
5. "Specification" grade. Fed. Spec. W-S-896.
6. Lever-type, cast aluminum, gasketed cover plate.
a. Cooper, Crouse-Hinds No. DS185 or engineer approved equal.
7. Locations indicated.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. General:

1. Install wiring devices and accessories in accordance with manufacturer's written instructions, and in accordance with recognized industry practices.
2. Coordinate with other work, including painting, electrical boxes, and wiring installation.
3. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for wiring devices. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A-486B.
4. Install wiring devices only in electrical boxes which are clean - free from building materials, dirt, and debris.
5. Wiring devices shall not be installed in boxes until wire pulling is completed.
6. Painting work shall be completed prior to device wall plate installation.

B. Receptacles:
1. Provide in locations identified and as required by the NEC.
2. Mount receptacles outlets 1'-6" (450 mm) above floor, walkways, or finished grade unless indicated otherwise.
3. Provide GFCI receptacles in areas defined as damp or wet, and outdoor locations.

C. Switches:
1. Mount 4 feet (1.2 meters) above floor, walkways, or finished grade unless indicated otherwise.
2. Install close to trim on lock side when located near doors.

D. Wiring Circuits:
1. Home Run Groupings:
a. Group in home runs with not more than one conductor of each phase and 100% sized neutral and ground wire in one conduit.
b. Circuits which are protected by ground fault circuit interrupter (GFCI) devices shall use their own separate and isolated neutral between the GFCI device and load.
2. Use circuit numbers as indicated.
3. Refer to Specification 26 05 19 Low Voltage Conductors and Cables for lighting and receptacle circuits, unless indicated otherwise.
4. Do not install wire smaller than No. 12 AWG.
5. Install larger size wire as indicated or required to conform to requirement of NFPA 70 (NEC).
6. Install in concealed and exposed conduit systems as indicated.

3.02 PROTECTION:

A. Protect installed devices from damage.

B. Devices and wall plates that are damaged, stained, or painted shall be replaced prior to final acceptance.

3.03 FIELD QUALITY CONTROL:

A. Testing:
1. Prior to energizing circuits, test wiring for electrical continuity and for short-circuits. Ensure proper polarity of connections is maintained.
2. After circuits are energized, test wiring devices and demonstrate compliance with requirements.
a. Test each receptacle with a receptacle tester to ensure proper polarity.
b. Test ground fault circuit interrupters with the local test button and with a receptacle tester to simulate a remote ground fault.

END OF SECTION 26 27 26

SECTION 26 28 16 –ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies the enclosed switches or breakers including:
   1. Nonfusible switches.

1.03 RELATED REQUIREMENTS:

A. Refer to applicable Division 26 Sections for wires/cables, grounding, identification, electrical raceways, and boxes and fittings required in connection with enclosed controllers.
B. Section 26 00 00 – General Electrical Requirements
C. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
D. Section 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems.
E. Section 26 05 53 – Identification for Electrical Systems.
F. SECTION 26 05 73 - Electrical Studies

1.04 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 – Enclosures for Electrical Equipment (1,000V Maximum).
   2. NEMA KS 1 – Enclosed Switches.
B. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 200, 250, 430 and 702 as applicable to installation and construction of enclosed controllers.
C. Underwriters Laboratories (UL): Provide controllers and components which are UL-listed and labeled.
   1. UL 50 – Enclosures for Electrical Equipment.
   2. UL 50E - UL STANDARD FOR SAFETY Enclosures for Electrical Equipment, Environmental Considerations.
   3. UL 98 – Enclosed and Dead-Front Switches.
   4. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   5. UL 508 – Electric Industrial Control Equipment.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design for seismic bracing and anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."
C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Short Circuit study is to be submitted based on equipment intended to be provided. Study is to be approved prior to purchase orders for equipment being issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve selective coordination.

C. Product Data:
   1. Submit manufacturer's data and installation instructions for each type of enclosed switch, disconnect, breaker, component, and accessories.
   2. Enclosure Details.
   3. Current and Voltage ratings.
   4. Short circuit ratings.
   5. Proof of any NTRL testing and certification of the equipment for the services as specified.
   6. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
   7. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device. Provide in PDF format.

D. Shop Drawings: Submit Shop Drawings showing dimensions and weights.
   1. Show tabulations of the following:
      a. Each installed unit's type and details.
      b. Factory-installed devices.
      c. Nameplate legends.
   2. Wiring Diagrams: Submit power and control schematic and wiring diagram. Differentiate between portions of wiring which are manufacturer factory installed and portions which are field-installed.
   3. Field quality-control reports.
   4. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

E. Closeout Submittals:
   1. Information listed above.
   2. Operation and Maintenance Data: Include the following as minimum:
      a. “As-Built” drawings.
      b. Field quality-control reports.
      c. Warranty information.
      d. Routine maintenance requirements for enclosed controllers and installed components.
      e. Manufacturer's written instructions for testing and adjusting circuit breaker trip settings.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.

1.08 COORDINATION, SEQUENCING AND SCHEDULING:

A. Sequence equipment installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

B. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.09 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.

1.10 PERFORMANCE/DESIGN CRITERIA:

A. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.

1.11 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements,
   1. Eaton.
   2. ABB/General Electric.
   3. Siemens.
   4. Square D, Schneider Electric.

2.02 NONFUSIBLE SWITCHES

A. For use on circuits with available fault current less than 10kA.

B. For circuits with available fault current greater than 10kA, refer to paragraph FUSIBLE SWITCHES.

C. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

D. Accessories:
   1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
   2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   3. Service-Rated Switches: Labeled for use as service equipment.
   4. Hookstick Handle: Provide switches that allow use of hookstick to operate handle.
   5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 FUSIBLE SWITCHES

A. For use as identified on the Drawings, or on circuits with available fault current greater than 10kA.

B. Type HD, Heavy Duty, Three Pole, Single Throw, 600 V(ac), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
   1. Provide with clips or bolt pads to accommodate required fuses.
   2. Provide required fuses per Electrical Studies.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Service-Rated Switches: Labeled for use as service equipment.
5. Hookstick Handle: Allows use of hookstick to operate handle.

2.04 ENCLOSURES:

A. Provide NEMA rated enclosures as indicated on the Drawings.
B. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location. Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.
C. Enclosure Finish: Enclosure must be:
   1. Gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1).
   2. Gray baked enamel paint, electrodeposited on cleaned, phosphatized galvannealed steel (UL 50E Types 3R, 12).
   3. Brush finish on Type 304 stainless steel (UL 50E Type 4-4X stainless steel).
   4. Copper-free cast aluminum alloy (UL 50E Types 7, 9).
D. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
E. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
F. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
G. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
B. Proceed with installation only after unsatisfactory conditions have been corrected.
   1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.02 SELECTION OF ENCLOSURES

A. Refer to Specification 26 00 00 for material service requirements, environmental ratings & hazardous locations.

3.03 INSTALLATION

A. Comply with manufacturer's published instructions.

B. Special Techniques:

1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
3. Comply with mounting and anchoring requirements specified in SECTION 26 05 19.
4. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Provide required fuses per Electrical Studies.

3.04 IDENTIFICATION

A. Provide identification as specified in SECTION 26 05 53.

B. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in SECTION 26 05 53.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections for Switches:

1. Visual and Mechanical Inspection:
    a. Inspect physical and mechanical condition.
    b. Inspect anchorage, alignment, grounding, and clearances.
    c. Verify that unit is clean.
    d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
    e. Verify that each fuse has adequate mechanical support and contact integrity.
    f. Inspect bolted electrical connections for high resistance using one of the following methods:
        (1) Use low-resistance ohmmeter.
            (a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
        (2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
            (a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
    g. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
    h. Verify correct phase barrier installation.
    i. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
    a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.

b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."

B. Tests and Inspections for Molded-Case Circuit Breakers:
1. Visual and Mechanical Inspection:
a. Verify that equipment nameplate data are as described in the Specifications and shown on Drawings.
b. Inspect physical and mechanical condition.
c. Inspect anchorage, alignment, grounding, and clearances.
d. Verify that unit is clean.
e. Operate circuit breaker to ensure smooth operation.
f. Inspect bolted electrical connections for high resistance using one of the following methods:
(1) Use low-resistance ohmmeter.
(a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
(2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
(a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
g. Inspect operating mechanism, contacts, and chutes in unsealed units.
h. Perform adjustments for final protective device settings in accordance with coordination study.
2. Electrical Tests:
a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
c. Perform contact/pole resistance test. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
d. Perform insulation resistance tests on control wiring with respect to ground. Applied potential must be 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600

V rated cable. Test duration must be one minute. For units with solid state components, follow manufacturer's recommendation. Insulation resistance values may be no less than 2 M Ω.

e. Determine the following by primary current injection:
   (1) Long-time pickup and delay. Pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   (2) Short-time pickup and delay. Short-time pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   (3) Ground-fault pickup and time delay. Ground-fault pickup values must be as specified. Trip characteristics may not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   (4) Instantaneous pickup. Instantaneous pickup values must be as specified and within manufacturer's published tolerances.

f. Test functionality of trip unit by means of primary current injection. Pickup values and trip characteristics must be as specified and within manufacturer's published tolerances.

g. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data. Minimum pickup voltage of shunt trip and close coils must be as indicated by manufacturer.

h. Verify correct operation of auxiliary features such as trip and pickup indicators; zone interlocking; electrical close and trip operation; trip-free, anti-pump function; and trip unit battery condition. Reset trip logs and indicators. Investigate units that do not function as designed.

i. Verify operation of charging mechanism. Investigate units that do not function as designed.

3. Test and adjust controls, remote monitoring, and safeties.
   a. See Section 01 40 00 "Contractor QA/QC" for retesting and reinspecting requirements and Section 01 73 00 "Execution" for requirements for correcting the Work.

4. Infrared Scanning:
   a. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
   b. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   c. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
   d. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
   e. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

C. Nonconforming Work:
   1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
   2. Remove and replace defective units and retest.
D. Collect, assemble, and submit test and inspection reports.
   1. Test procedures used.
   2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
   3. List deficiencies detected, remedial action taken, and observations after remedial action.
   4. Manufacturer Services:
   5. On equipment rated 400A and higher, engage factory-authorized service representative to supervise and support field tests and inspections.

3.06 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
B. Set field-adjustable circuit-breaker trip ranges as determined by the Electrical Studies provided under Section 26 05 73 – Electrical Studies.

3.07 PROTECTION

A. After installation, protect enclosed switches and circuit breakers from construction activities. Remove and replace items that are contaminated, defaced, damaged, or otherwise caused to be unfit for use prior to acceptance by Owner.

3.08 MAINTENANCE

A. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
B. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
C. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
D. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 28 16

SECTION 26 29 00 –ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section specifies enclosures for motor controllers including:
   1. Contactors, push buttons, switches, indicating lights, relays, and additional motor controller and all necessary parts for a complete assembly.
   2. Network components mounted within the motor enclosure.

B. Coordination of motor horsepower, short circuit rating, VFD or starter size, including overload protection, as recommended by the final Short-Circuit, Coordination and Arc-Flash Hazard Analysis Studies.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 29 - Hangers and Supports for Electrical Systems
D. SECTION 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems
E. SECTION 26 05 53 - Identification for Electrical Systems
F. SECTION 26 05 73 - Electrical Studies
G. SECTION 26 29 13 - Manual and Magnetic Motor Controllers
H. SECTION 26 29 23 - Variable-Frequency Motor Controllers
I. SECTION 46 05 93 - Common Motor Requirements for Process Equipment

1.04 REFERENCE STANDARDS:

A. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 – Enclosures for Electrical Equipment (1,000V Maximum).
   2. NEMA AB 1 – Molded-Case Circuit Breakers.
   3. NEMA ICS 1 – General Standards for Industrial Control Systems.
   4. NEMA ICS 2 – Industrial Control Devices, Controllers, and Assemblies.
   5. NEMA ICS 3 – Industrial Systems.
   6. NEMA ICS 6 – Enclosures for Industrial Controls and Systems.
   7. NEMA KS 1 – Enclosed Switches.

B. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 200, 250, 430 and 702 as applicable to installation and construction of enclosed controllers.

C. Underwriters Laboratories (UL): Provide controllers and components which are UL-listed and labeled.
   1. UL 50 – Enclosures for Electrical Equipment.
   2. UL 98 – Enclosed and Dead-Front Switches.
   3. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   4. UL 489 – Molded Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
   5. UL 508 – Electric Industrial Control Equipment.

1.05 DEFINITIONS:

A. CPT: Control power transformer.
B. MCCB: Molded-case circuit breaker.
C. MCP: Motor circuit protector.
D. N.C.: Normally closed.
E. N.O.: Normally open.
F. OCPD: Overcurrent protective device.
G. SCR: Silicon-controlled rectifier.

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Short Circuit study is to be submitted based on equipment intended to be provided. Study is to be approved prior to purchase orders for equipment being issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve selective coordination.
C. Product Data: Submit manufacturer's data and installation instructions on motor controllers, contactors, push buttons, selector switches, indicating lights and relays.
D. Shop Drawings: Submit Shop Drawings of motor controllers showing dimensions and weights. Submit dimensional data on push buttons, selector switches, indicating lights and relays.
    1. Show tabulations of the following:
        a. Each installed unit's type and details.
        b. Factory-installed devices.
        c. Nameplate legends.
        d. Short-circuit current rating of integrated unit.
        e. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.
E. Wiring Diagrams: Submit power and control schematic and wiring diagrams for motor controllers and contactors. Differentiate between portions of wiring which are manufacturer factory installed and portions which are field-installed.
F. Field quality-control reports.
G. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.
H. Closeout Submittals:
    1. Information listed above.
    2. Operation and Maintenance Data: Include the following as minimum:
        a. “As-Built” drawings.
        b. Field quality-control reports.
        c. Warranty information.
        d. Routine maintenance requirements for enclosed controllers and installed components.
        e. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
        f. Manufacturer's written instructions for setting field-adjustable overload relays. Include installed and operating load current with list of settings.
        g. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

h. Infrared scanning report.

I. Maintenance Material Submittals:
   1. Spare Parts:
      a. One spare LED indicating lamps for each type and color used.
      b. One spare indicating light assembly.
      c. Ten spare power and control fuses of each voltage and current rating used.
   2. All parts supplied with the equipment shall be properly labeled for ease of identification and to permit the shortest possible time to repair.

1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING:
- A. Deliver Equipment and components properly packaged in factory-fabricated type containers.
- B. Store Equipment and components in original packaging and in a clean dry space; protect from weather and construction traffic.
- C. Handle Equipment and components carefully to avoid breakage, impact, denting, and scoring of finishes. Do not install damaged Equipment; replace and return damaged units to Equipment manufacturer.

1.08 COORDINATION, SEQUENCING AND SCHEDULING:
- A. Sequence equipment installation work with other work to minimize possibility of damage and soiling during remainder of construction period.
- B. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.09 QUALITY ASSURANCE:
- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
- A. Subject to compliance with requirements, provide motor controllers, contactors, push buttons, switches, indicating lights, and relays of one of the following:
   1. Allen-Bradley, Rockwell Automation, Inc.
   2. Eaton.
   3. Schneider Electric.
   4. Siemens.

2.02 VARIABLE FREQUENCY DRIVES
- A. Refer to SECTION 26 29 23.

2.03 CIRCUIT BREAKERS:
- A. Rated 480V, 3-phase, 60-hertz, with RMS Symmetrical interrupting rating meeting the requirements of feeding equipment.
- B. External handle which clearly indicates when breaker is "ON," "OFF," or "TRIPPED" and is lockable in the "OFF" position.
- C. Molded-case, manually-operated, 3-pole.

D. Trip-free from handle.
E. Inverse time thermal element overload protection.
F. Instantaneous magnetic short-circuit protection on all poles.
G. Provide neutral and grounding lug kit.
H. Shall comply with NEMA AB1 and UL 489.

2.04 ENCLOSURES:

A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
B. Unless otherwise indicated, provide enclosed controllers with the following NEMA enclosure ratings:
   1. NEMA 12 enclosures for interior finished areas and electrical rooms.
C. Serviceability:
   1. Front Access: The VFD system shall be designed for front access only.
   2. Power Component Accessibility: All power components in the converter sections shall be designed for easy removal and accessibility to minimize repair downtime.
   3. Marking/Labeling: Sleeve-type wire marker tags or other acceptable means of permanent identification shall be applied to power and control wiring. Individual nameplates shall be provided for all major components of the VFD system.

2.05 SAFETY SWITCHES:

A. Refer to SECTION 26 28 16.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment. Examine areas and surfaces to receive enclosed controllers, with Manufacturer Rep present, for compliance with requirements and other conditions affecting performance of the Work.
B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
C. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing enclosed controllers and shall be maintained for the remainder of the construction period.
D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall.
B. For controllers not at walls, provide freestanding racks complying with Section 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems.
C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
D. Comply with NECA 1.
E. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to

comply with tightening torques specified in UL Standard 468A and the National Electrical Code.

3.03 IDENTIFICATION:

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 26 05 53 – Identification for Electrical Systems.
   1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
   2. Label each enclosure with engraved nameplate.
   3. Label each enclosure-mounted control and pilot device.

3.04 GROUNDING:

A. Provide equipment grounding connections for motor controller and control equipment as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounding.
B. Grounding shall conform to Section 26 05 26 – Grounding and Bonding for Electrical Systems.

3.05 FIELD QUALITY CONTROL:

A. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
B. Tests and Inspections:
   1. Inspect controllers, wiring, components, connections, and equipment installation.
   2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
   3. Test continuity of each circuit.
   4. Check all equipment grounds for continuity.
   5. Remove all blocking used for shipments.
   6. Verify that voltages at controller locations are within ±10% of motor nameplate rated voltages. If outside this range for any motor, notify Engineer before starting the motor(s).
   7. Test each motor for proper phase rotation.
   8. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
   9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
   10. Infrared Scanning:
      a. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
      b. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      c. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.

d. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
e. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

11.

C. Enclosed controllers will be considered defective if they do not pass tests and inspections.
D. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.06 ADJUSTING AND CLEANING:

A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.
B. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable instantaneous trip elements. Initially adjust to six times the motor nameplate full-load ampere ratings and attempt to start motors several times, allowing for motor cooldown between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Engineer before increasing settings.
C. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.
D. Coordinate with Section 26 05 73 – Electrical Studies.

3.07 DEMONSTRATION:

A. Upon completion of installation of motor controller and control equipment and electrical circuitry, energize circuitry and demonstrate functioning of equipment in accordance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.
B. Engage a factory-authorized service representative to train Owner's maintenance personnel to use and reprogram microprocessor-based, reduced-voltage solid-state controllers.
C. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

END OF SECTION 26 29 00

SECTION 26 29 23 – VARIABLE FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes variable frequency drives (VFD) motor controller Work by this Contract.
B. Every variable frequency drive shall consist of all system components including the enclosures required to meet the performance, protection, safety, testing, and certification criteria of this specification.
C. The VFD system shall:
   1. Represent a fully integrated package. Any components not manufactured by the VFD manufacturer shall be purchased by the VFD manufacturer and supplied with the VFD.
   2. Include all material and labor necessary to interconnect any VFD system elements, even if shipped separately.
D. Any modifications to a standard product provided to meet this specification shall be performed by the VFD manufacturer only.
E. The VFD system shall be completely factory pre-wired, assembled and then tested as a complete package by the VFD manufacturer, to assure a properly coordinated, fully integrated drive system.
F. Any third-party certification, safety or protection requirements shall be applied to the VFD system as a whole. Certification or protection of system elements or individual components by themselves is not acceptable.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
C. SECTION 26 05 29 - Hangers and Supports for Electrical Systems
D. SECTION 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems
E. SECTION 26 05 53 - Identification for Electrical Systems
F. SECTION 26 05 73 - Electrical Studies
G. SECTION 26 24 19 - Motor Control Centers
H. SECTION 26 29 00 - Enclosed Controllers
I. SECTION 46 05 93 - Common Motor Requirements for Water and Wastewater Equipment

1.04 REFERENCE STANDARDS:

A. Provide equipment in full accordance with the latest applicable rules, regulations, and standards of:
   1. American National Standards Institute (ANSI).
   2. National Electrical Manufacturers Association (NEMA):
      a. NEMA MG1 – Motors and Generators.
   3. Institute of Electrical and Electronics Engineers (IEEE).
      a. IEEE 519: Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.
B. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC): Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC Articles 200, 250, 430 and 702 as applicable to installation and construction of enclosed controllers.

C. Underwriters Laboratories (UL): Provide controllers and components which are UL-listed and labeled.
   1. UL 508 – Electric Industrial Control Equipment.
   2. UL 60947-4-1, 3rd Ed. - Low-Voltage Switchgear and Control gear – Part 4-1: Contactors and Motor Starters – Electromechanical Contactors and Motor-Starters.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: For stand-alone equipment, design for seismic bracing and anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements, design criteria indicated, and related product information for equipment to be supplied.

B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
   1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, site conditions, environmental ratings & hazardous locations.

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Short Circuit study is to be submitted based on equipment intended to be provided. Study is to be approved prior to purchase orders for equipment being issued. Equipment where the specified short circuit current ratings are not sufficient shall be explicitly noted and recommendations shall be made to achieve selective coordination.

C. Product Data:
   1. Product specification datasheets.
      a. Dimensions and weights.
      b. Current and Voltage ratings.
      c. Short circuit ratings.
      d. Proof of any NTRL testing and certification of the equipment for the services as specified.
      e. Detail features, characteristics, ratings, and factory settings.
   2. Installation and operation instructions.

D. Shop Drawings: Submit Shop Drawings of motor controllers
   1. Serial number.
   2. Nameplate data.
   3. Wiring Diagrams: Submit power and control schematic and wiring diagrams for motor controllers and contactors. Differentiate between portions of wiring which are manufacturer factory installed and portions which are field installed.
   4. Factory Test Reports.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.

B. Complete instructions for handling and storage shall be provided by the manufacturer prior to delivery of the equipment. All equipment shall have adequate provisions for handling by overhead crane or forklift truck.

C. Equipment shall be stored according to the manufacturer’s instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.

1.08 QUALITY ASSURANCE:

A. Factory Tests:
   1. The manufacturer shall conduct tests according to industry standard requirements.
   2. Perform factory tests on all VFD assemblies to assure that all devices and systems are in proper working order before delivery to jobsite.
   3. Test all power, control and communication systems for proper operation.
   4. Simulate actual system operation.
   5. Submit test reports as specified in Division 01.

B. VFDs shall be manufactured, assembled, tested and provided with a UL label.

1.09 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Subject to compliance with requirements, provide VFDs of the following:
   1. Allen-Bradley, Rockwell Automation, Inc.
   2. Eaton.
   3. Schneider Electric.
   4. Siemens.

2.02 GENERAL:

A. Provide a Variable-frequency motor controller (VFD), consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of a three-phase induction motors by adjusting output voltage and frequency.

B. Capable of communication protocol and being controlled across the PCS network.

C. Motor Compatibility:
   1. Motor life expectancy shall not be compromised in any way by operation with the VFD system. The VFD shall provide motor overload protection in any operating condition.
   2. The VFD output waveform shall be suitable for operating a squirrel cage induction motor without derating or requiring additional service factor.
   3. The system design shall not have any inherent output harmonic resonance in the operating speed range.
   4. The VFD output shall produce no electrically-induced, pulsating torque to the output shaft of the mechanical system eliminating the possibility of exciting a resonance caused by VFD induced torque pulsations.
   5. The VFD shall protect the motor from high-voltage dv/dt stress which would cause insulation breakdown of an "inverter ready" motor. When shown on the drawings, or if the VFD requires an output filter to meet this requirement, it shall be an integral part of the VFD system and be included within the VFD enclosure.
      a. As a minimum, an output filter shall be provided for motor lead lengths longer than 100 feet.
   6. Motor Output Filter:
      a. The output filter shall be designed to eliminate reflective waves and convert the PWM wave form to a near sinusoidal wave form.

b. Shall eliminate torque ripple and voltage wave reflection.
c. Designed for use with a wide range of carrier frequencies from 2kHz to 12kHz.
d. Short Term Overload Rating for 200% of rated current for a minimum of 3 minutes.
e. Insulation System shall be Class R (220°C) as minimum.
f. Temperature Rise of 115°C.
g. Ambient temperature rating of 40°C enclosed panel or 50°C open panel.
h. Voltage Distortion < 5% (typical).
i. UL listed.

D. Contactors are required to remove passive filters from the line when the VFD is not in service.
E. All protective devices and breakers as specified.
F. Designed for heat dissipation.
G. UL listed enclosure.
H. All soft communication interface equipment.
I. Any third party certification, safety or protection requirements shall be applied to the Integrated Package as a whole. Certification or protection of only system elements or individual components by themselves is not acceptable.
J. The VFD system shall be delivered to the site pre-assembled and wired with all specified interconnecting wiring and cable.
K. Complete instructions for handling and storage shall be provided prior to delivery of the equipment. All equipment shall have adequate provisions for handling.
L. VFDs delivered before the installation location is prepared shall be stored according to the manufacturer's instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.
M. VFD construction:
1. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."
2. Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection for motors as specified in Section 46 05 93.
3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.
4. Microprocessor based and utilized Pulse Width Modulation (PWM) for speed control of an induction motor.
5. Insulated Gate Bipolar Transistors (IGBT's).
6. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.
7. Adjustable speed acceleration and current limits.

N. VFD Performance requirements:
1. Power Factor: not less than 95% from 30 to 115% speed.
2. Service factor: 1.15
3. The VFD shall be capable of producing a variable AC voltage/frequency output to provide continuous operation of a standard induction motor over a 5-100% speed range with the following operational requirements:
a. Output waveform shall be suitable for operating a squirrel cage induction motor without derating or requiring additional service factor.
b. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFD input voltage rating.
c. Input AC Voltage Unbalance: Not exceeding 5 percent.
d. Input Frequency Tolerance: Plus or minus 3 percent of VFD frequency rating.
e. Minimum Efficiency: 96 percent at 60 Hz, full load.

f. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
g. Minimum Short-Circuit Current (Withstand) Rating:As required to match feeding equipment rating.
h. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
i. Humidity Rating: Less than 95 percent (noncondensing).
j. Altitude Rating: as required by the Site Conditions.
k. Vibration Withstand: Comply with NEMA ICS 61800-2.
l. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
m. Speed Regulation: Plus, or minus 5 percent.

O. VFD & motor protection, include all controls necessary to indicate and alarm if a protection has tripped and which protection tripped:
1. Surge Suppression: Factory installed as an integral part of the VFD, complying with UL 1449 SPD, Type 1 or Type 2.
2. Surge Suppression: Field-mounted surge suppressors complying with Section 26 43 13 "Surge Protection for Low-Voltage Electrical Power Circuits," UL 1449 SPD, Type 2.
3. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
4. Under- and overvoltage trips.
5. Inverter overcurrent trips.
6. VFD and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFDs and motor thermal characteristics, and for providing VFD overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
7. Critical frequency rejection, with three selectable, adjustable dead bands.
8. Instantaneous line-to-line and line-to-ground overcurrent trips.
9. The VFD system shall be protected from damage due to the following, without requiring an output contactor:
a. Loss-of-power protection due to opening of the overcurrent protection device.
b. Loss-of-any-phase protection.
c. Reverse-phase protection.
d. Short-circuit protection.
e. Motor regeneration due to backspin or loss of VFD input power.
10. The VFD shall be able to withstand the following fault conditions without damage to the power circuit components:
a. Failure to connect a motor to the VFD output.
b. VFD output open circuit that may occur during operation.
11. Motor-overtemperature fault.
12. Control signals shall meet noise immunity and safety requirements as defined by IEEE 519.

P. Input Harmonics:
1. The harmonic mitigation devices shall limit the total harmonic voltage distortion at the point of common coupling to 5% and total demand (current) distortion (TDD) to the levels defined by the latest version of IEEE 519 with the following exception: The TDD shall not exceed 12% even when higher limits are allowed.
2. The point of common coupling shall be defined as the bus servicing the feeder breaker to the harmonic mitigation device.

3. The VFD shall contribute less than 3% total harmonic distortion to the power distribution equipment.
4. Power factor shall be 0.98 lagging to 0.95 leading in the operating range of 50-100% load.
5. The harmonic mitigation device shall not introduce reactive power (kVAR) in excess of 15% of its kVA rating.

Q. VFD programmable settings:
1. The VFD shall include programmable I/O for application specific configuration.
2. The drive shall be configurable to operate in a local and remote mode.
3. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.
4. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.
5. Bidirectional Autospeed Search: Capable of starting VFD into rotating loads spinning in either direction and returning motor to set speed in proper direction, without causing damage to drive, motor, or load.
6. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.
7. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
8. Integral Input Disconnecting Means and OCPD: UL 489, thermal-magnetic circuit breaker with pad-lockable, door-mounted handle mechanism. Rated not less than 115% of VFD current rating.
9. Fault log data shall be stored in nonvolatile memory.
10. A "FAULT LOG" shall record, store, and display upon demand, a minimum of the last four fault events.
11. The drive shall provide for the following programmable input/output points configured as indicated:
    a. Six digital inputs.
    b. Two digital outputs, Form C Relay (Dry Contract rated a minimum of 2 Amps at 120 Vac);
    c. One analog input 4-20 mA isolated signal.
    d. One analog output 4-20 mA isolated signal.
12. All programming shall initially be performed at the factory and tested at the factory. Specific requirements for the starting and stopping sequences shall be as indicated.
13. The VFD shall be capable of implementing a speed control PID loop to maintain a setpoint as indicated.
14. The VFD shall be provided with a communication card capable of communicating on a PCS network.
    a. All control functions including start/stop and speed control shall be available via the network.
15. All status and monitored input points shall be available via the network.

R. Sound Level: Maximum allowable audible noise from the VFD system will be 80 dBA at a distance of one meter (3.3 ft) at any speed or load condition. VFD systems with audible noise

in excess of this limit shall be provided with sufficient noise abatement treatment to reduce the sound pressure level below 80 dBA.

2.03 ENCLOSURES:

A. Refer to SECTION 26 24 19 for motor controllers installed in MCCs.
B. Refer to SECTION 26 29 00 for motor controllers installed in freestanding enclosures.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install to conform to manufacturer's instructions.
B. Completely install as specified, indicated, or required for operation and continuous service at the locations indicated.

3.02 FIELD QUALITY CONTROL:

A. Manufacturer’s Field Services:
   1. Manufacturer's field service shall be provided as specified in this Section and in Division 01.
   2. Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
   3. VFD system manufacturer shall provide the field services of a factory technician for a minimum of 2 day(s) on 2 separate occasions total of 4 day(s) and 2 trips to supervise/inspect installation, test and start-up all equipment provided. All travel and living expenses shall be included. All equipment required for testing, start-up and performance verification shall be provided by the start-up technician.
   4. Assist the Owner in the setup and configuration of the motor controller on the SCADA or communications network.

END OF SECTION 26 29 23

SECTION 26 32 13 – ENGINE GENERATOR SETS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section shall consist of providing a packaged standby emergency generator set with resistive load bank, and associated controls with all required accessories as specified and shown on the plans. The equipment supplier must be the authorized distributor for each component of the products specified herein. The Work includes the furnishing of all labor, materials, equipment, test, and training to provide a complete and operational power system as shown on the plans, drawings, and specifications herein.

B. The power system shall be furnished by a single manufacturer who shall be responsible for the design, coordination, and testing of the complete system.

C. The equipment shall be produced by a manufacturer who has produced this type of equipment for a period of at least five years and who maintains a service organization available twenty-four hours a day throughout the year.

D. The complete packaged electrical system shall meet all requirements of the State of Colorado, city, and local codes, especially pertaining to emissions and fuel storage/delivery/ shutoff/monitoring systems.

1.03 RELATED REQUIREMENTS:

A. Section 03 30 00 – Concrete
B. Section 26 24 16 – Panelboards.
C. Section 40 61 96 – Process Control System Programming and Reports
D. Section 40 66 00 – Process Control Networks

1.04 REFERENCE STANDARDS:

A. National Fire Protection Association (NFPA):
   1. NFPA 30 – Flammable and Combustible Liquids.
   2. NFPA 37 – Standard for the Installation and Use of Stationary combustion Engines and Gas Turbines.
   3. NFPA 70 – National Electrical Code. Equipment shall be suitable for use in systems in compliance to Article 700, 701, and 702.
   4. NFPA 110 – Emergency and Standby Power Systems. (The generator set shall meet all requirements for Level 2 systems.)

B. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 3003.1 – Recommended Practice for System Grounding of Industrial and Commercial Power Systems

C. Underwriters' Laboratories, Inc. (UL):
   1. UL 486A – Wire Connectors and Soldering Lugs for Use with Copper Conductors.
   2. UL 2200 – Stationary Engine Generator Assemblies.

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA MG 1 – Motors and Generators.
   2. NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
   3. NEMA 250 – Enclosures for Electrical Equipment (1000V Maximum)

E. Military Standards (MIL):

1. MIL-STD-461F – Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment.

F. International Organization for Standardization (ISO)/International Electrotechnical Commission (IEC):
1. ISO 8528 part 4 – Control Systems for Generator Sets.

1.05 PERFORMANCE REQUIREMENTS:

A. Delegated Design: Design for seismic anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

C. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, site conditions, environmental ratings & hazardous locations.

D. Generator Sizing – Load Steps
1. Load Steps indicated for each generator set below shall be based on the pump motors and roof top units provided. Contractor to coordinate generator manufacturer and other vendors to ensure final generator sizing is adequate. Total generator load to not exceed 80% of the site rated capacity taking into account altitude, and ambient air conditions; max voltage dip not to exceed 10%, and max frequency dip not to exceed 5%. Generator sizes to be no smaller than indicated on the one-line diagrams.
2. Coordinate load steps with Section 40 61 96 to ensure PLC programming does not attempt startup
3. Potable Water Pump Station
   a. Step 1
      (1) LP1 & PP1
      (2) RTU-181 & RTU-182
   b. Step 2
      (1) Lead Pump (ie. PMP-101)
   c. Step 3
      (1) Lag Pump (i.e. PMP-102)
   d. Step 4
      (1) Lag2 Pump (i.e. PMP-103)
   e. Step 5
      (1) MXR-105 & MR-106
4. Reuse Water Pump Station
   a. Step 1
      (1) LP2 & PP2
      (2) RTU-281 & RTU-282
   b. Step 2
      (1) Lead Pump (i.e. PMP-201)
   c. Step 3
      (1) Lag Pump (i.e. PMP-202)
   d. Step 4
      (1) MXR-205

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Product Data: Submit for each type of product specified and included, with the following as minimum:
   1. Submit manufacturer's data on engine-driven generator set and components.
   2. Manufacturer's warranty.
   3. Submit application for Service Agreement with annual cost to Owner from Manufacturer for on-site service and maintenance (Owner may accept or decline such Service Agreement).
   4. Verification that complete packaged electrical system shall meet all requirements of the state, city, and local codes where the project is located.

C. Shop Drawings: Provide the following as minimum.
   1. Submit dimensioned drawings indicating weights, combustion air requirements, cooling air requirements, heat rejection rate, fuel consumption, noise criteria, field connection points, and nameplate data.
   2. Provide lifting requirements for setting equipment in place.
   3. Submit wiring diagrams for all power and control interconnect wiring. Complete drawing and wiring diagrams including, but not limited to, showing coordination and connections between the following:
      a. Engine generator.
      b. Generator control panel.
      c. Automatic starting controls.
      d. Resistive load bank.
      e. All auxiliaries.
   4. Certifications.

D. Factory Test Report, where required by this Specification.

E. Special Procedure Submittals:
   1. Start-up and commissioning instructions.
   2. Syllabus for Owner training.

F. Test and Evaluation Reports:
   1. Provide generator test records of the following final production tests:
      a. Single step load pickup.
      b. Transient and steady-state governing.
      c. Safety shutdown device testing.
      d. Voltage regulation.
      e. Rated power.
      f. Maximum power.

G. Closeout Submittals: Final documentation shall include the following as minimum:
   1. Operation and Maintenance Manuals including the following:
      a. Operation and maintenance manuals for the generator, engine, and all auxiliary components furnished.
      b. Certified "As-Built" drawings of all equipment and interconnecting diagrams.
      c. Copies of all approved Product Data.
      d. Copies of all approved Commissioning and Test Reports.
      e. Recommended preventive maintenance (PM) service and schedules.
      f. Spare parts and supply list with supplier names and part numbers.
      g. Warranty Information.
      h. Manufacturer's service and repair support during and after warranty including contact information.

i. Training Materials. Includes final edited training videos.

H. Maintenance Material Submittals:
1. Spare Parts:
a. Two complete sets of oil, air and fuel filters.
b. One quart of touch-up paint of each paint color used.
c. Two spare sets of fuses of each type and rating.
d. One set of special engine tools, if applicable.

1.07 QUALITY ASSURANCE:

A. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's standard design that has been in satisfactory use for at least one year prior to Bid opening.
B. Manufacturer must manufacture either the engine or the alternator.
C. Factory Tests of the generator shall include, but not limited to, the following:
1. Maximum power (kW).
2. Maximum motor starting (kVA) at 35% instantaneous voltage dip.
3. Alternator temperature rise by embedded thermocouple and/or by resistance method per NEMA MG1-32.40.
4. Governor speed regulation under steady-state and transient conditions.
5. Voltage regulation and generator transient response.
6. Harmonic analysis, voltage waveform deviation, and telephone influence factor.
7. Three-phase short circuit tests.
8. Alternator cooling air flow.
9. Fuel consumption at 100%, 75%, 50%, and 25%.
10. Overall engine-generator set efficiency.
11. Torsional analysis to verify that the generator set is free of harmful torsional stresses.
D. Factory Tests of the load bank shall include, but not be limited to, the following:
1. Maximum power usage (kW).
2. Resistive load elements.
3. Exhaust air flow.
4. Operational.
E. The complete packaged electrical system shall be UL 2200 listed and shall be provided with UL listed components.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Deliver the engine-driven generator and load bank properly packaged and mounted on skids to facilitate handling. Utilize factory-fabricated type containers or wrappings for protection of equipment.
B. Store diesel engine-driven generator equipment in original packaging and protect from weather and construction traffic. Store indoors when possible; where necessary to store outdoors, store above grade and enclose with watertight wrapping.
C. Handle diesel engine-driven generator equipment carefully to prevent physical damage to equipment and components. Do not install damaged equipment; remove from site and replace damaged equipment with new.
D. Provide lifting information for setting gen-set in place to include lifting points, center-of-gravity, etc. Identify lifting items needed including crane capacity, spreader bars needed, special rigging, etc.

1.09 WARRANTY:

A. All equipment furnished under this section shall be warranted by the contractor and the equipment manufacturer(s) for a minimum period of one year after completion of startup.
B. The manufacturer and its distributor of the packaged standby power system shall maintain a 24-hour parts and service organization. This organization shall be regularly engaged in a maintenance contract program to perform preventive maintenance and service on equipment similar to that specified.
C. Warranty shall include all parts, labor, and expenses to perform necessary work.
D. Other requirements as specified in Division 01.

1.10 MAINTENANCE:

A. All maintenance materials supplied with the equipment shall be properly labeled for ease of identification and to permit the shortest possible time to repair.
B. Any parts that come from a sub-supplier shall be labeled with that manufacturer's name and part number.
C. Manufacturer shall state closest point where spare parts are stocked and where service can be obtained.
D. Manufacturer shall warrant that all parts shall be available for a minimum of ten years.
E. Maximum response time for trouble calls shall be two hours.
F. A qualified service technician shall be onsite within twenty-four hours of a qualified request.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Caterpillar, Inc.
    1. 1250kW (Basis of Design)
        a. Model C32 V-12, 4 cycle water-cooled.
            (1) Generator Frame: 1445
            (2) Generator Arrangement: 5852024
            (3) Excitation Type: Permanent Magnet
    2. 400kW (Basis of Design)
        a. Model C15 ACERT in-line 6, 4 cycle.
            (1) Generator Frame: LC6124B
            (2) Generator Arrangement: 4183879
            (3) Excitation Type: AREP
B. Kohler Power, Kohler Co.

2.02 EQUIPMENT:

A. Generator Set: The generator system shall be completely self-contained and integrally assembled, with the engine, generator, exciter, control panel, muffler, battery, battery charger, water jacket heater, main circuit breakers, 50% resistive load bank, service panel, convenience duplex GFCI receptacle, intake air cleaner, radiator and fan and all necessary parts shall be mounted on a steel skid on vibration isolator and shall be housed in a weather protective and sound attenuated enclosure. The complete packaged standby power system shall include the engine-generator set and other necessary parts for a complete functioning system. The generator system shall meet or exceed EPA tier emission levels based on its size and use.
    1. 1250kW
        a. Caterpillar model C32 V-12, 4 cycle water-cooled used in bases of design.
            (1) Generator Frame: 1445

(2) Generator Arrangement: 5852024
(3) Excitation Type: Permanent Magnet

2. 400kW
   a. Caterpillar model C15 ACERT in-line 6, 4 cycle used in bases of design.
      (1) Generator Frame: LC6124B
      (2) Generator Arrangement: 4183879
      (3) Excitation Type: AREP

B. Resistive Load Bank: The 50% resistive load bank system shall be installed within the generator enclosure with separate and isolated control and power components. The resistance load bank shall include self-contained load and control system tied into the generator controls enabling the load bank controls to modulate the load bank as the supplied load changes.

C. The engine generator enclosure shall be provided with anchors, supports and bracing that will meet the local seismic zone rating when installed per the manufacturer's instructions.

2.03 ENGINE:

A. General:
   1. Four-stroke cycle, water-cooled diesel engine.
   2. Maximum operating speed of 1,800 rpm.
   3. Operate on No. 2 diesel fuel.
   4. 24V dc starting.
   5. Suitable for standby duty operation at nameplate rating.

B. Fuel System:
   1. No. 2 diesel fuel.
   2. A UL listed double wall subbase fuel tank with the capacity of 36 hours of operation at 100% of rated load. Provide all required tank openings. An interstitial tank leak alarm system shall be provided to detect fuel tank rupture.
      a. The tank leak alarm shall be provided with a dry contact for remote monitoring. The dry contact shall be rated for a minimum 3A at 120Vac operation and shall be factory wired to the generator control panel.
   3. The fuel system shall be provided with primary and secondary fuel filters, water separator, fuel priming pump, fuel pressure gauge, low fuel level alarm, flexible fuel lines, pressure relief vent, and electric and manual shutoff valves.
      a. The LOW and LOW-LOW fuel level alarm shall be provided with dry contacts for remote monitoring. Dry contacts shall be rated for a minimum of 3A at 120Vac operation and shall be factory wired to the generator control panel.
   4. Provide fuel level transmitter for the fuel tank factory wired to the generator control panel.
      a. The fuel level system shall provide a 4-20mA signal proportional to fuel level for remote monitoring.
   5. All fuel train components shall be engine mounted and piped.
   6. Fuel tank fill nozzle shall be located on appropriate side of unit for easy access for filling. Coordinate with site location to determine fill nozzle location.
   7. Fuel tank and system shall meet all requirements of the state, city, and local codes where the project is located.

C. Muffler:
   1. The engine exhaust silencer shall be a critical-grade type with a tailpipe and rain cap provided. The silencer shall be coated to be temperature and rust resistance for outdoor application.

2. Gas-proof, seamless, stainless steel, flexible exhaust bellows with threaded NPT or flange connection as necessary.
3. Refer to weatherproof enclosure paragraph below for sound requirements of the complete package.

D. Battery and Battery Charger:
1. 24Vdc lead-acid type storage battery, sized for ten cycles of 15-second cranking with engine at 0° ambient temperature.
2. Filled with proper quantity of electrolyte and fully charged at time of installation.
3. Battery system shall be provided with a disconnect switch.
4. Battery rack and battery cables, capable of holding the manufacturer's recommended batteries, shall be supplied.
5. Provide an automatic float and equalize battery charger with ±1% constant voltage regulation from no load to full load over ±10% AC input line variation, current limited during engine cranking and short circuit conditions, temperature compensated for ambient temperatures from -40°C to +60°C, 5% accurate voltmeter and ammeter, fused, reverse polarity and transient protected.
6. Battery charger shall operate from 120Vac, 60-hertz supply from the generator service panel and shall be capable of fully charging batteries within 24 hours.
7. The battery and battery charger shall be housed in the weather protective generator set enclosure.
8. Battery charger shall be provided with a dry contact for common alarm for remote monitoring. The dry contact shall be rated for 3A at 120Vac operation and shall be wired to the generator control panel.
9. Interlock preventing automatic restart attempts for the following shutdown conditions:
   a. Low lube oil pressure.
   b. High coolant temperature.
   c. Failure to start.

E. Cooling System:
1. High-temperature, 50 Deg. C radiator.
2. Thermostatically controlled water jacket heater for 208 - 240Vac operation to maintain 140°F minimum jacket water during idle periods.
3. Extended life coolant shall be provided to completely fill the radiator tank at the installation site.
4. Low coolant level alarm.
5. Unit mounted radiator with guard and duct flange.
6. Coolant drain line with valve.
7. Fan and belt guards.

F. Air inlet:
1. Air cleaner restriction indicator to indicate the need for maintenance.
2. Heavy-duty single element canister type air cleaner.
3. Air inlet louvers and baffles shall be designed to reduce rain and snow entry.

G. Lube:
1. Lubricating oil and filter.
2. Oil drain line with valves.
3. Lube oil pump, if required.

H. Governor:
1. Electronic isochronous type.

2.04 GENERATOR:

A. Alternator:
   1. Full standby kW rating as indicated on the plans at 0.8 power factor.
   2. 480/277 Vac wye, 3-phase, 4-wire, 60-hertz, 1,800-rpm operation.
   3. Salient-pole, brushless, self-ventilated, drip-proof construction with amortisseur rotor windings and skewed stator for smooth voltage waveform.
   4. The insulation shall meet the NEMA standard for Class H.
   5. Class F temperature rise of 105°C above 40°C ambient.
   6. Winding and bearing temperature detectors to sense high temperature in windings and bearings.
   7. Complete with a main circuit breaker, voltage regulation, control panel, and excitation system.
   8. Provide segregated low voltage accessory boxes for AC/DC. Separate boxes for generator AC output, low voltage AC auxiliary power and control wiring, and DC wiring. Provide single point access to accessory connections.
   9. Condensate strip heater to prevent the accumulation of moisture for dampness in the generator windings.
   10. Harmonic distortion of less than 5%.
   11. Overspeed capability of not less than 125%.

B. Excitation:
   1. Permanent magnet.

C. Voltage Regulation:
   1. Digital voltage regulator, 3-phase sensing, selectable voltage range, and volts/hertz.
   2. Accuracy of less than 1% no-load to full-load and less than 0.5% at steady-state.

D. Main Circuit Breaker:
   1. Insulated or molded case type, generator mounted.
   2. Provide with microprocessor based digital unit with breaker rating as required by manufacturer. The digital trip unit shall have the following features: long-time pickup, long-time delay, short-time pickup, short-time delay, and ground fault alarm. Provide arc energy reduction for trip units rated larger than 1200A.
   3. Provide breaker position and status contacts wired to the generator control panel for remote annunciation. Positions shall include the following:
      a. Closed.
      b. Open.
      c. Tripped.

E. Control Panel:
   1. Environment:
      a. -40°C to +70°C operating temperature range.
      b. 5-95% humidity, non-condensing.
   2. Unit mounted controller mounted on vibration isolators.
   3. The controller shall be rated for outdoor installation.
   4. Configured for 2-wire start/stop remote control (remote contact operation) from an automatic transfer scheme.
   5. Control panel shall include as minimum:
      a. Automatic start/stop operation.
      b. Adjustable cycle cranking.
      c. Digital ac metering with phase selector switch.
      d. Digital engine monitoring.
      e. Shutdown sensors and alarms with horn and reset.

f. Adjustable cool-down timer.
g. Local emergency stop push-button.
h. Lamp test.
i. Voltage control.

6. Control panel shall include as minimum the following displays:
   a. Engine oil pressure.
   b. Coolant temperature.
   c. Engine rpm.
   d. System dc volts.
   e. Engine running hours.
   f. Generator ac volts.
   g. Generator ac amps.
   h. kW meter.
   i. Percentage of rated power.
   j. kVA meter.
   k. kVAR meter.
   l. Power factor meter.
   m. kWhr meter.
   n. Frequency.
   o. Fuel Level.
7. Control panel shall provide the following indications for protection and diagnostics:
   a. Low oil pressure.
   b. High coolant temperature.
   c. Low coolant level.
   d. Overspeed.
   e. Overcrank.
   f. Emergency stop shutdown.
   g. Approaching high coolant temperature.
   h. Approaching low oil pressure.
   i. Low coolant temperature.
   j. Low dc voltage.
   k. Control switch not in Auto.
   l. Low fuel level.
   m. Battery charger ac fail.
   n. High battery voltage.
   o. EPS supplying load.
   p. Spare.
8. Control panel shall have programmable protective relay functions to include the following:
   a. High and low battery voltage.
   b. Under- and over-voltage.
   c. Under- and over-frequency.
   d. Overspeed.
   e. Reverse power.
9. Adjustable Time Delay Settings:
   a. Generator set run time (0 to 72 hours) - exercise.
   b. Time delay for engine start. Adjustment range, 0-5 minutes in one second increments.

c. Time delay engine cool-down. Adjustment range, 0-10 minutes in one second increments.
d. Cyclic cranking that allows up to six crank cycles and up to 45 seconds of crank time per crank cycle.
e. Over and under voltage delays.
f. Crank on and crank pause time.
g. Idle time.
h. High and low battery voltage trip point.

10. Shall accommodate remote mounted emergency shutdown push button.
11. Provide generator run relay, common warning, and common failure relays.
    a. The common failure relay shall monitor auxiliary faults, emergency stop, high engine temperature, low oil pressure, overcrank, and overspeed.
    b. Dry output contacts from these relays will be used for remote alarm.
    c. The following minimum status contacts shall be provided and wired through the main generator control panel for field connection.
        (1) Generator Control Panel – In Auto Mode.
        (2) Run Status.
        (3) Common Warning Alarm.
        (4) Common Shutdown/Failure Alarm.
        (5) Low Fuel Level Alarm.
        (6) Fuel Leak Alarm.
        (7) Generator Circuit Breaker Open.
        (8) Generator Circuit Breaker Closed.
        (9) Generator Circuit Breaker Tripped.
12. Refer to Section 40 66 00 and provide a managed network switch to allow SCADA connection to the following:
    a. Engine control panel.
    b. The resistive load bank automatic load controller.

2.05 WEATHERPROOF ENCLOSURE:

A. The weatherproof walk-in style housing shall be as follows:
    1. Sound attenuated with the maximum sound level of 68 dBA at 7 meters when operating at full load.
    2. Constructed of heavy-gauge steel, cleaned and powder-baked painted inside and out. Provide with the manufacturer's standard color.
    3. The complete exhaust system shall be internal to the enclosure.
    4. The radiator shall be ducted to the enclosure air outlet on the top to prevent air recirculation within the enclosure.
    5. The roof shall be pitched to prevent the accumulation of water.
    6. Enclosure shall be designed for local wind and snow loading requirements.
    7. The personnel doors shall be double-wide and located on either side of the enclosure.
    8. All hinges, latches, and recessed door handles shall be stainless steel and lockable.
    9. A permanent aluminum staircase with landing shall be provided at the main access door for ease of access into the generator enclosure.
    10. Provide interior lights and receptacles wired to the service panel. Provide LED strip lighting fixtures for normal operation and emergency driver units installed within the LED strip fixtures for emergency lighting. Provide light switches at each door.
    11. Provide enclosure ventilation with exhaust fan(s) and thermostats sized for ambient conditions to maintain internal temperature below component ratings.

12. Include grated, elevated platform for personnel entrance into the generator enclosure.

2.06 SERVICE PANEL:

A. Provide a 208/120Vac, single-phase, 60A, NEMA 3R electrical panel with the engine-generator set. The panel shall be unit mounted on the engine-generator set inside the weather protective sound attenuating enclosure. All auxiliary loads such as fuel immersion heater, water jacket heater, battery charger, generator condensate strip heater, convenience duplex GFCI receptacles, etc. The service panel shall be the means of single point connection to service all auxiliary loads mounted on the engine-generator set.

B. Shall consist of a 60A main molded-case circuit breaker, required number of branch circuit breakers, and 10% spare.

C. All wiring to the auxiliary loads shall be factory wired with copper wires and shall be sized and installed in accordance with the National Electrical Code.

D. The panel directory shall be provided and each load served shall be clearly marked on the panel directory.

2.07 AUTOMATIC TRANSFER CONTROLS:

A. The automatic transfer control system shall be as specified in Section 26 24 13 – Switchboards.

2.08 ACCESSORIES:

A. Provide a NEMA 4X remote push button station with red mushroom head push button for generator emergency stop. The push button shall be provided with a legend "Genset Emergency Stop". Locate on generator exterior.

B. Required amount of lube oil for initial fill.

C. Required amount of coolant for initial fill.

D. Full tank of diesel fuel for initial fill.

E. Vibration isolators for base skid mounting.

F. One set of special engine tools, if applicable.

2.09 FACTORY TEST

A. For generator sets larger than 1000kW perform factory test. Provide certified test results.

B. A 4-hour load bank test shall be performed under resistive load at 100 percent of the standby kW rating of the system. Provide required fuel.

C. Recorded generator operating parameters shall include:

1. Line-to-line voltage.
2. Line-to-neutral voltage.
3. Power factor.
4. Amperes.
5. kW.
6. kVA.
7. Frequency.
8. Phase rotation.
9. Engine temperature.
10. Oil pressure.
11. Battery charge level.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment.
B. Examine areas and conditions under which the engine-generator equipment is to be installed. Direct the vertical airflow of exhaust hot air above level of personnel and away from buildings.
C. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. Install diesel engine-driven generator units at location(s) indicated.
B. Install in accordance with the equipment manufacturer's written instructions, and with guidance from recognized industry practices, to ensure that engine-generator units fulfill requirements. Comply with NFPA, NEC, and NEMA standards pertaining to installation of engine-generator sets and accessories.
C. Coordinate with other work, including raceways, electrical boxes, fittings, fuel tanks, piping, and accessories, as necessary to interface installation of engine-generator equipment work with other work.
D. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and the National Electrical Code.
E. Install as indicated on concrete pad as shown on the Drawings. Final pad dimensions shall be coordinated with equipment supplied.
F. Anchor skids as recommended by the generator set manufacturer.
G. Connect all electrical and fuel connections as required.
H. Install units on vibration isolators in accordance with the manufacturer's instructions.
I. Fill all tanks (coolant, lubricants, diesel, etc.) to full with approved fluids. Refer to Field Testing paragraph, in this Section, for all required fuel during start up and refilling of the fuel tank after all tests are complete.
J. Make all necessary adjustments to ensure manufacturer’s recommended tolerances are met.
K. Ground the skid base as shown on the drawings.
L. Supply field power to the generator service panel as specified and indicated. All skid mounted equipment shall be rated for a 208/120 power supply.

3.03 FIELD QUALITY CONTROL:

A. Manufacturer’s Field Services:
    1. Manufacturer's field service shall be provided as specified in this Section and in Division 01.
    2. Engage manufacturer’s service technician to perform start-up services upon completion of installation and with Engineer in attendance.
B. Field Testing:
    1. Check fuel, lubricating oil, and antifreeze for conformity to manufacturer’s recommendations under site environmental conditions.
    2. Verify operational status of engine water jacket heaters, battery charger, and other auxiliaries.
    3. Perform “start-up” tests as recommended by manufacturer.
    4. Check for exhaust leaks, path of exhaust gases outside the enclosure, cooling air flow, motorized louver operation, movement during starting and stopping and vibration during running.

5. Recorded generator operating parameters shall include:
   a. Line-to-line voltage.
   b. Line-to-neutral voltage.
   c. Power factor.
   d. Amperes.
   e. kW.
   f. kVA.
   g. Frequency.
   h. Phase rotation.
   i. Engine temperature.
   j. Oil pressure.
   k. Battery charge level.
6. Verify generator is operational using the automatic transfer controls. Simulate power outage to verify proper start-up and transfer from normal utility power to generator power and retransfer from generator power to utility power.
7. After installation a 4-hour test shall be performed under facility load and supplemented with installed load bank as required to achieve 100 percent of the standby kW rating of the system.
8. Perform the engine generator acceptance testing as specified in NFPA 110 (7.13) and submit the final results of the acceptance testing to Engineer for review for compliance.
9. Provide all required fuel (coolant, lubricants, diesel, etc.) for start-up. Refill the fuel tank to full level after the completion of start-up.

3.04 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
   1. Touch Up:
      a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
      b. Field painting shall be performed based on manufacturer's recommended procedures.
      c. Manufacturer shall furnish Contractor with an adequate quantity of touch-up paint to match the factory applied finish.

3.05 TRAINING:

A. The system supplier shall provide a minimum of one day of training at the customer's facility for operations, maintenance and service personnel.
B. The training shall be performed after successful completion of a demonstration of operation of the equipment by the manufacturer and acceptance by the customer,
C. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, faults, diagnostic tools, troubleshooting, and preventive maintenance for engine-generator and battery systems.
D. Hands-on training shall be provided on equipment.
E. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.

F. The Owner at their option shall be allowed to video record all training sessions for future reference.
G. Contractor shall record the training sessions and provide a final edited version to the Owner on a DVD-ROM and electronic video file format.

END OF SECTION 26 32 13

SECTION 26 33 53 – STATIC UNINTERRUPTIBLE POWER SUPPLY

GENERAL

1.01 SUMMARY:

A. This Section specifies Uninterruptible Power Supply (UPS) systems and associated accessories.
B. Provide UPS units and accessories as specified.

1.02 RELATED REQUIREMENTS:

A. Section 26 24 13 - Switchboards
B. Section 26 24 19 - Motor Control Centers
C. Section 40 66 00 - Process Control Networks
D. Section 40 67 00 - Process Control Panels and Hardware.

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents.
B. The seller shall furnish Equipment which conforms in all respects to applicable industry standards and sound engineering practice.
C. Design, fabricate, assemble, install and test Equipment to conform to the applicable standards specified herein.
D. National Fire Protection Association (NFPA):
    1. NFPA 70 – National Electrical Code.
E. Institute of Electrical and Electronics Engineers (IEEE):
    1. IEEE C62.41 – Surge Voltages in Low-Voltage AC Power Circuits.
    2. IEEE C62.41.1 – Surge Environment in Low-Voltage (1000 Volts and less) AC Power Circuits.
    3. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000 Volts and less) AC Power Circuits.
    4. IEEE 519 – Harmonic Control in Electric Power Systems.
    5. IEEE 944 – Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Stations.
F. Code of Federal Regulations (CFR), Federal Communications Commission (FCC):
    1. 47 CFR - FCC Part 15, Subpart J, Class A.
G. Underwriters Laboratories (UL).
    1. UL 1449 – Surge Protective Devices.
    2. UL 1778 – Uninterruptible Power Supply Equipment.
H. British Standards Institute
    1. BS EN 50160 - Voltage characteristics of electricity supplied by public electricity networks.

1.04 SUBMITTALS:

A. Submit in accordance with Division 01.
B. Product Data:
    1. Device list and bills of material.
    2. Specification data sheets for all hardware and software.

1.05 QUALITY ASSURANCE:

A. All Equipment and Material furnished shall have an acceptable history of satisfactory reliable service in similar use for a period of at least two years.

B. Equivalent newly developed Equipment with less than two years actual service will be considered from established manufacturers if it has been adequately tested, meets the requirements of this Contract, and is approved by Contractor. Such Equipment shall be noted in the proposal for review.
C. Factory Tests:
   1. Perform factory tests on complete system to verify proper operation before delivery to jobsite.

1.06 SITE CONDITIONS:
A. All Equipment provided as part of this system shall be rated for the temperature, seismic and elevations as specified in the Site Conditions in Section 26 00 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:
A. Uninterruptible Power System (UPS):
   1. American Power Conversion (APC), Schneider Electric.
   2. Eaton.
   3. Liebert, Emerson Electric Company.

2.02 SCALABLE, DOUBLE CONVERSION UPS:
A. Scalable, network grade, on-line double conversion, uninterruptible power system with continuous line conditioning, inverter, batteries and control system.
B. N+1 redundancy with one more power module than is required to support rated load.
C. Field replaceable, hot swappable power and battery modules.
D. Redundant and hot swappable control modules.
E. Internal bypass.
F. Tower unit with minimum chassis capacity to support full unit rating and provide minimum runtime specified.
G. Electrical Capacity: Provide scalable unit with installed capacity and full unit rating as specified. Scalable increments shall be a maximum of 4kVA.
H. Provide a unit that will produce its full rated output continuously.
I. The unit shall utilize double conversion technology to continuously clean the power in either normal or emergency mode to protect against spikes, sags, surges, noise, lightning, and brownouts.
J. Input Voltage: 120 volt, 60 hertz, single phase (2-wire with ground).
K. Output Voltage: 120 volt, 60 hertz, single phase (2-wire with ground).
L. The unit shall automatically switch to battery inverter backup upon loss of power and retransfer on return of normal power. These transfers shall have no effect on the output waveform and shall be transparent to the connected load.
M. The output waveform will be 60 hertz ±0.5-hertz sine wave with less than 5% total harmonic distortion (THD).
N. Shall conform to IEEE 519.
O. Surge withstand shall exceed C62.41.1 and C62.41.2.
P. Noise rejection - common mode better than 120 dB; transverse mode greater than 60 dB.
Q. Output shall have an isolated neutral.
R. Electromagnetic interference shall be minimized to ensure that computer systems shall neither effect nor be affected by the UPS. RFI filtering shall be provided on the input and output to minimize high frequency noise interference.

S. The batteries shall be sealed maintenance-free type.
T. The battery charger shall be fully automatic capable of recharging the batteries within 3 hours.
U. The unit shall automatically disconnect from the batteries and shutdown, preventing damage to the batteries due to a deep discharge.
V. The battery capacity shall be such to be able to sustain a power outage of 30 minutes at 100% rated wattage output, and to maintain 50% of rated wattage output for a period of 60 minutes.
W. Ambient Environment: 0°C to 40°C.
X. Provide with an LCD operator interface. Status indicators and audible alarm shall indicate normal, transfer to inverter, battery charging and overload, or failure alarm.
Y. Provide with UPS management card with dry contact (relay) support to monitor external triggers and initiate actions on external devices. Input and output functions shall be configurable through DIP switches or software configuration. Contacts shall be rated for a minimum of 5A at 120Vac.
Z. The UPS shall conform to UL 1778. However, when a UPS is installed within UL 508A listed control panels, the control panel environment shall be maintained to UL 508A requirements.
1. For actuators loads the UPS output waveform shall conform to BS EN 50160.

2.03 MAINTENANCE BYPASS SWITCH:
A. Provide a maintenance bypass switch for the supplied UPS.
B. Bypass switch shall allow line and UPS inputs/outputs to be made using NEMA 5-15P cord and plug connections.
C. Transfer to and from maintenance bypass shall not interrupt the connected load.
D. Transfer time shall be less than 6 milliseconds.
E. Provide Liebert MicroPOD series, APC Service Bypass Panel, or approved equal.

PART 3 - EXECUTION

3.01 EXAMINATION:
A. Verify site conditions are suitable for installation of equipment. The area for installation shall be fully enclosed, weather tight, and free of contaminants.
B. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to installation and shall be maintained for the remainder of the construction period.

3.02 INSTALLATION:
A. Install the UPS system and associated accessories as indicated.
B. Provide the required access for maintenance of the equipment.
C. The UPS system shall be put in operation per the manufacturer's recommendations.

3.03 FIELD QUALITY CONTROL:
A. Manufacturer’s Field Services:
1. Manufacturer's field service shall be provided as specified in this Section and in Division 01.
2. The manufacturer shall provide the field services of a factory technician for a minimum of 1 day to supervise/inspect installation, test and start-up all equipment provided. All travel and living expenses shall be included. All equipment required for testing, start-up and performance verification shall be provided by the start-up technician.
3. Replacement parts shall be available 24 hours a day, 7 days a week, so the parts may be delivered to the customer site within 24 hours.

4. Assist the Subcontractor in the setup and configuration of the network card and associated communications.

B. Field Testing:
   1. Prior to energization check all accessible connections to manufacturer's torque tightening specifications.
   2. Prior to energization, check for short-circuits.
   3. Perform “start-up” tests as recommended by manufacturer.
   4. Verify proper operation of alarm and status signals.

3.04 ADJUSTING AND CLEANING:

A. Prior to final acceptance all UPS units and associated equipment shall be wiped clean and free from dust.

B. If equipment interiors have been exposed to dust and other contaminates the Subcontractor shall provide the necessary interior cleaning of equipment. Use precaution and proper cleaning methods to avoid damage of equipment.

3.05 TRAINING:

A. The training session shall be of sufficient content and duration to provide a basic understanding of the hardware/software in general and specific instruction on the Site-specific implementation.

B. The UPS system supplier shall provide a minimum of 4 hours of training at the customer's facility for operations, maintenance and service personnel.
   1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the equipment.
   2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, faults, diagnostic tools, troubleshooting, and preventive maintenance.
   3. Hands-on training shall be provided on equipment.
   4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.
   5. The training session shall be coordinated with Owner and Contractor.

C. Subcontractor shall record the training sessions and provide a final edited version to the Owner on a DVD-ROM and electronic video file format.

END OF SECTION 26 33 53

SECTION 26 35 26 – HARMONIC FILTERS

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Specification covers Active Harmonic Filters installed separately, and within other enclosures.

B. The manufacturer shall furnish, field commission and certify all installed AHF for satisfactory operation.

1.03 RELATED REQUIREMENTS:

A. SECTION 26 00 00 - General Electrical Requirements
B. SECTION 26 05 19 - Low Voltage Conductors and Cable
C. SECTION 26 05 26 - Grounding and Bonding for Electrical Systems
D. SECTION 26 05 53 - Electrical Identification
E. SECTION 26 05 73 - Electrical Studies
F. SECTION 26 24 19 - Motor Control Centers

1.04 REFERENCE STANDARDS:

A. UL1449 – 4rd Edition (2014), C22.2 No. 233.1-87 (Surge withstand capacity)
B. CSA 22.2, No. 14 & 66
C. ANSI IEEE std 519-2014
D. UL 508
E. NEMA 250, "Enclosures for Electrical Equipment (1000 Volts Maximum)
F. ASCE 7, "Minimum Design Loads for Buildings and Other Structures."
G. ICC IBC, "International Building Code."
H. ASTM E 329, "Standard Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction."
I. Electromagnetic Standard FCC 15j, Class A

1.05 DEFINITIONS:

A. AHF: Active Harmonic Filter
B. LED: Light Emitting Diode
C. TDD: Total Demand Distortion
D. THDi: Total Harmonic Distortion (current)
E. THDv: Total Harmonic Distortion (voltage)

1.06 PERFORMANCE REQUIREMENTS:

A. Refer to paragraph ACTIVE HARMONIC FILTER for harmonic filter performance requirements. Corrective amperage ratings shown on drawings are estimated based designed loads. Perform calculations based on final equipment sizing and submit for approval.

B. Delegated Design: Where units are mounted separately, design for seismic bracing and anchoring, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements, design criteria indicated, and related product information for equipment to be supplied.

C. Seismic Performance: Equipment shall withstand the effects of earthquake motions. Refer to Structural design.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces or short circuit current specified and the unit will be fully operational after the seismic event."

D. Materials and Designation: Refer to Specification 26 00 00 for material service requirements, site conditions, environmental ratings & hazardous locations.

1.07 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Refer to each Section of this Division for specific Product Data, Shop drawing and additional Submittal requirements.
C. Product Data: Submit for each type of product specified and included, with the following as minimum:
   1. Data sheets for all components furnished as part of the system package.
D. Shop Drawings: Provide the following as minimum.
   1. Fabrication and erection drawings.
   2. Equipment dimensions, shipping splits and shipping weights. The enclosure drawings shall include front, side, top, and bottom views of the enclosures with overall dimensions, and dimensioned conduit entrance locations.
   3. Equipment ratings.
   4. General outline drawing.
   5. Detailed equipment installation drawings.
   6. Schematic diagrams.
   7. Bill of materials.
   8. Nameplate schedule.
   9. Sizing calculations for active harmonic filters.
   10. Complete unit and internal wiring diagrams.
   11. External connection diagrams.
   12. Instrument transformer performance curves and data.
E. Special Procedure Submittals:
   1. Start-up and commissioning instructions.
   2. Syllabus for Owner training.
F. Test and Evaluation Reports:
   1. Factory acceptance test reports.
   2. Commissioning test reports.
G. Closeout Submittals: Final documentation shall include the following as minimum:
   1. Operation and Maintenance Manuals including the following:
      a. Operation and maintenance manuals for all components furnished.
      b. Certified “As-Built” drawings of all equipment with information listed above.
      c. A certified report shall be provided to the owner of successful completion of performance tests.
      d. Copies of all approved Product Data.
      e. Copies of all approved Test Reports.
      f. Spare parts and supply list with supplier names and part numbers.
      g. Warranty Information.
      h. Manufacturer’s service and repair support during and after warranty including contact information.
      i. Configuration sheet for each intelligent overload relay indicating as installed settings for each relay.
      j. Training Materials. Includes final edited training videos.

k. Infrared scan report.

H. Maintenance Material Submittals:

1. Spare Parts:
   a. Three spare LED indicating lamps for each type and color used.
   b. Three spare indicating light assemblies.
   c. Ten spare power and control fuses of each voltage and current rating used.
   d. One 12oz aerosol cans of manufacturer's touch-up paint for each color used. Color shall match the original factory applied color.
   e. All parts supplied with the equipment shall be properly labeled for ease of identification and to permit the shortest possible time to repair.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.

B. The AHF manufacturer shall be responsible for labeling all external connections required at the project site.

C. Complete instructions for handling and storage shall be provided by the manufacturer prior to delivery of the equipment. All equipment shall have adequate provisions for handling by overhead crane or forklift truck.

D. AHFs shall be stored according to the manufacturer's instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.

1.09 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in PART 3.

C. Factory Tests:

1. The manufacturer shall conduct tests according to industry standard requirements.
2. Perform factory tests on all harmonic filter assemblies to assure that all devices and systems are in proper working order before delivery to jobsite.
3. Test all power, control and communication systems for proper operation.
4. Simulate actual system operation.
5. Submit test reports as specified in Division 01.

1.10 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Equipment supplied across the site to be provided by one manufacturer.

1. Allen Bradley
2. Eaton
3. Schneider
4. Siemens

5. Approved Equal

B. When included on the one-line diagrams as integral to a piece of equipment the harmonic filter shall be of the same manufacturer or shall be a standard offering in combination with the enclosing equipment.

2.02 GENERAL DESCRIPTION

A. All active harmonic filter shall be defined as a power electronic device consisting of power semiconductors known as insulated gate bipolar transistors (IGBT) that switch into the AC lines to modulate its output to mitigate detrimental harmonic current and correct the displaced reactive current for the power source. A DC bus shall store power for power semiconductor switching. A microprocessor shall control the operation of the power converter. The converter design shall be a three-level design to optimize performance and minimize heat losses. AHF shall be packaged with an autotransformer at rated mains voltage above 480 VAC.

2.03 CONSTRUCTION

A. Separately mounted units shall be mounted in minimum NEMA Type 1-gasketed or Type 12 enclosure. Enclosures shall be freestanding with provisions for top and bottom entry of cables.

B. Refer to Specification 26 42 19 for direct installations within motor control centers, not freestanding.

2.04 ACTIVE HARMONIC FILTER

A. The point of common coupling shall be defined as the line side of the bus servicing the feeder breaker to the harmonic mitigation device.

B. Ratings and Application Requirements

1. TDD and THDv performance shall be limited to not more than 5% as contributed by the loads at the location of each AHF.
2. THDi performance shall be limited to not more than 3% as long as AHF is 50% or more loaded and all nonlinear loads have 3% or larger input impedance. A THDi set point may be set to optimize THDi performance.
3. Displacement power factor (PF) shall be corrected to 0.95 or better at the location of each AHF.
4. All nonlinear loads shall have input line reactors included that are rated 3% or higher impedance (inductance).
5. AHF shall be designed to operate continuously in an environment of 0 Deg to 40 Deg C ambient temperatures.
6. Storage conditions shall have a temperature range of -40 Deg to 65 Deg C and be clean and dry.
7. AHF shall with stand a relative humidity of not more than 95%, non-condensing.
8. AHF shall be full rated at a maximum altitude of 1000 meters (3300 feet). Above 1000 meters, a derating factor of 1% per 100 meters shall apply.
9. AHF shall not exceed an audible noise level of 80 decibels at one meter from enclosure.
10. System environmental conditioning requirement shall not exceed 7100W at 480V.
11. AHF shall be designed to operate from an input voltage of 380 to 480 VAC, plus 10% minus 15%.
12. AHF shall be designed to operate with a voltage frequency of 50 or 60 Hertz + / - 3 Hertz.
13. AHF shall be phase rotation insensitive. AHF shall detect phase rotation and align output accordingly.

14. AHF heat losses defined as maximum kW loss divided by maximum kvar output shall not exceed more than 5% at 480V.
15. AHF shall be UL listed according to UL508 and CSA listed according to CSA 22.2, No. 14 & 66.
16. AHF floor mount units shall include a door-interlocked circuit breaker rated at a minimum 100 kAIC (UL rated) up to 600 VAC.
17. AHF shall be designed with a current limiting function to protect the IGBT's.
    a. When the current limit level is attained, a message shall be displayed indicating the output capacity is at-maximum capacity and actuate the at-maximum capacity relay.
    b. Operation shall continue indefinitely at this level without trip or degradation of AHF.
18. AHF shall have automatic restart capability upon power loss return and fault resets.
    a. Fault trip limit shall occur after 5 restarts within a 5 minute period.
    b. Automatic restart shall occur for the following faults and may include other faults: AC line over voltage, AC line under-voltage, AC line power loss, and AC line phase imbalance, over temperature, under temperature, and DC bus over voltage.
19. Upon occurrence the fault trip limit, AHF shall stop output current production and lock out restart until the fault is manually cleared.
20. AHF shall incorporate an over-temperature output roll back that reduces the total output current to reduce power component heating in order to maintain maximum current correction within the electrical system.
21. AHF shall incorporate protective shutdown when air inlet temperature reaches 51° C.
22. AHF shall be designed to operate from an input voltage of 380 to 480 VAC or 600 VAC to 690 VAC, plus 10% minus 15%.
23. AHF shall be designed to operate with a voltage frequency of 50 or 60 Hertz + / - 3 Hertz.

C. Graphic Display Termainal
1. AHF shall have a door mounted human machine interface (HMI) with touch screen control rated NEMA 4- 12 (IP65), dust tight and liquid resistant.
2. HMI shall provide run/stop control from every screen.
3. HMI shall provide an oscilloscope feature to display specific parameters.
    a. HMI shall display the mains voltage and current waveforms.
    b. Performance trend information shall be displayed for load total rms current, load rms harmonic current per phase, AHF output harmonic current per phase, AC mains voltage per phase, THDi, TDD, THDv, load rms reactive current, and AHF output rms reactive current.
    c. Bar graphs shall be provided for display of the mains and load harmonic current amplitudes per harmonic order.
    d. Selected internal waveforms shall be provided for diagnostic and performance checks.
    e. All parameter adjustment shall be made via HMI and are password protected.
    f. HMI shall record and display an event log with time and date stamp. Event log shall be cleared manually by the user . A minimum 100 events shall be stored.
4. HMI shall provide external communications via a RJ-45 connector.
    a. Provide network connection to monitor remote run/stop and display of all operating parameters, set up parameters and diagnostic functions.
    b. Plant network utilizes ProfiNet for communications protocol. Provide converter or gateway as required.

5. HMI shall have a safety feature that locks out all other forms of control during service and commissioning.
    a. HMI must relinquish control to any other method of control.
6. HMI shall display a flashing warning screen in the event of a fault with full fault description. Error codes alone shall not be acceptable.
7. HMI shall be capable to download all pertinent parameters to an externally accessible USB memory device to permit remote diagnostic evaluations and to save unit set up parameters.
8. HMI shall include an on-board Commissioning Guide with automatic detection features.
    a. AHF shall automatically check and indicate AC line phase rotation.
    b. AHF shall automatically test for current transformers (CT) phase rotation and polarity. If installation is incorrect AHF shall compensate for phase rotation and orientation of CT's. If proper alignment cannot be achieved, a fault warning and lock out of operation shall occur.
    c. AHF shall automatically calibrate the CT for optimum harmonic cancellation performance.
    d. AHF shall perform a system integrity test at full capacity for a period of 15 minutes to validate installation.
    e. In the event any of the above cannot be reconciled, HMI shall lock out AHF function until commissioning agent corrects, verifies and clears each issue.

D. Function of AHF
1. AHF shall monitor the load current utilizing two current transformers (CT's) mounted on the AC lines for three phase loads. If phase to neutral loads are connected on a 4-wire system, three CT's are required.
    a. AHF shall analyze the content of the load current for harmonics from the 2nd to the 51st harmonic and determine the reactive current content representing displacement power factor.
    b. AHF shall be field selectable to operate as a harmonic filter or provide power factor correction or both.
    c. AHF shall be capable of open loop or closed loop operation.
2. AHF amperage output ratings shall be one of the following:
    a. A minimum of 60, 120, 200, or 300 amps from 380 to 480 VAC, or as shown on the drawings.
3. AHF shall provide for load balancing of AC lines current for harmonic and reactive currents regardless of actual load distribution per phase.
4. Up to 10 AHF of any size may be installed in parallel to inject current according to the information received from one set of mains CT's. Each unit shall be field selectable for operation as master or slave. If one unit is offline for maintenance or faulted, the remaining units shall automatically adjust the total output to make up for the offline unit(s).
    a. AHF that require dedicated master and slave units or power connections between unit DC buses shall not be acceptable.
    b. AHF that turn off all units when one is taken offline are not acceptable.
5. AHF shall have a NO (normally open) dry contact as secondary run/stop function.

E. Current Transformer
1. Current transformers shall be installed as defined by design engineer documentation.
2. A minimum of two current transformers per AHF location are required and mounted on phases A & B of the mains. If phase to neutral loads are connected on a 4-wire system, three CT's are required.

3. Current ratings of the current transformers shall be according to full load current rating of the circuit on which installed.
4. The secondary current rating shall be 5 amperes.
5. Current transformers rated for 50 to 400 Hertz shall be used.
6. 1% or better (metering class) accuracy shall be provided.
7. Current transformers shall be dedicated for AHF operation and not shared with other system components.

2.05 IDENTIFICATION:

A. Provide all warning signs, nameplates, labels and markers as specified in Section 26 05 53.
B. Label field-installed conductors, interconnecting wiring, and components;
C. Provide Equipment and conduit warning signs.
D. Provide Equipment nameplates.
E. Place arc flash label on equipment. Refer to Sections 26 05 73.
F. Create a directory to indicate installed circuit loads; incorporate equipment served and room designations as indicated on the Drawings. Use a computer printer to create directory; handwritten directories are not acceptable. Directory shall be subject to approval by the Engineer and Owner.
G. Provide each overcurrent device with a corresponding adhesive label with associated number and load served as indicated.
H. Refer to Section 26 05 53 for additional labeling information.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment.
B. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing AHFs and shall be maintained for the remainder of the construction period.

3.02 INSTALLATION:

A. Install shall conform to manufacturer's instructions.
B. Where necessary, meet requirements of seismic anchoring design.
C. Completely install as specified, indicated, or required for operation and continuous service at the locations indicated.
D. For freestanding enclosures install a 3.5-inch high concrete equipment (housekeeping) pad 3-inches wider and 3-inches deeper than the AHF. Clear dimension to anchor bolts to be a minimum of 4-inches.
E. Level, shim, and anchor to floor or wall with bolts or concrete anchors, and grout all floor-mounted equipment.
F. Install all necessary wiring or interconnections as required.
G. Make all internal and external connections as indicated and as required by manufacturer's wiring diagrams.
H. Check all internal and external connections, especially current transformer secondary short circuiting jumpers, and tighten as required.
I. Place arc flash label on equipment.

3.03 FIELD QUALITY CONTROL:

A. Field Testing:

1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
2. Perform "start-up" tests as recommended by manufacturer and per NETA MTS (latest version).
3. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specifications.
4. Prior to energization, check for electrical continuity of circuits and for short-circuits.
5. Prior to energization check with an insulation resistance tester: phase-to-phase and phase-to-ground insulation resistance levels to ensure requirements are fulfilled. Record and submit field test data.
6. Set all parameters associated with AHF for proper system performance. Settings shall be recorded and included with final documentation as specified.

B. Submit field testing and commissioning reports as specified in Division 01.

C. Infrared Scanning:
1. Infrared Scanning of equipment: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
2. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.
4. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
5. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

3.04 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.

B. All damaged or defective coatings shall be repaired prior to final acceptance.

C. Field Painting:
1. Touch Up:
   a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
   b. Field painting shall be performed based on manufacturer's recommended procedures.
   c. Equipment manufacturer shall furnish Contractor with touch-up paint listed in spare parts paragraph above.

3.05 ADJUSTING AND CLEANING:

A. After field installation and final wiring terminations are completed the field connected power and control wiring and cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.

B. Prior to final acceptance the equipment interior and exterior shall be wiped clean and free from dust and debris.

3.06 TRAINING:

A. The equipment supplier shall provide a minimum of 4 hours of training at the customer's facility for operations, maintenance and service personnel.
   1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
   2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, software mapping, programming, setup, configuration, control loop tuning, operational indicators, faults, diagnostic tools, troubleshooting, and preventive maintenance.
   3. Hands-on training shall be provided on equipment.
   4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.

B. The Owner at their option shall be allowed to video record all training sessions for future reference.

C. Contractor shall record the training sessions and provide a final edited version to the Owner on electronic video file format.

3.07 MAINTENANCE

A. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

B. Follow-up Infrared Scanning: Perform two follow-up infrared scans of equipment, one at four months and another at 11 months after Substantial Completion.

C. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.

D. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 26 35 26

SECTION 26 41 00 – LIGHTNING PROTECTION SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the furnishing and installation of a complete lightning protection system, including below-grade ground grid systems.
   1. Air terminals.
   2. Roof conductors.
   3. Down conductors.
   4. All mounting accessories.

B. Furnish a Master Label Certificate issued by Underwriters' Laboratories, Inc. for each system and attach to the base of the appropriate structure.

C. Provide lightning protection for the following structures:
   1. Pump Station Building.
   2. Potable and Reuse Water Tanks.

1.03 PERFORMANCE/DESIGN CRITERIA:

A. The lightning protection system design shall be completed by a qualified designer and installed by a Listed Lightning Protection Installer capable of providing a UL Master Label Inspection Certificate for each structure.

1.04 RELATED REQUIREMENTS:

A. SECTION 26 05 19 – Low Voltage Electrical Conductors and Cables.

B. SECTION 26 05 26 – Grounding and Bonding for Electrical Systems.

1.05 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

B. American National Standards Institute (ANSI).

C. Underwriters' Laboratories, Inc. (UL):
   1. 96 - Lightning Protection Components.
   2. 467 - Standard for Grounding and Bonding Equipment.

D. American Society for Testing and Materials (ASTM):
   1. B3 - Soft or Annealed Copper Wire.
   2. B8 - Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   3. B33 - Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.

E. National Fire Protection Association (NFPA):
   1. 70 - National Electrical Code.
   2. 780 - Installation of Lightning Protection System.

F. Lightning Protection Institute (LPI):
   1. 175 - Standard of Practice for the Design - Installation - Inspection of Lightning Protection Systems.

1.06 DEFINITIONS:

A. Definitions provided by NPFA 780:
   1. Class I Materials: Lightning conductors, air terminals, grounding electrodes, and associated fittings required for the protection of structures not exceeding 75 feet in height.
   2. Class II Materials: Lightning conductors, air terminals, grounding electrodes, and associated fittings required for the protection of structures exceeding 75 feet in height.

1.07 SUBMITTALS:

A. Product Data: For each type of product indicated.
B. Shop Drawings: For air terminals and mounting accessories.
   1. Layout of the lightning protection system, along with details of the components to be used in the installation.
   2. Include indications for use of raceway, data on how any concealments requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
   3. Mounting details for all components.
   4. Detailed layout drawings of lightning protection system, including air terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway and data on how concealment requirements will be met.
C. Qualification Data: For qualified Installer and manufacturer. Include data on UL listing.
D. Material Certificates:
   1. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
E. Field quality-control reports.
   1. Comply with recommendations in NPFA 780, Annex D, “Inspection and Maintenance of Lightning Protection Systems,” for recommended inspection reports of the lightning protection system.
F. Plans showing dimensioned as-built locations of grounding features, including the following:
   1. Ground rods.
   2. Ground loop conductor.

1.08 QUALITY ASSURANCE:

A. Installer Qualifications: Certified by UL as a Master Installer/Designer, trained and approved for installation of units required for this Project.
B. System Certificate:
   1. UL Master Label.
C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, “Definitions” Article.

1.09 PROJECT SITE CONDITIONS:

1. Refer to Section 26 00 00 for Project Site Conditions

1.10 COORDINATION:

A. Coordinate installation of lightning protection system with the installation of other building systems and components including electrical wiring, supporting structures, building materials, roof, and metal components requiring interface with lightning protection systems.
B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.

C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Lightning Protection System Components:
   1. Preferred Lightning Protection.
   2. Robbins Lightning Protection.
   3. Thompson Lightning Protection, Inc.
   4. Erico International Corporation.

B. Grounding Components:
   1. Burndy LLC.
   2. Erico International Corporation.
   3. Thomas & Betts.

C. Bare Ground Cable:
   1. Refer to Section 26 05 19 and 26 05 26.

D. Connection Materials:
   1. Exothermic Type Welding Process:
      a. Erico Products (CADWELD).
   2. Compression Type Connectors:
      a. Amp.
      b. Burndy.
      c. Thomas and Betts.

E. Ground Test Wells:
   1. Advanced Lightning Technology.
   2. Erico International Corporation.
   3. Synertech.

F. Mastic:
   1. Sonneborn-Sonoshield Mastics.
   2. W.R. Meadows-Sealmastic.

2.02 PERFORMANCE/DESIGN CRITERIA:

A. Materials shall be in compliance with the following standards:
   1. UL96.
   2. NFPA 780.
   3. All materials used for the system installation shall comply in size, composition, and weight to all requirements of NFPA and UL for the class of system in which they are installed. All materials shall be labeled or listed by UL for use in Master Labeled Systems.
   4. Roof and down conductors shall be in compliance with ASTM B8.

2.03 LIGHTNING PROTECTION SYSTEM:

A. General Requirements:
   1. Material: All materials shall be aluminum, copper, or bronze.
   2. Compatibility: All portions of the system shall be galvanically compatible to the building material to which they are to be attached. Connections between copper and aluminum portions of the system shall be made with appropriate bimetallic coupling devices. In all areas, the conductor shall be supported to maintain clearance from all galvanically incompatible materials or shall be of the same material.

3. All system components shall be, to the maximum extent possible, the product of a single manufacturer. All components shall be type Class Ias required by NFPA 780.

B. Air Terminals:
   1. Solid Air Terminal Rods:
      a. Diameter: 1/2-inch diameter.
      b. Length: 18 inches.
      c. Material: Copper or Aluminum. Ensure compatibility with base and roofing materials.
   2. Mounting hardware:
      a. Mounting Base Material: Copper or Aluminum. Ensure compatibility with base and roofing materials.
      b. Mounting Type: Roof, Side, Universal, as required.
      c. Anchor: Provide adhesive or metallic anchor compatible with building materials. Adhesives to be compatible with roofing membranes, where present.
   3. Air terminals and interconnecting cable shall be provided for all roof-mounted equipment subject to a direct strike as required by NFPA 780.
   4. All air terminal bases shall be securely mounted to the building structure by bases secured as specified.

C. Roof and Down Conductors:
   1. Material: Aluminum or copper. Ensure compatibility with roofing materials.

D. Down Conductor Guards: Guards shall be of self-extinguishing, high-impact polyvinyl chloride or polyethylene.

E. Grounding Grid System: Refer to Section 26 05 26 and to Electrical Drawings.

F. Ground Test Wells:
   1. Concrete or high density polymer concrete box or ring with bolted cover.
   2. Cover shall be permanently marked as “Electrical” or “Ground Test Well.”
   3. Refer to Section 26 05 26.

G. Bonding Plates, Connectors, Terminals, and Clamps: Provide electrical bonding plates, connectors, terminals, lugs, and clamps as recommended by bonding plate, connector, terminal, and clamp manufacturers for indicated applications.
   1. Bolted Connectors for Pipes: Copper or copper-alloy, pressure type with at least two silicon bronze or stainless-steel bolts and lock washers.
   2. Irreversible Compression Fittings: Pure wrought copper extrusion clamps and connectors, made to be held in the dies of an installation tool. Connectors must be factory filled with an oxide inhibitor.
   3. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Lightning Protection System:
   1. Install lightning protection systems as indicated, in accordance with equipment manufacturer's written instructions, and in compliance with UL 96A.
   2. Suitably protect cable and air terminals from damage during construction.
   3. Air Terminals:
      a. The structural steel framework of building may be used as the main conductor of a lightning protection system.

b. Air terminals shall be installed within 2 feet of all ends, edges, and corners of the building.
c. Place air terminals so that roof hatches fall within the zone of protection. Bond roof hatches to the lightning protection system with braided bonding jumpers.

4. Conductors:
a. Protect down conductors from physical damage and displacement by installing guards.
b. Install conductor with direct paths from air terminals to ground connections avoiding sharp bends (minimum radius - 8 inches and no bends shall be less than 90 degrees) and narrow loops. Where indicated, run conductors in nonmetallic PVC raceway Schedule 80 with a minimum elbow radius of 8 inches.
c. Conceal the following conductors:
(1) Down conductors.
d. Do not install copper lightning protection materials on aluminum roofing, siding material, or other aluminum surfaces. On aluminum surfaces, use aluminum lightning protection materials.

5. Bonding: Install in accordance with UL 96A, NFPA 780, and the NEC.

B. Connection Materials:
1. Cable-to-cable, cable-to-rod connection shall be exothermic-type welding process or irreversible compression type connectors. All compression-type connections shall be inspected for proper die index number.
2. Provide bimetallic or tin-plated copper connectors when joining copper to aluminum conductors.
3. Cable to structural steel:
a. Use exothermic weld where possible.
b. Where exothermic weld will damage structural steel, use bolted fittings if it can be field drilled.
c. Use irreversible compression ground clamp with breakaway bolt head to building steel that cannot be altered.
d. When structural steel is used as part of the lightning protection system, the structural steel shall be electrically continuous and shall be bonded to the lightning protection conductors at both the top and the bottom of the structural columns.
4. Cable to Equipment Ground Lugs:
a. Copper alloy terminal with twin clamping element.
b. Bolt to equipment housing with silicon bronze or stainless-steel bolts and lock washers.

C. Ground Grid System:
1. Wire and Cable:
a. General:
(1) Install using as few joints as possible.
(2) Protect against unraveling, caging, and abrasion by several wrappings of plastic tape on all ends.
(3) Install so as not to be entirely encircled or closely encircled by magnetic material.
(4) Suitably protect against damage during construction. Replace or repair cable at Owner's discretion if cable is damaged by anyone before final acceptance.
(5) Protect cable at all points where cable leaves concrete by wrapping rubber tape on 2 inches either side of the plane formed by the finished concrete surface.

b. Buried Installations:
(1) Install at locations and depths as specified or indicated. Otherwise install at least 18 inches below finished grade or deeper if necessary in order to be in contact with earth. Install outside of foundation or wall at a distance of not less than 2 feet.
(2) Maintain clearance of at least three feet from all underground metal piping or structures where possible, otherwise tape all ground conductors within this clearance.
(3) Backfill with excavated earth free from rocks or stones. Thoroughly compact backfill.

2. Ground Rods:
a. Install rods where indicated by driving and not by drilling or jetting.
b. Drive rods into unexcavated portion of the earth where possible.
c. Where rods must be installed in excavation areas, drive rods into earth after compaction of backfill is completed.
d. Drive to a depth such that top of rods will be approximately 18 inches below final grade, or subgrade, and connect to the buried grid ground conductors.

3. Connections:
a. Conform to manufacturer's instructions.
b. Chemically degrease and dry completely before welding or applying compression type connectors.
c. Apply coating to all exothermic-welded connections to be buried, at 15-mils dry film thickness, after checking of connections by Owner’s Engineer.
d. Make up bolted connections clean and tight.
e. Low-resistance connections with resistance drop not exceeding 1 ohm.
f. Do not cover up connections before they are checked by Engineer.

4. Ground Test Wells:
a. Install at locations indicated on Drawings.
b. Use bolted connections at test wells.

5. The lightning protection system shall be permanently bonded to the grounding electrode system per NPFA 780.

D. Corrosion Protection:
1. Use no combination of materials that may form an electrolytic couple of such nature that corrosion is accelerated in the presence of moisture, unless moisture is permanently excluded from the junction of such metals.
2. Where unusual conditions exist that would cause deterioration or corrosion of conductors, use conductors with suitable protective coatings.
3. Aluminum down conductors shall not be used where contact with the earth is possible.

E. Sleeve and Sleeve Seal Installation for Electrical Penetrations:
1. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.02 FIELD QUALITY CONTROL:

A. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

B. Provide inspection according to UL 96A and delivery of UL Master Label Certificate to Owner.

END OF SECTION 26 41 00

SECTION 26 43 13 – SURGE PROTECTIVE DEVICES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes parallel and series-wired, surge protective devices (SPDs) for service entrance and AC distribution equipment not exceeding 1000V, including disconnects, switchboards, motor control centers, panelboards, as well as point-of-service equipment, power for control panels.

1.02 RELATED REQUIREMENTS:

A. Section 26 24 16 - Panelboards
B. Section 26 24 19 - Motor Control Centers
C. Section 40 66 00 - Process Control Networks
D. Section 40 67 00 - Process Control Panels and Hardware

1.03 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. National Fire Protection Association (NFPA):
    1. NFPA 70 – National Electrical Code (NEC)
        a. Article 285 – Surge-Protective Devices (SPDs) 1 kV or Less.
    2. NFPA 780 – Standards for the Installation of Lightning Protection Systems.
C. National Electrical Manufacturers Association (NEMA). Comply with applicable requirements of the following standards:
    1. NEMA 250 – Enclosures for Electrical Equipment (1,000V maximum).
D. Underwriters Laboratories (UL). Comply with applicable requirements of the following standards:
    1. UL 1283 – Electromagnetic Interference Filters.
    2. UL 1449 4th Edition – Surge Protective Devices.
E. Institute of Electrical and Electronic Engineers (IEEE) comply with applicable requirements of the following standard.
    1. IEEE C62.33 – Test Specifications for Varistor Surge-Protective Devices.
    2. IEEE C62.41.1 – Surge Environment in Low-Voltage (1000V and less) AC Power Circuits.
    3. IEEE C62.41.2 – Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
    4. IEEE C62.45 – Surge Testing for Equipment Connected to Low Voltage (1000V and less) AC Power Circuits.
    5. IEEE C62.62 – Test Specification for Surge Protective Devices for Low Voltage AC Power Circuitry.
    6. IEEE Std 1100 (Emerald Book) – Recommended Practice for Powering and Grounding Electronic Equipment.

1.04 DEFINITIONS AND ABBREVIATIONS:

A. I-n: I-nominal rating.
B. MCOV: Maximum Continuous Operating Voltage rating.
C. MOV: Metal Oxide Varistors.
D. SAD: Silicon Avalanche Diodes.
E. SCCR: Short Circuit Current Rating.
F. SPD: Surge Protection Device.

G. VPR: Voltage Protection Rating.

1.05 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.
B. Product Data:
   1. Data sheets:
      a. Physical details and dimensions.
      b. Power input voltage and frequency.
      c. Type category.
      d. UL 1449 Listing documentation verifying the following:
         (1) Short Circuit Current Rating (SCCR).
         (2) Voltage Protection Ratings (VPRs) for all modes.
         (3) Maximum Continuous Operating Voltage rate (MCOV) for Type 1 and Type 2 SPDs.
         (4) I-nominal rating (I-n) for Type 1 and Type 2 SPDs.
         (5) Device type designation.
      e. Peak surge current rating per phase.
   2. Tests, inspections: At the shop, factory, plant, or place of manufacture.
   3. Verification of performance: Compliance with specified criteria.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Integral SPDs shall be delivered, pre-installed, and stored according to the requirements of the distribution equipment or control panel in which they are installed.

1.07 SITE CONDITIONS:

A. All Equipment provided as part of this system shall be rated for the temperature, seismic and elevations as specified in the Site Conditions identified in Section 26 00 00.

1.08 WARRANTY

A. Contractor – 1 year.
B. Manufacturer Supplied – 5 year minimum.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. A manufacturer's presence on this list does not guarantee that all of its models are acceptable. The Subcontractor shall verify each SPD model meets all requirements of this specification.
B. AC Power Distribution Units:
   1. Advanced Protection Technologies, Inc.
   2. Eaton.
   3. Erico International Corporation.
   4. General Electric.
   5. Mersen.
   6. Schneider Electric.
   7. Siemens.

2.02 GENERAL REQUIREMENTS FOR SURGE PROTECTIVE DEVICES:

A. UL 1449 4th Edition listed and labeled.

B. Shall be UL labeled as a Type 1 or Type 2 device, shall be intended to be installed on the load side of the service entrance equipment and shall not require external or supplemental overcurrent safety controls to meet UL 1449 4th Edition.
C. The surge protective device (SPD) shall be of a non-modular design using fast-acting transient energy protection that will divert and dissipate the surge energy.
D. Shall provide independent, directly-connected suppression components on each mode in the electrical distribution system, at least seven modes in Wye systems (L-N, L-G, N-G) and six modes (L-L, L-G) in Delta and impedance grounded Wye systems.
E. Shall be an integral or internally-mounted device as specified or indicated.
F. Shall use metal oxide varistor or MOV-hybrid technology as necessary. (Spark gaps, selenium cells and SCRs shall not be acceptable.)
G. Shall include internal fuses and thermally protection over every suppression component of every mode, including N-G unless protecting the service entrance.
H. Shall have integral, panel front status monitors or remote status panel ability as a minimum to indicate a continuous positive status of all protected modes, including N-G mode where applicable. Diagnostics shall be electrically isolated to prevent damage by surges.
I. Shall be UL labeled with a short circuit current rating of 200kA.
J. The maximum continuous operating voltage at 60 Hz shall be capable of sustaining at least 115% of the peak voltages continuously without degrading.
K. The maximum UL 1449 4th Edition Voltage Protection Ratings (VPR) for the device must not exceed the following:

Service	L-N	L-G	N-G	L-L	MCOV
120V 2-wire + Gnd	600V	1000V	600V	NA	150
120/240Vac 3-Wire + Gnd	700V	700V	700V	1200V	150
208/120Vac 3-phase, 3 or 4-wire	700V	700V	700V	1200V	150/276
480 Vac 3-phase, 3 Wire Delta	NA	1800V	NA	1800V	550
480/277 Vac 3-phase, 3-wire or 4-wire	1200V	1200V	1200V	2000V	550/320

L. Type 1 and Type 2 SPDs shall be UL labeled with 20kA I-n for compliance to UL 96A Lightning Protection Master Label and NFPA 780 with the following minimum protection characteristics:
   1. UL 1283 Listed. (Latest Edition)

2. I_n: 20kA (per mode)
3. SCCR: 100kAIC (minimum)
4. MCOV: 550V
5. UL Voltage Protection Rating:
   a. L-L: 1800V
   b. L-N, L-G, N-G: 900V
6. Response time of less than 25 nanoseconds.

M. Provide SPDT contacts for remote indication. Contacts rated 5A at 120Vac minimum.
N. Equipped with an LED status indicator for verification that unit is functioning.

2.03 SERVICE ENTRANCE SURGE PROTECTIVE DEVICE:

A. Located in Switchboards (SWBD-1A & SWBD-2A).The SPD shall be suitable for the equipment voltage, phase, and wire configuration shown on the drawings.
B. Service entrance units shall be tested and demonstrated suitable for application within ANSI/IEEE C62.41 Category C environments.
C. Shall have a minimum peak surge current of 240 kA per phase, or as indicated on the Drawings.
D. Shall include EMI/RFI filtering for ring wave suppression.
E. Shall have a minimum EMI/RFI filtering of -30dB at 100 kHz.

2.04 SURGE PROTECTIVE DEVICE FOR DOWNSTREAM DISTRIBUTION SWITCHBOARDS, MOTOR CONTROL CENTERS, AND PANELBOARDS:

A. The SPD shall be suitable for the equipment voltage, phase, and wire configuration shown on the drawings.
B. SPD units shall be tested and demonstrated suitable for application with ANSI/IEEE C62.41 Category B environments.
C. Shall have a minimum peak surge current of 120 kA per phase, or as indicated on the Drawings.
D. Minimum surge current capacity (I_{max}) of per mode (8/20µs), shown below:
   1. MCCs and Switchboards: 250kA
   2. 480V Panelboards: 250kA
   3. 240V and below: 100kA
E. Units mounted internal to protected equipment shall have a NEMA 1 enclosure designed for back panel or DIN rail mounting within a control panel or motor control center.
F. Shall include EMI/RFI filtering for ring wave suppression.
G. Shall have a minimum EMI/RFI filtering of -30dB at 100 kHz.

2.05 SURGE PROTECTIVE DEVICE FOR POINT OF SERVICE EQUIPMENT

A. Surge suppressors shall be installed to protect at 120/240V, 1-phase, 3-wire 60Hz distribution and process control panels.
   1. Shall meet Type 2 SPD criteria with the following minimum protection characteristics:
      a. I_n: 20kA (per mode)
      b. SCCR: 100kAIC (minimum)
      c. MCOV: 150V (L-G), 270 (L-L).
      d. UL Voltage Protection Rating:
         (1) L-L: 1000V
         (2) L-N, L-G, N-G: 600V
   2. Designed for 120/240Vac, single-phase operation as required.
   3. EMI/RFI filtering.

4. Peak clamping voltage of 320 volts line to neutral and 350 volts line to ground with Category B waveform.
5. Minimum surge current capacity of 10 kA per mode (8/20µs).
6. Response time of less than 25 nanoseconds.
7. Equipped with an LED status indicator for verification that unit is functioning.
8. NEMA 1 enclosure designed for back panel or DIN rail mounting within a control panel.

B. Panel I/O Surge Suppressors:
1. Provide DIN rail mounted terminal block type transient voltage surge suppressors for all inputs and outputs that are wired to devices located outside of the building envelope.
2. Finger safe screw type terminals.
3. Replaceable surge modules.
4. Three-stage surge protection.
5. Provisions for labeling terminal block numbers.
6. Analog and 24Vdc Signal Surge Protection:
   a. Series surge suppressor.
   b. Minimum surge current capacity of 10 kA per mode (8/20µs).
   c. Minimum lightning surge current capacity of 500A per path (10/350µs).
   d. Maximum let thru voltage line to ground of 45 Vdc.
   e. Maximum let thru voltage line to line of 90 Vdc.
   f. Response time of less than 5 nanoseconds.
   g. Maximum series resistance of 10 ohms.
   h. Minimum continuous current rating of 300 mA.
7. 120Vac Discrete Signal Surge Protection:
   a. Series surge suppressor.
   b. Minimum surge current capacity of 4 kA per mode (8/20µs).
   c. Minimum lightning surge current capacity of 2.5 kA per path (10/350µs).
   d. Maximum let thru voltage line to ground 380 Vac.
   e. Maximum let thru voltage line to line of 600 Vac.
8. Minimum continuous current rating of 15A.
9. Response time of less than 25 nanoseconds.

C. Shall be designed to pass the appropriate IEEE testing standards included below:
1. IEEE C62.11.
2. IEEE C62.33.
3. IEEE C62.36.
4. IEEE C62.45.
5. IEEE C62.62.

2.06 SURGE PROTECTION DEVICE FOR DATA CONNECTIONS

A. Din rail mounted, metallic enclosure with RJ-45 in and out connections.
B. Reliable to 10Gbps transmission speeds.
C. Nominal Discharge Current (8/20) µs (Core-Core): 100A
D. Nominal Discharge Current (8/20) µs (Core-Earth): 2kA
E. Total discharge current I_{total} (8/20) µs 10 kA
F. Nominal pulse current I_{an} (10/700) µs (Core-Core) ≤ 40 A
G. Nominal pulse current I_{an} (10/700) µs (Core-Earth) ≤ 160 A
H. Maximum continuous voltage UC ≤ 3.3 V DC (± 60 V DC/PoE+)
I. Residual voltage at I_n (conductor-conductor) ≤ 15 V, ≤ 100 V (PoE)
J. Voltage protection level Up (core-core): ≤ 9 V (B2 - 1 kV/25 A), ≤ 100 V (B2 - 1 kV/25 A - PoE), ≤ 15 V (500 V / 100 A)

K. Voltage protection level Up (core-ground): ≤ 900 V (B2 - 4 kV/100 A), ≤ 700 V (C2 - 4 kV/2 kA)
L. Response time tA (core-core): ≤ 1 ns
M. Response time tA (core-earth): ≤ 100 ns
N. Equal to Phoenix Contact DT-LAN-CAT.6+ 2881007, or approved equal.

2.07 ADDITIONAL REQUIREMENTS FOR PLUG-ON SPDS:

A. Shall be directly connected to the equipment bus bar through an integral circuit breaker sized as recommended by the manufacturer.
B. Shall include a display with a resettable counter for the combined total number of transient voltage surges detected since the counter was reset.

2.08 ACCESSORIES:

A. Monitoring Diagnostics/Accessories:
    1. Protection Status Indicators - Each unit shall have a green/red solid-state indicator light that reports the status of the protection element on each phase.
        a. Wye configured units, shall have indication in the L-N and L-G and N-G modes.
        b. Delta configured units, shall have status indication in the L-G and L-L modes.
        c. The absence of a green light and the presence of a red light shall indicate that damage has occurred on the respective phase or mode. All protection status indicators must indicate the actual status of the protection on each phase or mode. If power is removed from any one phase, the indicator lights must continue to indicate the status of the protection on all other phases and protection modes. Diagnostics packages that simply indicate whether power is present on a particular phase shall not be accepted.
    2. Surge Event Counter: The SPD shall be equipped with an LCD display that indicates to the user how many surges have occurred at the location.
        a. The surge counter shall trigger each time a surge event with a peak current magnitude of a minimum of 50 ± 20A occurs. A reset pushbutton shall also be standard, allowing the surge counter to be zeroed. The reset button shall contain a mechanism to prevent accidental resetting of the counter via a single, short-duration button press. In order to prevent accidental resetting, the surge counter reset button shall be depressed for a minimum of 2 seconds in order to clear the surge count total.
        b. The ongoing surge count shall be stored in non-volatile memory. If power to the SPD is completely interrupted, the ongoing count indicated on the surge counter's display prior to the interruption shall be stored in non-volatile memory and displayed after power is restored. The surge counter's memory shall not require a backup battery in order to achieve this functionality.

2.09 FINISHES:

A. Manufacturer shall prepare surfaces, prime, and finish paint all surfaces with manufacturer's standard coating system. Coating system and color shall be suitable for intended services.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine area and location of equipment to receive SPDs for compliance with manufacturer's environmental conditions and other conditions affecting performance of the Work.

B. Examine field installed SPDs before installation. Reject SPDs that have been wet, moisture damaged, or physically damaged.
C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 GENERAL INSTALLATION REQUIREMENTS:

A. The installation of the surge suppression system shall be installed in strict accordance with the manufacturer's recommended practices and in compliance with the NEC.
B. The Subcontractor shall verify the proper application of the SPD (i.e. voltage, phases, etc.)
C. The Subcontractor shall verify that all neutral conductors are bonded to the system ground at the service entrance or at the serving transformer prior to installation of the SPD.
D. The phase, neutral and grounding conductors serving the SPD shall be gently twisted to reduce the SPD system inductance and shall be kept at the minimum length. Avoid any sharp bends and coils in the conductors.
E. Do not perform insulation resistance tests on a piece of electrical equipment with an SPD installed. SPDs are not designed to withstand the relatively high voltages applied for the duration of a megger test measured in seconds. Disconnect the SPD during insulation testing and reconnect immediately after testing is over.

3.03 INSTALLATION OF EXTERNALLY-MOUNTED SPDS:

A. Externally mounted SPDs are only permitted with Engineer approval.
B. The SPD shall be located immediately adjacent or nippled to the equipment being protected to meet the manufacturer recommended installation.
C. Provide a disconnecting means or overcurrent protection and wiring as recommended by the manufacturer. When no recommendation is provided install the SPD through a 30-Amp circuit breaker using 10-gauge wire.
D. When installed at a service entrance, the SPD shall be installed on the load side of the main service disconnect overcurrent device.
E. When installed at a separately-derived system, the SPD shall be connected on the load side of the first overcurrent device.
F. When protecting a panelboard, switchboard or motor control center, install the SPD through a breaker as a disconnecting source per the manufacturer's installation instructions. Installer may reasonably rearrange breaker locations to ensure short and straightest possible leads to SPD.
G. If the lead length exceeds 18-inches, the Subcontractor shall notify the Contractor and contact the surge suppression manufacturer for installation assistance.
H. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL Standard 468A and the National Electrical Code.
I. The SPD installation shall be certified by a licensed electrician that the installation is in accordance with the manufacturer’s recommendations, applicable electrical code requirements, and the requirements of this specification. Any deficiencies noted shall be corrected by the Subcontractor. Provide written documentation of this inspection as part of the closeout documentation.

3.04 INSTALLATION OF INTERNALLY-MOUNTED SPDS:

A. When installed within a switchboard, motor control center, or panelboard, the SPD shall be installed in a dedicated bucket or space.

B. When installed within a control panel, the SPD shall be provided and installed by the control panel fabricator. Refer to Section 40 67 00 – Process Control Panels and Hardware.
C. Provide a disconnecting means or overcurrent protection and wiring as recommended by the manufacturer. When no recommendation is provided install the SPD through a 30-Amp circuit breaker using 10-gauge wire.

3.05 FIELD QUALITY CONTROL:

A. Perform tests and inspections: Inspect SPDs, modules, connections, and installation. Test and Inspect SPDs for proper function per manufacturers recommendations.

3.06 FINISHES:

A. Externally Mounted SPDs are permitted with approval of the Contractor: SPD enclosure coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
    1. Touch Up:
        a. Subcontractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
        b. Field painting shall be performed based on manufacturer's recommended procedures.
        c. Subcontractor shall provide the necessary quantity of Manufacturer's touch-up paint to match the factory applied finish.

3.07 ADJUSTING AND CLEANING:

A. For externally mounted SPDs: After field installation and final wiring terminations are completed the SPD wiring and cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.
B. Prior to final acceptance enclosure interior and exterior shall be wiped clean and free from dust and debris.

3.08 DEMONSTRATION:

A. Upon completion of installation of SPDs and associated electrical circuitry, energize circuitry and demonstrate functioning of equipment in accordance with manufacturer's requirements. Where possible, correct any malfunctioning units at the project site, then retest to demonstrate compliance; otherwise, remove and replace with new units, and retest to demonstrate compliance.

3.09 TRAINING:

A. Provide a minimum of 1 hours of training for each type of SPD provided at the customer's facility for operations, maintenance, and service personnel.
    1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
    2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, faults, diagnostic tools, troubleshooting, and preventive maintenance.
    3. Hands-on training shall be provided on equipment. Specific training shall demonstrate the replacement procedures for SPD modules.
    4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.

B. Subcontractor shall record the training sessions and provide a final edited version to the Owner on a video DVD-ROM and electronic video file format.

END OF SECTION 26 43 13

SECTION 26 50 00 – LIGHTING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes the following:
   1. Interior Luminaires:
      a. Light-emitting Diode (LED).
   2. Exterior luminaires.
      a. Light-emitting diode (LED).
   3. Emergency lighting.
   4. Exit signs.
   5. Drivers.
   6. Emergency drivers
   7. Luminaire accessories.

1.03 RELATED REQUIREMENTS:

A. Section 26 00 00 – General Electrical Requirements.
B. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
C. Section 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems.
D. Section 26 05 53 – Identification for Electrical Systems.
E. Section 26 27 26 – Wiring Devices.

1.04 REFERENCE STANDARDS:

A. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO LTS – Standard Specifications for Structural Supports for Highway Signs, Luminaires and Traffic Signals; American Association of State Highway and Transportation Officials; 5th Edition, with 2011 Interim Revisions.
B. American National Standards Institute (ANSI)/Institute of Electrical and Electronic Engineers (IEEE):
   1. ANSI/IEEE C62.41.2 – Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits; 2002 (Cor 1, 2012).
   2. ANSI/IEEE C136.10 – American National Standard for Roadway and Area Lighting Equipment - Locking-Type Photocontrol Devices and Mating Receptacles - Physical and Electrical Interchangeability and Testing; 2010.
C. Illuminating Engineering Society of North America (IESNA):
   1. IESNA LM-63 – ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
   2. IESNA LM-64 – Photometric Measurements of Parking Areas; 2001 (Reaffirmed 2007).
   3. IESNA LM-79 – Electrical and Photometric Measurements of Solid-State Lighting; Latest Edition.
D. National Electrical Contractors Association (NECA):
   1. NECA 1 – Standard for Good Workmanship in Electrical Construction; National Electrical Contractors Association; 2010.
   2. NECA/IESNA 500 –Standard for Installing Indoor Commercial Lighting Systems; National Electrical Contractors Association; 2006.

3. NECA/IESNA 501 – Recommended Practice for Installing Exterior Lighting Systems; 2006.
4. NECA/IESNA 502 – Standard for Installing Industrial Lighting Systems; National Electrical Contractors Association; 2006.

E. National Fire Protection Associations (NFPA):
1. NFPA 70 – National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
2. NFPA 101 – Life Safety Code; National Fire Protection Association; 2012.

F. Underwriters Laboratories (UL):
1. UL 844 –Luminaires for Use in Hazardous (Classified) Locations; Current Edition, Including All Revisions.
2. UL 924 – Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
3. UL 1598 – Luminaires; Current Edition, Including All Revisions.
4. UL 8750 – Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

1.05 ADMINISTRATIVE REQUIREMENTS:

A. Coordination:
1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the Work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
3. Coordinate the placement of exit signs with equipment, signage or other potential obstructions to visibility installed under other sections or by others.
4. Notify Engineer of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

1.06 SUBMITTALS:

A. Submittals to be prepared in accordance with Specification 01 33 00.

B. Shop Drawings:
1. Indicate dimensions and components for each luminaire that is not a standard product of the manufacturer.
2. Provide photometric calculations where luminaires are proposed for substitution.

C. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features. Arrange in order of luminaire designation.
1. LED control gear, controllers, arrays, modules, and packages
2. Include rated life, color temperature, color rendering index (CRI), initial and mean lumen output, and energy efficiency data.
3. Emergency Lighting Units: Battery and charger data.
4. Exit Signs: Battery and charger data.

5. Provide means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

D. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

E. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

F. Maintenance Materials: Furnish the following for Owner's use in maintenance of Project.
1. See Division 01 for additional Equipment and Materials provisions.
2. Extra Lenses and Louvers: 2% of total quantity installed for each type, but not less than one of each type.
3. Extra Globes and Guards: 2% of total quantity installed for each type, but not less than one of each type.
4. Extra Fuses: 5% of total quantity installed for each type, but not less than two of each type.
5. Extra LED drivers: 2% of total quantity installed for each type, but not less than one of each type.

G. Project Record Documents: Record actual connections and locations of luminaires, any associated pull or junction boxes, and any remote components.

1.07 QUALITY ASSURANCE:

A. Conform to requirements of NFPA 70.

B. Maintain at the Project Site a copy of each referenced document that prescribes execution requirements.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this Section with minimum three years documented experience.

E. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

1.09 FIELD CONDITIONS:

A. Maintain field conditions within manufacturer's required service conditions during and after installation.

1.10 WARRANTY:

A. See Section 01 78 00 - Closeout Submittals for additional warranty requirements.

B. Interior Lighting:
1. LED luminaires shall have a minimum 5-year manufacturer warranty.
2. Provide five-year pro-rata warranty for batteries for emergency lighting units.
3. Provide ten-year pro-rata warranty for batteries for self-powered exit signs.
4. Provide three-year full warranty for emergency drivers.

C. Exterior Lighting:
1. Provide five-year manufacturer warranty for all exterior luminaires.
2. Provide five-year manufacturer warranty for metal corrosion.
3. Provide five-year manufacturer warranty for color retention.

D. Repair or replace all luminaires that fail in finish, materials, and workmanship within manufacturer's standard warranty period, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Luminaires:
   1. Acuity Brands, Inc.
      a. Holophane.
      b. Lithonia.
      c. Mark Architectural Lighting.
      d. Peerless.
   2. Benjamin Division; Thomas Industries Inc.
   3. Cooper Lighting, a division of Eaton.
   4. CPM Lighting, Inc. (Columbia-Prescolite-Moldcast).
   5. Day-Bright Lighting, Division of Emerson Electric Co.
   6. Hubbell Lighting, Inc.
   7. KIM Lighting, Inc.
   8. Lutron Electronics Company, Inc.
   9. HE Williams.
   10. Philips Lighting.

B. Emergency Lighting Units and Exit Signs:
   1. Acuity Brands, Inc.
   2. Cooper Lighting, a division of Eaton.
   3. Hubbell Lighting, Inc.
   4. HE Williams.
   5. Philips Lighting.

C. Drivers:
   1. General Electric Company/GE Lighting.
   2. Iota Engineering.
   3. Lutron Electronics Company, Inc.
   4. Osram Sylvania.
   5. Philips Lighting Electronics/Advance.
   6. Manufacturer Limitations: Where possible, for each type of luminaire provide Drivers produced by a single manufacturer.

D. Emergency Drivers:
   1. Iota Engineering, LLC.
   2. Lithonia Lighting.
   3. Philips Emergency Lighting/Bodine.
   4. Manufacturer Limitations: Where possible, for each type of luminaire provide emergency drivers produced by a single manufacturer.

E. Light Sensitive Control Devices:
   1. Cooper - Crouse-Hinds, a division of Eaton.
   2. Intermatic, Inc.
   3. Fisher-Pierce, Sunrise Technologies of the Electro Switch Corporation.

F. Motion Sensing Devices.
   1. RAB.

2.02 LUMINAIRE TYPES:

A. Furnish products as indicated in the luminaire schedule included on the Contract Drawings.

2.03 LUMINAIRES:

A. Provide products that comply with requirements of NFPA 70.
B. Provide products that are listed and labeled as complying with UL 8750, where applicable.
C. Provide products listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
D. Provide products complying with Federal Energy Management Program (FEMP) requirements.
E. Provide products labeled as vibration and shock resistant and shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
F. Provide exterior lighting products complying with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
G. Unless otherwise indicated, provide complete luminaires including LED control gear, controllers, arrays, modules, and packages, reflectors, lenses, housings and other components required to position, energize and protect the light source and distribute the light.
H. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, hardware, supports, trims, accessories, etc., as necessary for a complete operating system.
I. Provide products suitable to withstand normal handling, installation, and service without any damage, distortion, corrosion, fading, discoloring, etc.
J. Interior Luminaire Materials:
    1. Metal Parts:
        a. Free of burrs and sharp corners and edges.
        b. Sheet metal components shall be steel unless otherwise indicated.
        c. Form and support to prevent warping and sagging.
    2. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit components without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during repairs and when secured in operating position.
    3. Diffusers and Globes:
        a. Acrylic Diffusers: 100% virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
        b. Glass: Annealed crystal glass unless otherwise indicated.
        c. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
    4. Housings:
        a. Extruded-aluminum housing and heat sink.
        b. Painted finish after fabrication, finish as indicated in luminaire schedule.
    5. Conduit: Minimum 3/4 inch (21 mm) in diameter, type as specified.
    6. Comply with Comply with UL 8750 and CSA C22.2 No. 250.13. Include recommended LED control gear, controllers, arrays, modules, and packages. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing with unit properly enclosed.
    7. Metal Finishes:
        a. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples, and if they can be and are assembled or installed to minimize contrast.
K. Exterior Luminaire Materials:

1. Metal Parts: Free of burrs and sharp corners and edges.
2. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
3. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
4. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit repairs without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect driver when door opens.
5. Exposed Hardware Material: Stainless steel.
6. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
7. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
8. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
    a. White Surfaces: 85%.
    b. Specular Surfaces: 83%.
    c. Diffusing Specular Surfaces: 75%.
9. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
10. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
11. Factory-Applied Labels: Comply with Comply with UL 8750 and CSA C22.2 No. 250.13. Include recommended LED control gear, controllers, arrays, modules, and packages. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles with unit properly enclosed.

L. LED Luminaires:
1. General:
    a. LED Luminaire Components: UL 8750 recognized or listed as applicable. Tested according to LM-79.
    b. Luminaires shall be binned with a minimum of a three-step MacAdam Ellipse to ensure color consistency among luminaires.
2. LED Luminaires with Integral LEDs:
    a. Correlated Color Temperature (CCT):
        (1) 4,000K unless otherwise indicated.
    b. Color Rendering Index (CRI): Not less than 80.
    c. Average Rated Life: Not less than 50,000 hours for an operating cycle of three hours per start.
    d. Luminaires shall be dimmable from 100% to 5% of maximum light output where indicated.
    e. LED Assembly shall be mounted to die cast aluminum housing for thermal management.
    f. LED drivers shall have a power factor greater than 0.90 lagging and less than 20 percent total harmonic current distortion (THD).
    g. Operating temperature of LED assembly and fixture shall be rated for -30 to +40°C ambient.

h. Fixture shall be UL listed for operation in damp locations when indicated.

M. Luminaires Mounted in Continuous Rows:
1. Provide quantity of units required for length indicated, with all accessories required for joining and aligning.

2.04 EXIT SIGNS:

A. Description: Exit signs and similar signs for special purpose applications such as area of refuge/rescue assistance.

B. All Exit Signs: Internally illuminated with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes and listed and labeled as complying with UL 924.
1. Number of Faces: Single or double as indicated or as required for the installed location.
2. Directional Arrows: As indicated or as required for the installed location.

C. Self-Powered Exit Signs:
1. Operation: Upon interruption of normal power source or brownout condition exceeding 20% voltage drop from nominal, solid-state control automatically switches connected light sources to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
2. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
3. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
4. Provide low-voltage disconnect to prevent battery damage from deep discharge.
5. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

D. Accessories:
1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.
2. Provide compatible accessory wire guards where indicated.

2.05 DRIVERS:

A. LED Drivers:
1. Provide LED drivers that are UL recognized complying with UL 8750.
2. Inrush Current: Not exceeding peak currents specified in NEMA 410.
3. Input Voltage: Suitable for operation at voltage of connected source, with variation tolerance of ±10%.
4. Total Harmonic Distortion: Not greater than 20%.
5. Power Factor: Not less than 0.95.
6. Sound Rating: Class A, suitable for average ambient noise level of 20 to 24 decibels.
7. Compatibility: Specifically designed for use with the specified LEDs, with no visible flicker and for full light output unless dimmer or bi-level switching control is indicated.
8. Driver Operating Frequency: Greater than 40 kHz.
9. Current Crest Factor: Not greater than 1.5.
10. Surge Tolerance: Capable of withstanding characteristic surges according to IEEE C62.41.2, location category A.
11. Electromagnetic Interference/Radio Frequency Interference (EMI/RFI) Limits: Comply with FCC requirements of CFR, Title 47, Part 18, for Class A, non-consumer applications.
12. Driver Marking: Include wiring diagrams with light source (LED) connections.

2.06 EMERGENCY DRIVERS:

A. LED Emergency Drivers:

1. Description: Self-contained, battery powered, LED emergency driver units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
2. Compatibility:
   a. Drivers: Compatible with AC drivers and LED loads rated for Class 2 output.
3. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s) to the emergency driver for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
4. Emergency drivers shall include sufficient time delays to prevent overcurrent of the LED's in the event both emergency and standard drivers supply load simultaneously.
5. Battery:
   a. Sealed maintenance-free high-temperature nickel cadmium unless otherwise indicated. Minimum of 7 year life expectancy.
   b. Recharge time shall be 24 hours or less.
6. Emergency Illumination Output:
   (1) Operate at lumen output necessary to achieve required illumination.
7. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.
8. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status and field selectable audible alert.
9. Operating Temperature: From 32ºF (0ºC) to 122ºF (50ºC) unless otherwise indicated or required for the installed location.
10. Accessories:
    a. Provide compatible accessory remote combination test switch/indicator light where indicated.

2.07 LIGHT SOURCES:

A. LED Lamps: Wattage and bulb type as indicated, with base type as required for luminaire.

1. Correlated Color Temperature (CCT):
   (1) Indoor: 4,000K unless otherwise indicated.
   (2) Outdoor: 4,000K unless otherwise indicated.
2. Color Rendering Index (CRI): Not less than 80.
3. Average Rated Life: Not less than 50,000 hours for an operating cycle of three hours per start.
4. Luminaires shall be dimmable from 100% to 0% of maximum light output where indicated.

2.08 ACCESSORIES:

A. Interior Lighting:

1. Stems for Suspended Luminaires: Steel tubing, minimum 1/2 inch size, factory finished to match luminaire or field-painted as directed.
2. Threaded Rods for Suspended Luminaires: Zinc-plated steel, minimum 1/4 inch size, field-painted as directed.

3. Wires for Suspended Luminaires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gauge (2.68 mm).
4. Wires for Suspended Luminaires in Humid Spaces: ASTM A580/A580M, composition 302 or 304, annealed stainless steel, 12 gauge (2.68 mm).
5. Hook Hangers for Suspended Luminaires: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug. Hook hanger shall include safety latch.

B. Motion Sensing Devices:
1. RAB STL200:
a. Voltage: 120V AC, 60Hz
b. Switch Capacity: 1000 watts incandescent at 120V.
c. Detection: 200° view.
d. Photoelectric Control:
(1) Deactivates lighting during daylight. Fully adjustable for custom application.
e. UL Listed for wet locations.
f. 6000V Surge Protected.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify that field measurements are as shown on the drawings.
B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
C. Verify that suitable support frames are installed where required.
D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
E. Verify that conditions are satisfactory for installation prior to starting work.

3.02 PREPARATION:

A. Provide extension rings to bring outlet boxes flush with finished surface.
B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

3.03 INSTALLATION:

A. Coordinate locations of outlet boxes provided under Section 26 05 33 – Raceways, Boxes, Seals, and Fittings for Electrical Systems as required for installation of luminaires provided under this Section.
B. Install products according to manufacturer's instructions.
C. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.
D. Supports:
1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and making repairs.
3. Provide support for luminaire without causing deflection of ceiling or wall.
4. Luminaire mounting devices shall be capable of supporting a horizontal force of 100% of luminaire weight and vertical force of 400% of luminaire weight.

E. Suspended Luminaires:
1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.

3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet in length, with no more than 4 feet (1.2 m) between supports.
4. Install canopies tight to mounting surface.
5. Where longer than 48 inches (1200 mm), brace to limit swinging.
6. Unless otherwise indicated, support pendants from swivel hangers.
7. Provide damping of luminaire oscillations where needed.
8. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of luminaire chassis, including one at each end.

F. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
1. Attach luminaire per manufacturer's recommendations.
2. Do not attach luminaires directly to gypsum board.

G. Corrosion Protection:
1. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
2. Steel Conduits: Comply with Section 26 05 33 – Raceways, Boxes, Seals and Fittings for Electrical Systems.

H. Install accessories furnished with each luminaire.

I. Bond products and metal accessories to branch circuit equipment grounding conductor.

J. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
2. Install lock-on device on branch circuit breaker serving units.

K. Emergency Drivers:
1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.
2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal driver(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
3. Install lock-on device on branch circuit breaker serving units.

L. Burn-In: Operate luminaires at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace luminaires that fail prematurely due to improper burn-in.

3.04 FIELD QUALITY CONTROL:

A. Inspect each product for damage and defects.

B. Operate each luminaire after installation and connection to verify proper operation.

C. Test self-powered exit signs, emergency lighting units, and emergency drivers to verify proper operation upon loss of normal power supply.

D. Verify operation of photoelectric controls.

E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy drivers as determined by Engineer.

F. Measure illumination levels at night with calibrated meters to verify conformance with performance requirements. Record test results in written report to be included with submittals.
1. Test according to IESNA LM-64 (parking areas).

G. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.05 ADJUSTING:

A. Aim and position adjustable luminaires to achieve desired illumination as indicated or as directed by Engineer. Secure locking fittings in place.

B. Aim and position adjustable emergency lighting units to achieve optimum illumination of egress path as required or as directed by Engineer or authority having jurisdiction.

C. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Engineer or authority having jurisdiction.

D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to two visits to Project during other-than-normal hours for this purpose. Some of this Work may be required during hours of darkness.

3.06 CLEANING:

A. Clean surfaces according to NECA 500 (commercial lighting), NECA 501 (exterior lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.

3.07 CLOSEOUT ACTIVITIES:

A. See Section 01 78 00 - Closeout Submittals for closeout submittals.

B. Demonstration: Demonstrate proper operation of luminaires to Engineer, and correct deficiencies or make adjustments as directed.

C. Just prior to Substantial Completion, replace all luminaires that have failed.

3.08 PROTECTION:

A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 26 50 00

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

SECTION 28 10 00 – ELECTRONIC ACCESS CONTROL AND INTRUSION DETECTION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this SECTION.

1.02 SUMMARY:

A. This Section describes the requirements for security access control and intrusion detection systems. The systems shall be user-configurable and scalable.

B. The completed system shall include, but not be limited to, the following major components:
   1. Security access control and monitoring software.
   2. Access control panels.
   3. Door hardware with integrated strike locks and panic bars shall be as specified in SECTION 08 70 00.
   4. Door and gate contacts.
   5. Card readers.
   6. Gate pedestals with sun shades.
   7. Power supplies as required.

C.

D. Coordinate with the door vendor for door lock type and door hardware.

E. All equipment shall be UL listed.

1.03 DELEGATED DESIGN:

A. The Contractor shall be responsible for providing fully operational security access control and intrusion detection systems as indicated on drawings. All necessary hardware and software required for the fully-operational system shall be the responsibility of the Contractor and shall be provided at no additional cost to the Owner.

1.04 RELATED REQUIREMENTS:

A. SECTION 08 70 00 – Finish Hardware.

B. SECTION 26 05 19 – Electrical Power Conductors and Cables.

C. SECTION 26 05 26 – Grounding and Bonding for Electrical Systems.

D. SECTION 26 05 33 – Raceways, Boxes, and Supports for Electrical Systems.

E. SECTION 40 66 00 – Process Control Networks.

1.05 REFERENCE STANDARDS:

A. Electronic Components Industry Association (ECIA):
   1. EIA/ECA-310-E – Cabinets, Racks, Panels, and Associated Equipment.

B. National Fire Protection Association (NFPA):
   1. 70 – National Electrical Code (NEC).

C. National Electrical Manufacturers Association (NEMA):
   1. 250 – Enclosures for Electrical Equipment (1,000V maximum).

D. Underwriters Laboratories (UL):
   1. 50 – Enclosures for Electrical Equipment.

1.06 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Manufacturer with prime responsibility shall assume responsibility for all Compliance Submittals.
C. Product Data: Submit the following for each type of product specified and included as minimum:
    1. Data sheets for all components furnished.
D. Qualification Statements:
    1. Fabricator's qualifications.
E. Shop Drawings: Provide the following as minimum:
    1. Fabrication drawings, front elevation, wiring diagrams, and bills of material for access control panels.
    2. Electrical connection diagrams showing termination locations for all field wiring. External connection diagrams shall indicate cable number and wire color for field cables terminated at the panel.
    3. Engraving schedule and physical dimensions for nameplates.
F. Special Procedure Submittals:
    1. Test Plan:
        a. Provide a complete and detailed test plan for the supplied access control panels.
        b. Include procedures for certification, validation, and testing.
    2. Syllabus for Owner training.
G. Test and Evaluation Reports:
    1. Factory test reports.
    2. Field test reports.
H. Closeout Submittals: Final documentation shall include the following as minimum:
    1. Operation and Maintenance Manuals including the following:
        a. Operation and maintenance manuals for all components furnished.
        b. Certified "As-Built"/"As-Installed" drawings.
        c. Copies of all approved Product Data.
        d. Copies of all approved Test Reports.
        e. Spare parts and supply list.
        f. Warranty Information.
        g. Contractor Information.
I. Maintenance Material Submittals:
    1. Spare Parts:
        a. Provide five (5) spare fuses of each type used including those used in power supplies.
        b. Provide 10 spare access cards.
    2. Software:
        a. Original media (i.e. CD/DVD-ROM disks and/or flash drives) containing all software associated with the supplied equipment.
        b. Organize and submit all software copies in a 3-ring binder.

1.07 QUALITY ASSURANCE:

A. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to Bid opening.

1.08 DELIVERY, STORAGE, AND HANDLING:

A. Access control panels and associate equipment shall be packaged and shipped to the project site in such a manner as to avoid damage.

B. All equipment shall be stored according to the manufacturer's instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.

1.09 PROJECT SITE CONDITIONS:

A. Do not store or install the control panel equipment specified herein until designated installation spaces are suitable for intended service.

B. For indoor control panels final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing panel and shall be maintained for the remainder of the construction period.

1.10 WARRANTY:

A. All equipment shall be provided with a minimum one-year warranty period.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Access Control System (Controllers, control panels, software, and accessories):
   1. Match owner's existing system.

B. Door and Gate Contacts:
   1. George Risk Industries, Inc.
   2. G.E. Interlogix - Sentrol.
   3. Honeywell.
   4. Engineer approved equal.

C. Request-to-Exit (REX) Motion Detectors:
   1. G.E. Security.
   2. Honeywell.
   3. Bosch Security Systems.
   4. Engineer approved equal.

D. Card Readers:
   1. Match owner's existing system.

2.02 ACCESS CONTROL SYSTEM:

A. The access control system shall include, but is not limited to, access controllers, communications adapters, access control panels, power supplies, and system software.

B. The access control system shall be based on components compatible with Owner's existing equipment used throughout the City.

C. Each card access system shall have the following I/O capabilities:
   1. Inputs:
      a. Card Readers
      b. Request to Exit (REX): Normally open loop.
      c. Door Switch: Normally closed loop.
   2. Outputs:
      a. Main Relay: Form C, SPDT, 12-24VAC/DC, 2A.
      b. Alarm Shunt: Form C, SPDT, 12-24VAC/DC, 1A.
      c. Door Ajar: Form C, SPDT, 12-24VAC/DC, 1A.

d. Forced Door: Form C, SPDT, 12-24VAC/DC, 1A.

D. Communications:
   1. The system shall support Ethernet (CAT6E) Communication for interconnection of multiple backplanes.

E. The system shall be expandable for control of up to 64 modules per site and be networked with unlimited sites.

F. The peripherals, specified in this Section, shall be fully compatible with the specified access control system. The Contractor shall be responsible for integrating the peripherals to the access control system.

G. The network cabling and all required wiring between peripherals and network components shall be provided as recommended by the equipment manufacturers.

H. The access control system shall be fully operational with programmed information. The Contractor shall coordinate with the Owner for the programming input data.

I. The access control system components shall be housed in a NEMA 12 lockable enclosure.
   1. The enclosure shall be ventilated and sized to accommodate all required components and dissipate the heat generated in the panel.
   2. The interconnecting cables and wires shall be neatly arranged and installed in wiring channels.
   3. The components shall be DIN rail or shelf mounted inside the enclosure and shall be secured.
   4. Provide DIN-railed mounted terminal strips, as required, inside the enclosure for all field wiring terminations, excluding communication cables. The terminal strips shall be rated for 300V applications and shall be sized to accommodate field wire sizes.

J. Provide all required power supplies for all components housed in the security panel and all peripheral devices connected to the security panel. Power supplies shall have minimum of 25% spare capacity. All power supplies shall be provided with overload and short circuit protection and shall be mounted in the security panel.

K. Each access control panel shall include a 7AH battery with charging system to provide backup in the event of power failure. Battery and charger shall be as recommended by the manufacturer.

L. A tamper switch shall be provided for the enclosure and the switch shall be wired to an input in the plant control system. Provide Sentrol Model 3012 or equal.

M. Software:
   1. Provide all required software installed on the indicated workstations for complete system monitoring and management of the access control system.
   2. The software shall store all system transactions in a common database stored on the network server.
   3. The System Repository folder shall be located on a Windows Server operating system and the System Manager shall operate on Windows operating system.

2.03 DOOR CONTACTS:

A. Recessed mounted door contacts shall meet the following requirements:
   1. Designed for recessed mounting in the door frame.
   2. 3/4-inch diameter.
   3. Minimum 1/2-inch gap in steel doors.
   4. Hermetically sealed reed switch with matching actuating magnet.
   5. Minimum one foot lead length.
   6. Normally closed when active (door is closed).

7. Compatible with specified access control modules.

B. Surface mounted door contacts shall meet the following requirements:
   1. Hermetically sealed reed switch with matching actuating magnet.
   2. Brushed anodized aluminum housing.
   3. Three foot stainless steel armored cable.
   4. Mounting bracket as required.
   5. Normally closed when active (door is closed).
   6. Compatible with specified access control modules.
   7. All mounting hardware shall be included for the installation.

2.04 GATE CONTACTS:

A. The gate contacts shall meet the following requirements:
   1. Hermetically sealed reed switch with matching actuating magnet.
   2. Brushed anodized aluminum housing.
   3. 3-inch wide operation gap distance.
   4. Minimum three foot stainless steel armored cable.
   5. Mounting bracket as required.
   6. Normally open contact.
   7. Compatible with specified access control modules.

2.05 MOTION REQUEST TO EXIT (REX) DETECTORS:

A. The motion REX detector shall meet the following requirements:
   1. Dual technology utilizing passive infrared and radar technology.
   2. Voltage: 12 to 24 Vac/Vdc.
   3. Alarm Output: DPDT Form C contact.
   4. Alarm duration: Adjustable from 0.5 – 60 seconds.
   5. Adjustable detection range 5-15 feet.
   6. Activation LED.
   7. Operating temperature: -29°C to 49°C., 0 to 95% non-condensing
   8. All mounting hardware (wall mount) shall be included for the installation.

2.06 CARD READER:

A. The card reader specified herein is based on HID ProxPoint Plus 6005 Model proximity readers.

B. The card reader shall meet the following requirements:
   1. Read range: Up to 3 inches with compatible card.
   2. Input voltage: 5–16Vdc at reader.
   3. Operating temperature: -30°C to 65°C.
   4. Enclosure: The reader shall be of potted, polycarbonate material, sealed to a NEMA rating of 4X.
   5. LED indicator with tri-color standard (red, green, amber).
   6. Audio tone.
   7. Output format: Wiegand.
   8. Frequency: 125 kHz (excitation).
   9. Factory or field programmable.
   10. Rated for indoor and outdoor installation.
   11. Compatible with specified access control modules.

C. Provide a minimum of twenty 125 kHz HID Proximity Access Cards compatible with the owners existing system.

2.07 PEDESTALS:

A. Provide 40-inch gooseneck pedestal with offset for mounting of enclosures for access control, intercom and camera. The stand shall be hollow to allow for the passage of cables and shall be designed for mounting on a concrete foundation as indicated.
B. Provide lockable NEMA 4 enclosure with rain shield over the face mounted components for mounting of indicated devices. Enclosure shall be sized to accommodate the indicated components.
C. Pedestal and enclosure shall be provided with a natural aluminum or stainless steel corrosion resistant finish.

2.08 WIRING SYSTEM:

A. Provide basic wiring materials which comply with SECTION 26 05 19 – Electrical Power Conductors and Cables and SECTION 26 05 33 – Raceways, Boxes, and Supports for Electrical Systems.
B. Wire and cabling types shall be in accordance with the requirements of the system manufacturer.
C. Provide multi-conductor cables as indicated on the drawings.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment.
B. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing the access control panels and shall be maintained for the remainder of the construction period.

3.02 INSTALLATION:

A. The security access control and intrusion detection systems, specified herein, shall be installed by trained and qualified personnel who have minimum of five (5) years of experience installing similar systems. All components shall be installed in accordance with the manufacturer's installation manuals and recognized industry practices.
B. Provide all labor, materials, startup, programming, etc. for a fully functioning system.
C. Mount equipment plumb, level, square, and secure.
D. Installation of basic wiring system materials:
    1. Install wiring, raceways, and electrical boxes and fittings in accordance with SECTION 26 05 19 – Electrical Power Conductors and Cables and SECTION 26 05 33 – Raceways, Boxes, and Supports for Electrical Systems.
    2. Install all wiring in raceways.
    3. Where possible, install wires and cables without splices. Make connections and splices at terminal strips in terminal boxes, cabinets or at equipment terminals.

3.03 PROGRAMMING:

A. The access control system shall be programmed to allow access to the indicated areas. Coordinate with the Owner for a complete list of employees and access control rights.

B. Forms shall be developed to allow easy entry of new employees and editing of existing employee rights.
C. Program the database tags, descriptions, and alarm reports in a clear and concise manner.
D. The security system shall be programmed to provide the indicated outputs to the plant control system.
E. The security access control for the entrance/exit automatic gate operators shall meet the following sequence of operations:
    1. Normal Request for Entry: The security access control system shall open the gate when the request for entry is made via the entry card reader or when a valid card is presented to the card reader in the control room associated with the entrance gate. Once the gate reaches its full open status, the gate shall be programmed to stay open for 30 seconds before the gate starts its closing cycle. The gate closing cycle shall be inhibited if the gate operator and associated protective devices detect any obstruction along the closing path of the gate. Once the obstruction is removed, the gate shall proceed with the closing.
    2. Normal Request to Exit: The gate shall be designed for a free exit using an inductive loop request to exit. If the inductive loop detects the presence of a vehicle the request to exit contact shall be activated to the gate access control module and the gate shall open. Once the gate reaches its full open status, the gate shall be programmed to stay open for 30 seconds before the gate starts its closing cycle. The gate closing cycle shall be inhibited if the gate operator and associated protective devices detect any obstruction along the closing path of the gate.
F. The security access control for a typical man door shall meet the following sequence of operations:
    1. Normal Request for Entry: The security access control system shall actuate the man door electric strike when the request for entry is made via the man door card reader. The electric strike shall be released and remain released for 10 seconds before the system secures the electric strike.
    2. Normal Request to Exit: The man door shall be designed for a free exit using a request to exit push bar or a motion sensing device located on the door interior. The request to exit push bar or motion sensing device shall initiate a contact closure to the access control module exit circuit. The access control module shall release the electric strike and give a permissive to the system for a free exit. The system shall incorporate a 10 second time delay after the request to exit is given to complete the exit cycle.

3.04 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services:
    1. The equipment supplier shall provide the field services of a trained technician for the amount of time required to commission, test and start-up all equipment provided.
    2. All travel and living expenses shall be included for all trips to the site. All equipment required for testing, start-up and performance verification shall be provided by the start-up technician.
B. Check all internal and external connections and tighten as required.
C. Perform I/O checkout on all points and verify proper operation.
D. Verify proper connection of communication cabling and proper communication system configuration.
E. Field verify proper operation of all inputs and outputs.
F. Record results of I/O checkout and submit test reports as specified in DIVISION 01.

3.05 ADJUSTING AND CLEANING:

A. After field installation and final wiring terminations are completed the access control panel wiring and cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.
B. Wiring duct covers shall be replaced and secured as required.
C. Prior to Construction Acceptance control panel interior and exterior shall be wiped clean and free from dust and debris.

3.06 TRAINING:

A. Provide a minimum of 2 hours of training at the customer's facility for operations, maintenance and service personnel.
    1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
    2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, faults, diagnostic tools, troubleshooting, and preventive maintenance.
    3. Hands-on training shall be provided on equipment.
    4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.
B. The Owner at their option shall be allowed to video record all training sessions for future reference.

END OF SECTION 28 10 00

DIVISION 31 – EARTHWORK

SECTION 31 20 00 – SITE PREPARATION AND EARTHWORK

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes Site preparation activities and certain items of earthwork common to other related work as necessary to complete the Work including:
   1. Clearing and Grubbing.
   2. Disposal of Waste Materials.
   3. Stripping.
   4. Excavation.
   5. Stockpiling.
   6. Fill.
   7. Borrow.
   8. Site Grading.
   9. Topsoiling.
   10. Weed Management.
   11. Maintenance and Repair.

1.03 RELATED REQUIREMENTS:

A. Section 02 41 19 - Selective Demolition.
B. Section 31 23 13 - Subgrade Preparation.
C. Section 31 23 16 - Excavation and Filling for Structures.
D. Section 31 23 33 - Trenching and Backfilling for Utilities.
E. Section 32 11 23 - Crushed Aggregate Base Course.

1.04 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. ASTM International (ASTM): (Approved equivalent AASHTO standards may be substituted.)
   1. ASTM D698 – Standard Test Methods for Laboratory Compaction Characteristics of Soils Using Standard Effort (12,400 ft-lbf/ft3 (600 kN□m/m3)).
   2. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
   3. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   4. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   5. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   6. ASTM D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
C. U.S. Department of Interior, Bureau of Reclamation (USBR):

1. Earth Manual, 2nd Edition, Designation E-12, Relative Density of Cohesionless Soils, Alternate Method.

D. City and County of Broomfield (CCoB) Standards and Specifications
E. State of Colorado Department of Transportation (CDOT)
   1. Standard Specifications for Road and Bridge Construction.

1.05 DEFINITIONS:

A. Refer to PART 2 for detailed definitions and included materials.
B. Borrow: Earth materials obtained from sources other than excavations or stockpiles within the area to be graded by Contractor.
C. Clearing: The removal of trees, shrubs, and other vegetation above the existing grade surface.
D. Dike: A fill that will be required to hold water.
E. Excavation: Material removed (cut) below the elevation of the original (existing) ground surface.
F. Fill: Material placed above the elevation of the original (existing) ground surface after stripping or material used in restoring an earlier excavation.
G. Grubbing: The removal of roots, shrubs, and other vegetation to a depth below the ground surface.
H. Stripping: Excavation of any overlying layer of material to expose material of a different type, use, or class.
I. Structural Fill: A screened earthen material used to create a strong stable base where native soils may be too weak to support a structure.
J. Subgrade: The surface layer of earth on which structures, pavements, railroads, or other surfacing materials, except topsoil, are to be placed.
K. Topsoil: The final surface layer of earth material intended to support vegetation.

1.06 SUBMITTALS:

A. Submit as specified in Division 01.
B. Includes, but not limited to, the following:
   1. Test results from laboratory testing of proposed borrow materials.
   2. Test results from laboratory testing of fill and pipe embedment materials.
   3. Erosion Control Plan.
   4. On-site Material Data.
   5. Dewatering Plan, as required.
   6. Sheeting and Shoring Excavation Plan, as required.

1.07 QUALITY ASSURANCE:

A. Sampling and Testing:
   1. Owner will, through the services of an independent, commercial laboratory, perform all off-site testing of Owner-furnished materials.
   2. Tests to determine conformance with all requirements of this specification for quality and properties of all Contractor-secured materials, including borrow materials proposed for use, shall be performed by an independent, commercial laboratory retained and compensated by Contractor, and approved by Engineer.
   3. It is the responsibility of the contractor to provide the proper means and equipment to excavate and grade as necessary to allow independent, commercial laboratory to perform testing.

1.08 JOB CONDITIONS:

A. Lines and grades shall be as indicated. Engineer will furnish benchmarks, base lines, and reference points as necessary to permit Contractor to lay out and construct the Work properly.

B. Carefully maintain all benchmarks, monuments, and other reference points and replace as directed by Engineer if disturbed or destroyed.

C. Prior to submitting Bid, make arrangements with Owner for entry to Site for the purpose of conducting subsurface investigations, including test borings.

D. Disposition of Utilities:

1. Adequately protect from damage all active utilities and remove or relocate only as indicated.
2. Report inactive and abandoned utilities encountered in excavating and grading operations. Remove, plug, or cap as directed by Engineer.

E. Survey work, to accurately determine locations, elevations, and quantities of Contract pay items, shall be performed during construction by a Professional Surveyor registered in the state of Colorado. Surveyor shall be retained and compensated by Contractor. Contractor shall notify Engineer prior to commencing survey work.

PART 2 - PRODUCTS

2.01 MATERIALS ENCOUNTERED

A. Suitable Materials: Materials suitable for use in construction include material that is free of debris, roots, organic matter, frozen matter, and which is free of stone having any dimension greater than two inches in areas requiring a high degree of compaction, or six inches in other embankment and fill areas:

1. Cohesionless materials that classify as GP, GW, GM, GC, SP, SW, SM, or SC in accordance with the Unified Soil Classified System, ASTM D2487, include gravels, gravel-sand mixtures, sands, and gravelly sands exclusive of clayey and silty material; materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
2. Cohesive materials that classify as ML, MH, CL, or CH in accordance with the Unified Soil Classification System, ASTM D2487, include silts and clays generally exclusive of sands and gravel; materials for which impact compaction will produce a well-defined moisture-density relationship curve.
3. Suitable material shall have no more than 4% lignite by weight.

B. Unsuitable Materials: Materials unsuitable for use in construction include all material that contains debris, roots, organic matter, frozen matter, shale particles, or material containing gravel or stone with any dimension greater than two inches in areas requiring a high degree of compaction or six inches in other embankment and fill areas, or other materials that are determined by ENGINEER as too wet or otherwise unsuitable for providing a stable subgrade or stable foundation for structures.

C. Non-Expansive Soils: A fill material should be considered non-expansive if the swell potential under a 200 psf surcharge pressure does not exceed 1/2% when a sample remolded to 95% of the standard Proctor (ASTM D 698) maximum dry density at optimum moisture content is wetted.

1. Imported non-expansive fill material should have a maximum of 65% passing the No. 200 sieve and a maximum plasticity index of 10. Imported or on-site fill materials not meeting the above plasticity index criteria may be acceptable provided the maximum

percentage passing the No. 200 sieve specified above, and the swell criteria outlined in item 3 above are satisfied.

D. Materials to be excavated shall be classified as follows for purpose of payment:
   1. Common Excavation: Includes all materials excavated other than rock excavation and all boulders or detached pieces or solid rock, less than two (2) cubic yards in volume.
   2. Waste Materials: Waste materials, as described for purposes of this Section, consist of unsuitable materials, excess suitable material, rock, demolition debris, and other materials considered unacceptable for use as fill, and which are not environmentally contaminated. Waste materials shall not include environmental pollutants, hazardous substances, contaminated products, by-products, samples, or waste materials of any kind that are regulated under environmental laws.

2.02 EMBANKMENT AND FILL

A. General Fill shall be free of waste, debris, and frozen material, suitable for embankment construction, and contain a maximum six-inch stone size in any dimension. It shall be of such a nature and character that it can be compacted to the minimum specified dry density with a reasonable compaction effort.
B. Moisture content shall be that required to obtain specified compaction of the soil or as indicated.
C. Perform moisture curing by wetting or drying of the material as required to attain required compaction criteria.

2.03 GRANULAR MATERIAL:

A. Granular material for bedding and backfill of structures shall meet the requirements specified in Section 31 23 16 – Excavation and Backfill for Structures.
B. Granular material for pipe bedding and trench stabilization shall meet the requirements specified in Section 31 23 33 – Trenching and Backfill for Utilities.
C. Aggregate for below pavement shall meet the requirements specified in Section 32 11 23 – Crushed Aggregate Road Base.
D. Rip rap material shall meet the requirements specified in Section 31 32 11 – Soil Surface Erosion Control.

PART 3 - EXECUTION

3.01 SITE PREPARATION:

A. The Contractor shall develop access to the construction area(s) as necessary.
B. Contractor shall contact utility companies and locate, mark out, and protect all existing utilities before commencement of the Work.
C. The Contractor shall install temporary erosion and sediment control measures as specified in the contract drawings prior to beginning the Work. Measures shall be constructed in substantial compliance with local, state, federal, and jurisdictional agencies regulation and shall be maintained until completion of Contract and termination of applicable permits. Accumulated sediment shall be disposed of on-site by the Contractor in a manner approved by the Owner.

3.02 DEMOLITION:

A. Complete demolition of site features as indicated on the Drawings and in accordance with Section 02 41 19 – Selective Demolition.

3.03 CLEARING AND GRUBBING:

A. Clear and grub all areas where earthwork is to be performed, including borrow areas, and any other areas beyond the earthwork limits where indicated.

B. Clearing:

1. Clearing includes felling and disposal of trees and scraping areas clean of all brush, grass, weeds, roots, and other combustible material found on or above the existing ground surface inside the clearing limits.
2. Remove and keep separate topsoil from areas within limits of excavation, trenching, borrow, and areas designated to receive fill.
3. Clear vegetation to a minimum depth of 6 inches, but to a sufficient depth to remove excessive roots in heavy vegetation, unsuitable material, or brush areas and as required to remove all soil containing organic material or segregate topsoil.
4. Stockpile topsoil in areas approved by Owner and Engineer, where it will not interfere with construction operations or existing facilities. Stockpiled topsoil shall be reasonably free of subsoil, debris, and stones larger than 2-inch diameter.
5. Conduct work in a manner to prevent damage to property and to provide for the safety of employees and others.
6. Keep operations within construction limits as indicated in contract drawings.

C. Grubbing:

1. Grubbing includes the removal and disposal of all tree stumps and roots where fill is to be placed and when the excavated material is to be used as fill. Removal and disposal of tree stumps and roots larger than 3 inches in diameter will be required at all other locations.
2. Remove to a depth of at least 12 inches below existing grade elevation at all other locations.
3. Backfill all excavated depressions with approved material and grade to drain.

3.04 EXCAVATION:

A. General:

1. Excavate all materials found within the designated limits for excavation.
2. Excavation shall be performed to the lines and grades indicated in the Drawings. No excavation shall begin until the Contractor has provided construction staking for the proposed work.
3. Perform excavation by any recognized method of good practice to complete the Work in the most expeditious manner and in conformance with specified requirements.
4. Take precautions to ensure no damage to existing facilities or equipment, or other work.
5. All materials encountered, regardless of type, character composition and condition thereof, shall be considered "unclassified" for the purpose of payment. Rock encountered shall be handled at no extra cost to Owner.
6. All materials excavated shall either be placed in stockpiles to be used as General Fill material or hauled to the designated waste spoil stockpile area. During excavation, grades shall be maintained to provide drainage of any surface waters that may impact the Work.
7. Limits of excavation shall be as shown on the contract drawings and specified below:
   a. Six inches below bottom of slab for all structures.
   b. One foot outside the lines of the vertical surface on a structure.

B. Dewatering:

1. Control grading around excavations to prevent surface water from flowing into excavation areas.

2. Drain or pump as required to continually maintain, including days not normally worked, all excavations free of water or mud from any source, and discharge to approved drains or channels. Commence when water first appears and continue as required to keep excavation free of standing water during entire time excavation is open.
3. Use pumps of adequate capacity to ensure rapid drainage of area, and construct and use drainage channels and subdrains with sumps as required.
4. When water is found in the excavation, remove unsuitable excessively wet subgrade materials and replace with approved compacted fill material as directed by Engineer and at no additional cost to Owner.
5. Contractor shall submit a dewatering plan prior to beginning excavation.

C. Blasting:
1. Blasting will not be permitted.

3.05 STOCKPILING:

A. Clear, grub, and seal, by rubber-tired equipment, the ground surface at stockpile locations.
B. Maintain stockpiles in a neat and well-drained condition.
C. Provide drainage for the stockpiles and surrounding areas by methods approved by the Engineer.
D. Stockpile in amounts sufficient for and in a manner to segregate materials suitable for constructing fills and top soiling.
E. Segregate waste material stockpiles from suitable materials to avoid contamination of suitable materials.
F. Do not obstruct or prevent access to the following existing roads, driveways, utilities, or drainage features.
G. Perform in a manner to avoid endangering the Work, stability of banks or structures, or health of trees and shrubs to be saved.
H. Maintain safe distance between toe of stockpile and edge of excavation or trench.
I. Stockpile in other areas or off Site when adjacent structures, easement limitations, or other restrictions prohibit sufficient storage adjacent to the Work. Off-Site areas shall be arranged for by Contractor at no additional cost to Owner.

3.06 DISPOSAL OF WASTE MATERIALS:

A. Waste Materials: Includes excess suitable materials, and materials unsuitable for use in the Work.
1. Unsuitable materials include all material that contains debris, roots, organic matter, frozen matter, rock (with any dimension greater than one-half the loose layer thickness), or other materials that are determined by the Engineer as too wet or otherwise unsuitable for providing an acceptable fill or subgrade for roads and structures.
2. Suitable materials include material that is free of debris, roots, organic matter, refuse, coal, ashes, cinders, frozen matter and, which is free of rock with any dimension greater than one-half the specified loose layer thickness and conform to the cohesive or cohesionless fill material specified herein.

B. Remove unsuitable materials from work area as excavated.
C. Keep excess suitable material segregated from unsuitable waste in the disposal area. Excess materials should be removed in a reasonable time as approved by Owner and Engineer.
D. Segregate and protect different suitable materials that the contractor will reuse on the site in locations approved by the Owner and Engineer.

E. Unsuitable materials shall be disposed of at a location arranged for by Contractor, at no additional cost to Owner.
F. Deposit in indicated waste areas.
   1. Spaced in lifts not exceeding 12 inches in thickness.
   2. Compact by routing hauling and spreading equipment uniformly over the surface of each lift.
   3. Place waste rock in interior of waste areas not less than 12 inches below the final surface grade.
   4. Grade waste areas to leave them with an orderly uniformly graded appearance and to be free draining. Final slopes shall not be steeper than 3 horizontal to 1 vertical; nor shall final grades be flatter than 1%.
G. Disposal of Debris:
   1. Dispose of debris from clearing, grubbing, and demolition at a location off the Site, as arranged for by Contractor, at no additional cost to Owner.
   2. Contractor may claim and salvage any timber or other debris which he may consider of value but shall not delay in any manner either this Contract or other work with salvaging operations.

3.07 FILL:
A. General:
   1. The construction of "fill" shall consist of obtaining suitable materials and placing these materials in compacted lifts.
   2. Construct fill to the contours and elevations indicated, using approved equipment and suitable approved materials specified above. Obtain materials for fill construction in the following order of priority:
      a. From indicated on-Site excavation.
      b. From borrow areas secured by Contractor.
   3. If the slope bounding the fill area is steeper than six horizontal to one vertical, step or serrate prior to placing the material as indicated.
   4. Do not place snow, ice, or frozen earth in fill and do not place fill on a frozen surface.
   5. Place fill material only on ground surfaces which conforms to the following:
      a. Scarified to 12 inches deep prior to placement of first lift.
      b. Compacted prior to placement of second or succeeding lifts.
      c. Wetted or dried as required to obtain correct moisture content.
      d. Approved by Engineer.
   6. Do not place fill for dikes on any fractured rock surface. If fractured rock is encountered, remove to a depth of 2 feet below the impoundment bottom and replace with suitable compacted fill.
   7. All slopes on fills shall be constructed 1 foot wider than indicated and then dressed to the final grade.
B. Earthen (Cohesive) Fill:
   1. Material shall be friable sandy or silty clay containing sufficient fine material to provide a dense mass free of voids when compacted. When impact compacted, these materials will produce a well-defined moisture-density relationship curve.
   2. Material shall not contain more than 10% by volume of rock and gravel and not contain particles with maximum dimension greater than one-half the depth of the layer to be compacted.

3. Compact with approved equipment to a minimum of 95% of maximum dry density and within the moisture content range from 1% to 4% above optimum. Optimum moisture and maximum density shall be determined by standard Proctor, ASTM D698.
4. Place fill material in 8-inch maximum layers (uncompacted depth) in all areas.
5. Perform any wetting or drying of the material as required to obtain the specified density when compacted and to maintain specified moisture content range at the time of placement.

C. Sand and Gravel (Cohesionless) Fill:
1. Include gravels, gravel-sand mixtures, sands, and gravelly sands exclusive of clayey and silty components. These materials have the following properties:
   a. Free-draining.
   b. Impact compaction will not produce a well-defined moisture-density relationship curve.
   c. The maximum density by impact methods will generally be less than by vibratory methods.
2. Place sand and gravel fill in 8-inch maximum lifts (uncompacted depth).
3. Obtain compaction by use of approved vibratory rollers and other equipment during the placement and grading of layers.
4. Compact to a minimum of 95% of maximum dry density within 2% above or below optimum moisture content as determined by modified Proctor, ASTM D1557.

D. Compaction Testing:
1. The minimum frequency of in-place compaction testing including density and moisture content will be in accordance with Section 311.02 Minimum Testing Requirements of the CCoB Standards and Specifications.
2. Perform additional tests when Engineer suspects the quality of moisture control or effectiveness of compaction.
3. Fill failing to meet required densities shall be removed or scarified and recompacted as necessary to achieve specified results.
4. Removal of in-place material and replacement with approved new material will be required if scarifying and recompaction do not product the required densities.

E. Equipment:
1. Compaction equipment shall conform to the following requirements and be subject to the approval of Engineer.
   a. Tamping Rollers:
      (1) May be towed or self-propelled.
      (2) Have staggered uniformly spaced knobs or feet. When fully loaded, they shall exert at least 250 psi on combined area of tamping feet in contact with ground.
      (3) Be equipped with cleaning fingers maintained at full length to prevent accumulation of material between feet.
      (4) Maintain all equipment in good repair.
   b. Pneumatic Rollers:
      (1) Have two axles, not less than nine wheels with pneumatic tires of equal size, diameter, and ply rating, a rigid steel frame, and a body suitable for ballast loading. Tracking wheels shall overlap by a minimum of 1/4-inch.
      (2) Tires shall be uniformly inflated at all times.
      (3) Self-propelled or towed.

c. Vibratory Rollers:
   (1) Have either one or two smooth-surfaced steel drums with a minimum diameter of 42 inches.
   (2) Have a minimum vibrating force of 300 pounds per cycle per inch of drum width.
   (3) Have a minimum vibrating frequency of 1,200 cycles per minute with a means of adjusting the resonance of the dynamic force.
   (4) May be self-propelled or towed.

d. Power tampers shall be used for compaction of material in areas where it is impractical or unsafe to use heavy equipment, and as recommended by Engineer.

e. Vibratory plate compactor may be used for compaction of sand and/or gravel material in areas where it is impractical or unsafe to use heavy equipment, and as recommended by Engineer.

3.08 BORROW:

A. Borrow materials refers to all fill materials and topsoil obtained from approved locations either on or off the jobsite.

B. Borrow shall include all clearing, grubbing, excavating, handling, and final disposal of materials as specified. Borrow, if required, to bring fill areas to the lines and grades indicated, shall be furnished by Contractor, as specified, at no additional cost to Owner.

C. Borrow areas shall be:
   1. Arranged by Contractor at no additional cost to Owner.
   2. Subject to approval by Engineer.

D. Prior to incorporating borrow materials into the Project, borrow material from each source shall be tested by an independent laboratory compensated by Contractor. Tests on borrow materials shall include, unified soil classification, grain size analysis, liquid limit, plasticity index, moisture density relations of soils, and permeability. Contractor shall submit copies of test results to Engineer, and Owner. Material removed from borrow areas shall be as approved by Engineer. Excavate borrow material in uniform layers not greater than 2 feet in thickness except as indicated.

E. Leave borrow areas graded to drain and to present a neat appearance.

F. Seed and mulch surface of borrow area after grading. Contractor will be held responsible for any erosion that occurs until a sturdy growth over a minimum of 98% of the area seeded is established.

3.09 SITE GRADING:

A. Excavate, fill, and rough grade to bring Project area to subgrades as follows:
   1. To underside of respective surfacing or base course for surfaced areas.
   2. As indicated on grading sections for seeded areas, ditches, and slopes.
   3. As indicated for unsurfaced and unseeded areas.

B. Finish Grading:
   1. Grade and compact all areas within the Project, including excavated and filled sections, and adjacent transition areas reasonably smooth and free from irregular surface changes.
   2. Degree of finish shall be that ordinarily obtained from blade grader or scraper operations, except as otherwise specified.
   3. Site grading for sloped landscape areas shall not be more than 0.2 foot above or below established grade with due allowance for topsoil.

4. Site grading near buildings and relatively flat landscape areas with allowances for surface materials shall not be more than 0.1 feet above or below established grade.
5. Finished grades for roads, drives, and surfaced areas shall not be lower than indicated, nor higher than 0.1-foot above that indicated.
6. Finish all ditches and swales to drain readily.
7. Unless otherwise indicated, slope the subgrade evenly to provide drainage away from (indicated future) building walls in all directions at a grade not less than 1/4-inch per foot.
8. Provide roundings at top and bottom of banks and at other breaks in grade.

3.10 SUBGRADE PREPARATION:

A. Subgrade preparation shall be in accordance with Section 31 23 13 – Subgrade Preparation.

3.11 TOPSOILING:

A. Topsoil Materials:
   1. Shall be material excavated from within the upper 6 inches, of on-Site excavations; and be obtained from Site areas having healthy plant growth prior to stripping.
   2. Contractor may furnish topsoil from off-Site borrow areas at his option and without additional charge to Owner provided these materials are:
      a. From that portion of the soil profile defined as the "A" horizon by the Soil Science Society of America.
      b. Fertile, friable, and loamy soil of uniform quality without admixture of subsoil materials, gravel, hardpan, debris, weeds, or other similar impurities.
      c. Demonstrate healthy plant growth prior to stripping.
      d. From areas from which topsoil has not been previously removed by erosion or mechanical methods.

B. Place topsoil on all areas indicated and on borrow areas.

C. Treatment of Subgrade Prior to Topsoil Placement:
   1. Clear Site of vegetation heavy enough to interfere with proper grading and tillage operations.
   2. Clear surfaces of all stones or other objects larger than 2 inches in thickness or diameter, all roots, brush, wire, grade stakes, or other objectionable material.
   3. Loosen subgrade by discing or scarifying to a depth of 6 inches wherever compacted by traffic or other causes to permit bonding of the topsoil to the subgrade.

D. Placement:
   1. Distribute over required areas without compaction other than that obtained with spreading equipment.
   2. Place to extent material is available within following limits:
      a. Not less than 4 inches in depth.
      b. Do not exceed 6 inches in depth.
   3. Shape cuts and fills to drain as indicated.
   4. Grade to match contours of adjacent areas and permit good natural drainage.
   5. Provide gentle mound over trenches.

E. After topsoil has been spread, clear surface of stones or other objects larger than 2 inches in thickness or diameter and all other objects that might interfere with planting and maintenance operations.

F. Protect topsoiled areas from the elements until grass is established. Repair eroded areas as required.

G. Keep paved areas clean. Promptly remove topsoil or other dirt dropped on surfacing.

3.12 MAINTENANCE AND REPAIR:

A. Maintenance:
   1. Protect newly graded and topsoiled areas from actions of the elements.
   2. Settling or erosion occurring prior to landscaping shall be filled and repaired and grades reestablished to the required elevations and slopes.
   3. Do not drive on or otherwise over compact areas where topsoil has been placed.

B. Correction of Settlement:
   1. Under provisions of the guarantee, Contractor is responsible for correcting any settlement in excess of the amount of the specified grading tolerance for the specific areas of fill and damages created thereby within one year after acceptance of the Work.
   2. Make repairs within 10 days from the date of notification by Owner of fill settlement and resulting damage.
   3. Make own arrangements for access to the Site for purposes of repair.

END OF SECTION 31 20 00

SECTION 31 23 13 – SUBGRADE PREPARATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section covers subgrade preparation for manholes, vaults, tanks, structures, asphalt, and concrete pavement.

1.03 RELATED REQUIREMENTS:

A. Section 31 20 00 - Site Preparation and Earthwork.
B. Section 32 11 23 - Crushed Aggregate Base Course.
C. Section 32 12 15 - Bituminous Tack Coat.
D. Section 32 12 17 - Hot Mix Asphaltic Concrete Pavement.
E. Section 32 16 00 - Curbs, Gutters, Sidewalks, Median and Paved Drainage.

1.04 DEFINITIONS:

A. Unsuitable Material:
   1. Material encountered in excavation areas classified by Engineer as "organic silt" or "organic clay" when tested to conform to ASTM D2488.
   2. In situ moisture content outside the range necessary for preparation of subgrade will not be cause for classification as unsuitable material.

1.05 REFERENCE STANDARDS:

A. Applicable Standards:
   1. ASTM International (ASTM):
      a. D698 - Test Method for Laboratory Compaction Characteristic of Soil Using Standard Effort (12,400 ft-lbf/ft³) (600 kNm/m³).
      b. D1556 - Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
      c. D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
      d. D2167 - Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
      e. D2488 - Practice for Description and Identification of Soils (Visual Manual Procedure).
      f. D2937 - Test Method for Density of Soil in Place by the Drive-Cylinder Method.
      g. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
B. City and County of Broomfield (CCoB) Standards and Specifications

1.06 SUBMITTALS:

A. Submit as specified in Division 01.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Equipment includes all units necessary to construct subgrade conforming to requirements specified, such as, but not limited to:
   1. Scarifiers.
   2. Discs.
   3. Water distributor.
   4. Blade graders.
   5. Subgrade planers.
   6. Templates, straightedges, and other devices necessary to accurately check grade and crown.
   7. Pneumatic rollers.
   8. Tamping rollers.
   9. Self-propelled, steel-wheel rollers.

2.02 PNEUMATIC ROLLERS:

A. Self-propelled.
B. Two axles with not less than nine wheels using pneumatic tires.
C. Rigid steel frame and body suitable for ballast loading.

2.03 TAMPING ROLLERS:

A. Towed or self-propelled.
B. Staggered, uniformly spaced knobs or feet exerting not less than 1725 kPa (250 psi) on combined area in contact with the ground.
C. Equipped with cleaning fingers maintained at full length to prevent accumulation of material between the feet.

2.04 STEEL-WHEEL ROLLERS:

A. Self-propelled tandem or three-wheel.
B. Weight not less than 10 tons.
C. Equipped with scrapers to prevent accumulation of material on the rollers.

2.05 SUBGRADE PLANERS:

A. Designed to roll on forms or be electronically controlled by erected stringline or other reference.
B. Adjustable to produce a subgrade of exact elevation and cross section specified.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Prepare and maintain subgrade at the time the overlying pavement, base course, curb, walk, subbase course, paved drainage, slab-on-grade, or other surfacing is constructed thereon.
B. Remove unsuitable material to the limits designated by Engineer and replace with suitable fill material.

3.02 CONSTRUCTION REQUIREMENTS:

A. Grade and compact subgrade to meet specified requirements.

B. Extend subgrade 6 inches, or such greater distance as is necessary, for support of equipment and forms used to place the overlying material beyond the limits of the overlying course.

3.03 MOISTURE CONTROL:

A. Aerate, dry, or add moisture if necessary to produce a finished subgrade that is nonyielding and meets specified density.
B. Scarify and disc subgrade material in both cut and fill areas having a moisture content too high to permit preparation of subgrade meeting specified requirements.
C. Depth of manipulation shall be not less than 6 inches in all areas nor greater than 18 inches in cut areas.
D. Contractor may, without cost to Owner, remove and replace or stabilize-in-place by acceptable methods, subgrade materials in lieu of adjusting the moisture content of in situ subgrade materials.
E. Weak or compressible areas which cannot be satisfactorily compacted shall be removed and replaced with properly compacted soil material.
F. Standing water or excessive moisture will not be allowed. Subgrades deemed to be too wet shall be dried and recompacted as required to meet specifications for subgrades.

3.04 SUBGRADE FOR FILLS AND EMBANKMENTS:

A. Roughen by discing or scarifying and wet or dry top 12 inches of in-place materials for placement of fill or embankment. Material shall be moisture conditioned and compacted in accordance with the criteria below.

3.05 COMPACTION:

A. Cohesive Material: Compact to a minimum of 95% of the maximum dry density and within the moisture content range from 1% to 4% above optimum as determined by standard Proctor method, ASTM D698.
B. Cohesionless Material: Compact to a minimum of 95% of the maximum dry density within 2% above or below of optimum moisture content as determined by modified Proctor method, ASTM D1557.

3.06 SURFACE TOLERANCES:

A. Surface Tolerances:
    1. Maximum Compensating Deviation from Grade and Cross Section:
        a. ±0.02 ft. for flexible and rigid pavement and bases, except driveways.
        b. ±0.04 ft. for all other subgrade.
B. Test the completed subgrade for conformance to specified tolerances by means of straightedge, stringline, template, or other approved devices.
C. Rework areas deviating from the specified tolerances by removing material from high spots and placing material in low areas.

3.07 FIELD QUALITY CONTROL:

A. Contractor shall, through services of an independent laboratory, test density and moisture content of the completed subgrade.
B. Tests will conform to ASTM D1556, ASTM D2167, ASTM D2937, or ASTM D6938.
C. Construct succeeding courses on prepared subgrade only after it has been tested.

3.08 MAINTENANCE:

A. Maintain completed subgrade in finished condition until the overlying pavement or base course is placed.
B. Restore all completed subgrade damaged prior to construction of the overlying course.
C. Engineer's approval of subgrade at the time of its completion does not relieve Contractor of the requirement to maintain subgrade until such time as the overlying material is in place. Subgrade approval is only valid for 24-hours and may be voided if a weather event occurs.

END OF SECTION 31 23 13

SECTION 31 23 16 – EXCAVATION, FILLING AND BACKFILLING FOR STRUCTURES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes all necessary excavation and filling (under and adjacent to structures), for structures and all related work, including ductbanks and manholes.

1.03 RELATED REQUIREMENTS

A. Section 31 20 00 - Site Preparation and Earthwork.
B. Section 31 23 13 – Subgrade Preparation
C. Section 31 23 33 - Trenching and Backfilling for Utilities
D. Division 3 – Concrete

1.04 REFERENCES:

A. Applicable Standards:
    1. American Society for Testing and Materials (ASTM): Equivalent AASHTO Standards may be substituted as approved by Engineer.
        a. C88 - Test Methods for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
        b. D75 - Practice for Sampling Aggregates.
        c. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft. lbf/ft^3 (600 kN-m/m^3)).
        d. D1556 - Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method.
        e. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).
        f. D4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
        g. D4318 - Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
        h. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
        i. STP479 - Special Procedures for Testing Soil and Rock for Engineering Purposes, 5th Edition, "Burmister Method."
    2. Occupational Safety and Health Administration (OHSA):
        a. Part 1926 - Safety and Health Regulations for Construction.
B. City and County of Broomfield (CCoB)
    1. Standards and Specifications
C. State of Colorado Department of Transportation (CDOT)
    1. Standard Specifications for Road and Bridge Construction

1.05 SUBMITTALS:

A. Submit as specified in DIVISION 1.
B. Includes, but not limited to, the following:
    1. Test results from laboratory testing of proposed borrow materials.
    2. Test results from laboratory testing of imported granular materials.

C. Where selecting an option for excavation, trenching and shroing in compliance with local, state or federal safety regulations such as "OSHA Part 1926" or successor regulations, which require design by a registered professional engineer, submit the following:
   1. Copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of professional enigneer legally authorized to practice in the jurisdiction where the Project is located.
   2. Documents provided with evidence of registered professional engineer's seal, signature, and date in accordance with appropriate state licensing requirements.

1.06 QUALITY ASSURANCE:

A. Sampling and Testing:
   1. Owner will, through the services of an independent, commercial laboratory, perform all tests of Owner-furnished materials.
   2. Tests to determine conformance with all requirements of this Specification for quality and properties of all Contractor-secured materials, including borrow materials (both on or off Site) proposed for use, shall be performed by an independent commercial laboratory retained and compensated by Contractor, and approved by Engineer.
   3. When incorporating materials into the Project, quality control testing will be performed during construction by a testing laboratory retained and compensated by Owner.
   4. construction by a testing laboratory retained and compensated by Owner.

PART 2 - PRODUCTS

2.01 FILL AND BACKFILL MATERIAL:

A. Earth Backfill: Use suitable material as specified in Section 31 20 00.
B. Bedding Material:
   1. The bedding material for the utility structures shall meet the requirements of Section 343.00 Bedding for Pipelines and Services Lines of the CCoB Standards and Specifications.
C. Filter Material:
   1. Filter material for placement under void forms shall meet the requirements of Class B Gradation in Section 703.09 of the CDOT Standard Specifications for Road and Bridge Construction.
D. Structural Backfill for Tanks:
   1. Structural backfill should consist of moisture conditioned on-site soils not containing claystone, or imported non-expansive soils with 30% to 80% passing the No. 200 sieve, having a maximum liquid limit of 35 and a maximum plasticity index of 12. As well, the swell potential of non-expansive fill materials when remolded to 95% of the strandard Proctor maximum dry density at optimum moisture content (as determined by ASTM D698 testing) should be less than 1% when wetted under a 200 psf surchage pressure.
   2. Imported aggregate for structural backfill of tanks shall meet the criteria for CDOT Class 1 Structual Backfill as shown in Section 703.08 of the CDOT Standard Specifications for Road and Bridge Construction.

2.02 CONCRETE:

A. Concrete shall be as specified in Division 3.

PART 3 - EXECUTION

3.01 EXCAVATION:

A. Perform as specified in Section 31 23 33 and as follows:
   1. Excavate all materials found within the designated limits for excavation.
   2. Make excavation area adequate to permit efficient erection and removal of forms and to provide minimum clearances for filling as indicated.
   3. Perform excavation by any recognized method of good practice to complete the Work in the most expeditious manner in conformance with specified requirements.
   4. Take precautions to ensure no damage to existing facilities or equipment, or other work.
   5. All materials encountered, regardless of type, character composition and condition thereof, shall be considered "unclassified" for the purpose of payment. Rock encountered shall be handled at no additional cost to Owner.

B. Trim to neat lines where details call for concrete to be deposited against earth.

C. Excavate by hand in areas where space and access will not permit use of machines.

B. During excavation, materials suitable for backfilling shall be piled in an orderly manner a distance of at least two feet from the banks of the trench to avoid overloading and to prevent slides or cave-ins.

D. If loose or soft zones are encountered that do not improve with subgrade preparation, over excavate, and restore bottom of excavation to proper elevations with compacted structural fill in areas over excavated, as approved.

E. Where rock is encountered in a portion of a structural excavation and a nonrock material is encountered in an adjacent area of the same structural excavation, remove the rock to a minimum of 18 inches below the depth indicated for the structure's base and replace with structural fill.

3.02 DEWATERING:

A. Control grading around excavations to prevent surface water from flowing into excavation areas.

B. Drain or pump as required to continually maintain, including days not normally worked, all excavations and trenches free of water or mud from any source, and discharge to approved drains or channels. Commence when water first appears and continue as required to keep excavation free of standing water during entire time excavation is open.

C. Use pumps of adequate capacity to ensure rapid drainage of area, and construct and use drainage channels and subdrains with sumps as required.

D. When water is found in the excavation, remove unsuitable excessively wet subgrade materials and replace with approved compacted fill material as directed by Engineer and at no additional cost to Owner.

E. Contractor shall submit a dewatering plan prior to beginning excavation.

3.03 BEDDING MATERIAL:

A. General:
   1. Place on stable, suitable subgrade as specified in Section 31 20 00.
      a. Obtain Engineer's approval and remove all forms, unsuitable material, and debris from the subgrade or excavation area prior to commencing placement of any fill.
      b. Do not place snow, ice, or frozen earth in fill and do not place fill on a frozen surface.
   2. Place in layers of uniform thickness keeping the working surface of the entire area level.
   3. Place adjacent to structures simultaneously on all sides of structures.
   4. Exercise care in the use of heavy equipment in areas adjacent to structures.
   5. Place bedding material to the depth and dimensions shown on the contract drawings.

B. Compact bedding as follows:
   1. In lifts not exceeding 12 inches in compacted depth.
   2. Rod, spade, or use pneumatic or vibratory equipment as required to obtain not less than 80% relative density as determined by ASTM Method D4253 and D4254 throughout depth of embedment.

3.04 BACKFILLING:

A. Earth Backfill:
   1. Backfill only after concrete has attained 70% design strength
   2. Backfill adjacent to structures only after, in the opinion of Engineer, a sufficient portion of the structure has been built to resist the imposed load.
   3. Remove all debris from excavation prior to placement of material.
   4. The slope bounding the excavation, if streeper than 3 horizontal: 1 vertical, shall be stepped or serrated prior to placing the backfill material.
   5. Perform backfilling simultaneously on all sides of structures.
   6. Place backfill in level layers not exceeding 8 inches in loose-layer thickness.
   7. Exercise extreme care in the use of heavy equipment in areas adjacent to structures.

3.05 FIELD QUALITY ASSURANCE:

A. Compaction:
   1. Owner will, through services of an independent laboratory, test all filling and backfilling for structures to determine conformance with density relationships specified. The Contractor shall be responsible for coordination with the testing agency for arranging testing as needed.
   2. Method of test shall be as specified in SECTION 31 20 00.
   3. The frequency of tests shall be in compliance with jurisdictional requirements or as otherwise required by Owner.
   4. It is the responsibility of the Contractor to provide the proper means and equipment to excavate and grade as necessary to allow independent, commercial laboratory to perform testing. Refer to Section 31 20 00.

END OF SECTION 31 23 16

SECTION 31 23 33 - TRENCHING AND BACKFILLING FOR UTILITIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplmentary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes:
   1. Excavation, sheeting, bracing, and all operations necessary for the preparation of trenches for bedding of pipes and pipe appurtenances, conduit, and buried cable.
   2. Pipe embedments and encasements.
   3. Backfilling of trenches.

1.03 RELATED REQUIREMENTS

A. Division 03 - Conrete.
B. Section 31 20 00 - Site Preparation and Earthwork.
C. Section 31 23 16 - Excavation, Filling, and Backfilling for Structures.
D. Section 33 31 50 - Pipe Installation

1.04 REFERENCES STANDARDS:

A. Applicable Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M147 - Materials for Aggregate and Soil-Aggregate Subbase, Base and Surface Courses.
      b. T99 - The Moisture-Density Relations of Soils Using a 5.5-Pound (2.5-kg) Rammer and a 12-Inch (305-mm) Drop.
      c. T104 - Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.
   2. American Society for Testing and Materials (ASTM):
      a. D4253 - Test Method for Maximum Index Density of Soils Using a Vibratory Table.
      b. D4254 - Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   3. Occupational Safety and Health Administration (OSHA):
      a. Part 1926 - Safety and Health Regulations for Construction.

B. City and County of Broomfield (CCoB)
   1. Standards and Specifications

A. State of Colorado Department of Transportation (CDOT)
   1. Standard Specifications for Highway Construction.

1.05 SUBMITTALS:

A. Submit as specified in Division 01.
B. Includes, but not limited to, the following:
   1. Test results from laboratory testing of imported granular materials.
   2. Steel reinforcement for concrete encasement.
   3. Steel reinforcement for concrete cradle.
   4. Concrete Submittals as specified in Division 03.
C. Where selecting an option for excavation, trenching, and shoring in compliance with local, state, or federal safety regulations such as "OSHA Part 1926" or successor regulations, which

require design by a registered professional engineer, submit (for information only and not for Engineer approval) the following:

1. Copies of design calculations and notes for sloping, benching, support systems, shield systems, and other protective systems prepared by or under the supervision of a professional engineer legally authorized to practice in the jurisdiction where the Project is located.
2. Documents provided with evidence of registered professional engineer's seal, signature, and date in accordance with appropriate state licensing requirements.

PART 2 - PRODUCTS

2.01 BEDDING MATERIAL:

A. The Bedding material for all utility installations shall meet the requirements of Section 343.00 Bedding for Pipelines and Services Lines of the CCoB Standards and Specifications.

2.02 TRENCH STABILIZATION MATERIAL:

A. Material shall be one of the following:
   1. As specified in this PART 2 Granular Pipe Embedment.
   2. 2-inch minus river-run or pit run gravel free from clay balls, roots and organic matter, graded from course to fine, with less than 8 percent by weight passing a ¼-inch sieve.
   3. Alternate approved by the Owner and Engineer.

2.03 CONCRETE:

A. Concrete and reinforcing steel shall conform to applicable requirements of Division 03.

2.04 GENERAL TRENCH BACKFILL MATERIALS:

A. Obtain from the following:
   1. Trenches and other excavations included in this Contract.
   2. Borrow from location off Site.
   3. Combination of above.
B. Free from organic matter, refuse, ashes, cinders, frozen, or other unsuitable material.
C. Gravel, rock, or shale particle size limited as follows:
   1. Not to exceed 2 inches in greatest dimension within 12 inches of pipe or conduit.
   2. Gravel, rock, or shale not allowed within 12 inches of buried cable.
   3. Maximum dimension one-half the depth of layer to be compacted in other areas.
D. Contain sufficient fine materials to provide a dense mass free of voids and capable of satisfactory compaction.
E. Have moisture content enabling satisfactory placement and compaction.
F. Blended or otherwise processed to provide required gradation and moisture content for cohesive and cohesionless materials as described in Section 31 20 00 – 3.10 “Subgrade Preparation”.
G. Where trench alignment reaches have low tolerance for surface settlements, pipe bedding and backfill should consist of “controlled low strenth material” (CLSM), a lean, sand-cement slurrym “flowable fill” or similar material.
   1. CLSM used as pipe bedding and trench backfill should exhibit a 28-day unconfined compressive strength between 50 to 150 psi.
   2. CLSM should be placed in several lifts to avoid “floating” pipes. Other measures should be taken to maintain pipe alignment during CLSM placment.

PART 3 - EXECUTION

3.01 TRENCHING:

A. Equipment and Methods:
   1. Types of Equipment and methods may be at Contractor's option, where structures or other facilities are not endangered.
   2. Equipment and methods shall be subject to approval of jurisdictional agency where stability or usefulness of other facilities may be impaired.
   3. Perform by hand methods when required to save or protect trees, culverts, utilities, or other structures above or below ground.
   4. Maximum length of open trench shall be limited to 50 feet in advance and to 50 feet behind pipe installation, except as approved.
   5. Trenches outside fenced areas shall be backfilled or covered at the end of the day.

B. Side Walls:
   1. Temporary un-shored excavation slopes up to 15 feet in height should be cut no steeper that 1½ : 1 (horizontal : vertical) in on-site soils in the absences of seepage.
   2. Make vertical or slope within specified trench-width limitations below a horizontal plane 12 inches above top of pipe.
   3. Vertical or sloped (stepped) as required for stability, above a horizontal plane 12 inches above top of pipe.
   4. Sheet and brace where necessary. Conform to applicable requirements of Section 31 23 16.
   5. Excavate without undercutting.

C. Trench Depth:
   1. Depth shall be sufficient to provide the minimum bedding requirements for the pipe being placed.
   2. Do not exceed the indicated depth where conditions of bottom are satisfactory.
   3. Increase depth as necessary to remove unsuitable supporting materials.

D. Trench Bottom:
   1. Protect and maintain when suitable natural materials are encountered.
   2. Remove rock fragments and materials disturbed during excavation or raveled from trench walls.
   3. Restore to proper subgrade with trench-stabilization material when overexcavated:
      a. Correct, at no additional cost to Owner, when trench is overexcavated without authority or to stabilize bottom rendered unsuitable through negligence or improper operations.
      b. Placement of Trench Stabilization Material:
         (1) Compact in lifts not exceeding 6-inch loose thickness:
            (a) With pneumatic or vibratory equipment.
            (b) To density specified for granular pipe embedment.

E. Trench Width:
   1. Excavate trench to a width which will permit satisfactory jointing of the pipe and thorough tamping of the bedding.
   2. Minimum and Maximum Trench Width:
      a. Maximum trench width shall not be more than 18-inches wider than the diameter of the pipe or width of trench box, whichever is greater
      b. Minimum trench width shall not be less than 12-inches wider than the diameter of the pipe.

c. Maximum trench width limitations shall apply beginning 4 feet from manhole or structure walls.
d. Maximum width shall be as near the minimum specified as can be controlled by construction equipment and methods used.
e. Correct when overexcavated at no additional cost to Owner:
(1) Use stronger pipe or higher class embedment.

F. Trenching in Fill Areas: Perform trenching in fill areas only after compacted fill has reached an elevation of not less than 1 foot above the top of the pipe.

G. Test Pits:
1. Excavate test pits sufficiently in advance of trenching to enable adequate planning of construction procedure.
2. Locate as follows:
a. Where unstable material is suspected that may require special protective measures.
b. Where groundwater may require special handling methods.
c. Where advisable to assess adequacy of blasting pattern.
d. Where indicated or otherwise approved.
e. Where interference or conflict with other utilities or structures could affect alignment of pipe.
3. With lateral dimension not less than minimum trench width specified for location excavated.
4. To depth required to obtain information desired.

H. Design, furnish, place, maintain, and subsequently remove, to the extent required, a system of temporary supports for cut and cover, or open cut including bracing, dewatering, and associated items to support the sides and ends of the excavations where excavation slopes might endanger in-place or proposed improvements, extend beyond construction rights-of-way, or where specified or indicated.

I. Space and arrange sheeting and bracing as required to exclude adjacent material and according to the stability of excavation slopes.

J. Contractor shall make his own assessment of existing conditions including adjacent property, the possible effects of his proposed temporary works and construction methods, and shall select and design such support systems, methods, and details as will assure safety to the public, adjacent property, and the completed Work.

K. Modify or relocate underground utilities which shall be exposed by hand or other excavation methods acceptable to Owner and Engineer.

L. Provide sheeting, shoring, and bracing for trench excavation in the subgrade of the excavation to prevent movement of the main excavation support system.

M. Provide sheeting, shoring, and bracing as indicated or specified to meet the following requirements:
1. Prevent undermining and damage to all structures, buildings, existing utilities, pavements, and slabs.
2. Excavations shall be accomplished with vertical banks where necessary for construction activities or as indicated, and also within all limits of excavation noted on the Drawings.
a. Temporary un-shored excavation slopes up to 15 feet in height should be cut no steeper that 1½ : 1 (horizontal : vertical) in on-site soils in the absences of seepage.
3. Design excavation support system and components to support lateral earth pressures, unrelieved hydrostatic pressures, utility loads, traffic and construction loads, and building and other surcharge loads to allow the safe and expeditious construction of the permanent structures without movement or settlement of the ground, and to prevent damage to or movement of adjacent buildings, structures, Underground Facilities, and other

improvements. The design shall account for staged removal of bracing to suit the sequence of concrete placement for permanent and structure and backfill.

4. Except as otherwise specified herein, shoring, and sheeting materials may be extracted and reused at the Contractor's option; however, Contractor shall remove and replace any existing structure or utility damaged during shoring and sheeting. Remove sheeting and bracing as backfill progresses. Fill voids left after withdrawal with sand or other approved material.
5. Where shoring and sheeting materials must be left in-place in the completed Work to prevent settlements or damage to adjacent structures or as directed by Engineer, backfill the excavation to within 3 feet below the finished grade and remove the remaining exposed portion of the shoring before completing the backfill. If soldier piles and wood lagging are used for shoring, remove wood lagging to within 3 feet of finished grade in incremental steps of approximately 6 inches as the backfill is constructed, or to Engineer's design if more stringent. The location of all shoring and sheeting left in-place shall be documented on drawings and provided to Engineer and Owner.
6. Contractor shall be responsible for proper design, installation, operation, maintenance, and any failure of any component of the system.
7. Provision for Contingencies:
    a. The performance of the components of the support system shall be monitored for both vertical and horizontal movement daily.
    b. A contingency plan or alternative procedure shall be provided for implementation if the designed system does not adequately perform.
    c. The materials and equipment necessary to implement the contingency plan shall be kept readily available.
8. Damages:
    a. Contractor shall document all existing damage to adjacent facilities and submit the information to Owner prior to performing any excavation. Documentation shall include a written description, diagrams, measurements, and appropriate photographs.
    b. Repair all damage resulting from Contractor excavation and remove and replace all undermined pavements with Owner-approved equal, either concrete or asphalt at Contractor's expense.

N. Restoring Overexcavation:
1. Restore overexcavation of depth 6 inches or less as follows:
    a. For structures that are required to rest on undisturbed earth, restore with concrete.
    b. For structures that are required to rest on compacted granular fill base, restore with compacted granular fill.
2. Restore uniform overexcavation of depth greater than 6 inches with structural fill.
3. Restore nonuniform overexcavation by excavating to a uniform depth. Restore with granular material for depth less than 6 inches or with structural fill for depth more than 6 inches.
4. Perform at no extra cost to Owner.

O. Top with 3-inch concrete seal coat if required to provide satisfactory subgrade for structural base slabs.
1. Seal coats shall conform to applicable requirements of DIVISION 3.

P. Blasting:
1. Blasting will not be permitted.

3.02 PIPE EMBEDMENTS AND ENCASEMENTS:

A. Place pipe bedding as follows:
   2. Level bottom layer at proper grade to receive and uniformly support pipe barrel throughout its length.
   3. Form shallow depression under each joint to facilitate jointing operations.
   4. Form depression under each joint so that no part of bell or coupling is in contact with trench when pipe is placed in position.
   5. Add second layer simultaneously to both sides of the pipe with care to avoid displacement.
   6. Complete promptly after completion of jointing operations and approval to proceed.
   7. Substitute for any part of earth backfill to within 2 feet of final grade to voids between utilities.

3.03 BACKFILLING:

A. Placement:
   1. Complete promptly after approval to proceed:
      a. Upon completion of pipe embedment.
   2. Use hand methods to a horizontal plane 6 inches above top of pipe- coupling, conduit or duct banks.
   3. Use approved mechanical methods where hand backfill is not required.
   4. Place in layers of thickness within compacting ability of equipment used.
   5. Until compacted depth over conduit exceeds 3 feet, do not drop fill material over 5 feet. Then distance may be increased 2 feet for each additional 1 foot of cover. Backfill conduit trenches in layers of maximum 8 inches.

B. Compaction:
   1. Perform with spreading equipment supplemented by hand-operated equipment and rollers as required to obtain density specified.
   2. Accomplish without inundation or flooding.
   3. Except as indicated otherwise, compact cohesive and cohesionless materials as described in Section 31 20 00.
   4. Backfill failing to meet required densities shall be removed or scarified and recompacted as necessary to achieve specified results.

3.04 FIELD QUALITY CONTROL:

A. Compaction: Contractor will, through services of an independent laboratory, test all trench-stabilization material, granular pipe embedment, earth-pipe embedment, clay cut-off walls, and trench backfill to determine conformance with specified moisture- density relationships:
   1. Method of test will be as specified in Section 31 20 00.

B. Concrete: Contractor shall test all concrete for use in encasements, cradles, and concrete cut-off walls to determine conformance with Specifications. Method of test shall be as specified in Division 03.

END OF SECTION 31 23 33

SECTION 31 32 11 – SOIL SURFACE EROSION CONTROL

PART 1 - GENERAL

1.01 SUMMARY:

A. The Work consists of furnishing and installing soil surface erosion controls to prevent the pollution of water and land, including fine grading, structural measures, and miscellaneous related work as indicated on the Drawings or specified herein. These measures shall be installed at the locations where needed to control erosion and water pollution during and after the construction of the project, and as shown on the Drawings.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 31 20 00 – Site Preparation and Earthwork
B. Section 33 41 00 – Storm Drainage System

1.03 REFERENCES:

A. Applicable Standards
   1. American Society for Testing and Materials (ASTM):
      a. D6460 – Standard Test Method for Determination of Rolled Erosion Control Product (RECP) Performance in Protecting Earthen Channels from Stormwater-Induced Erosion
      b. C172 - Standard Practice for Sampling Freshly Mixed Concrete
   2. Colorado Department of Transportation (CDOT)
      a. Standard Specifications for Road and Bridge Construction
         (1) Section 216 Soil Retention Covering
         (2) Section 412 Portland Cement Concrete Pavement
         (3) Section 507 Slope and Ditch Paving
         (4) Section 601Structural Concrete
         (5) Section 602 Reinforcing Steel
      b. M&S Standard Plans.
         (1) M-216-1 Soil Retention Covering
         (2) M-603-2 Reinforced Concrete Pipe
         (3) M-603-5 Polyvinyl Chloride (PVC) Pipe (AASHTO M304)
         (4) M-604-11 Inlet, Type D

1.04 SUBMITTALS:

A. Submit prior to work, as specified in Division 1.
   1. Dust control agents other than water must be approved by Engineer prior to use.
   2. Stormwater Quality (SWQ) permit application for review by City and County of Broomfield (CCoB) in accordance with submittal requirements defined in Division 1. The SWQ permit application shall be submitted to the Engineer for informational purposes only. The SWQ permit application shall include, but is not limited to, the following:
      a. Copy of CDPHE stormwater discharge permit for construction activities.
      b. SWQ Permit Fee
      c. Best management practices (BMPs) cost opinion worksheet
      d. SWQ Permit Surety
      e. Stormwater Management Plan (SWMP):
         (1) Adjustments to the approved plan may be required by CCoB based on actual construction operations. Changes to the plan shall only be made with the written approval of CCoB.

(2) The SWMP and methods proposed by Contractor must be in conformance with all applicable permits and approved by Adams County prior to installation and prior to moving onto the construction site.
(3) Submit the SWMP at least two weeks prior to any ground disturbing activities.
(4) Prepare schedules to implement stormwater management features, including but not limited to erosion and sediment control work, and submit for acceptance at preconstruction conference.
(5) The erosion and sediment controls shown on the Drawings and listed in this section shall be used by Contractor as a guideline only. The Contractor shall be responsible for the development and implementation of the SWMP.
(6) The SWMP may include measures for the control of erosion and sedimentation, and measures for stormwater quality management.
(7) Contractor shall take the necessary steps to comply with the intent of erosion and sediment controls shown on the Drawings, and other applicable standards, permit conditions, and regulations of appropriate agencies.

3. Construction Schedule. Submit a revised construction schedule when special conditions warrant a variance to earthwork operations.
4. QC Inspection Reports
5. Product data for turf reinforcement mat demonstrating and certifying the material meets the requirements of this section.
6. Product data for all storm drain pipe.

1.05 QUALITY ASSURANCE & CONTROL:

A. Inspect BMPs each workday and maintain the in effective operating condition, Maintenance of the BMPs should be proactive not reactive.
B. Erosion controls shall be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.

1.06 OPERATING CONDITIONS:

A. Temporary Erosion and Sediment Controls: Furnish, install, construct, and maintain temporary measures to control erosion and minimize the siltation of intermittent streams and the pollution of private properties. Temporary erosion and sediment control measures shall be constructed in substantial compliance with local, state, federal, and jurisdictional agency's regulations and Drawings. Temporary erosion and sediment control measures shall be maintained throughout construction.
B. Properties adjacent to the Project shall be protected from sediment deposition.

1.07 DELIVERY, STORAGE AND HANDLING:

A. Store materials in designated areas and as recommended by the Manufacturer protected from the elements, direct exposure, and damage. Do not drop containers from trucks. Material shall be free of defects that would void required performance or warranty.

PART 2 - PRODUCTS

2.01 SOIL RETENTION BLANKET

A. Soil retention blanket is required for areas shown on the contract drawings. Contractor shall include in seeding plan the use of soil retention blanket on disturbed areas after broadcast seeding. The soil retention blanket for use outside of stormwater channels shall meet the requirements specified in Section 216.02 of the CDOT Standard Specifications for Road and Bridge Construction.

2.02 TURF REINFORCEMENT MAT:

A. The turf reinforcement mat to be used in the drainage channels shall meet the requirements of Product Class 2 turf reinforcement mat as specified in Section 216.02 of the CDOT Standard Specifications for Road and Bridge Construction. The turf reinforcement mat shall be able to withstand shear stress of 2.5 pounds per square foot (psf) and stormwater flow velocity of 7 feet per second (fps) for unvegetated conditions in accordance with ASTM D6460.

B. Installation staple patterns shall be clearly marked on the turf reinforcement mattings with environmentally safe paint. All mats shall be manufactured with a colored thread stitched along both outer edges (approximately 2 to 5 inches from the edge) as an overlap guide for adjacent mats.

2.03 RIPRAP:

A. Riprap to be installed at the outlet of storm drainage piping shall meet the requirements specified in Section 506.02 of the CDOT Standard Specifications for Road and Bridge Construction. The riprap stone size shall be D50 = 6-inches.

2.04 RAIN GARDEN:

A. Rain Garden to be installed where shown on the contract drawings and shall meet the requirements of Bioretention Systems in Section T-3 of chapter 4 of the MHFD Criteria Manual Volume 3.

PART 3 - EXECUTION

3.01 GENERAL:

A. All temporary erosion and sediment control practices shall be maintained and repaired as needed to ensure continued performance of their intended function.

B. Engineer will monitor Contractor's erosion control and work methods. If the overall function and intent of erosion control is not being met, The Contractor shall provide additional measures as required to obtain the desired results.

C. The erosion control features installed by Contractor shall be adequately maintained by Contractor until the project is accepted.

D. Properties adjacent to the site of a land disturbance shall be protected from sediment deposition.

3.02 WEATHER CONDITIONS:

A. Perform erosion control operations under favorable weather conditions; when excessive moisture, frozen ground or other unsatisfactory conditions prevail, the work shall be stopped as directed. When special conditions warrant a variance to earthwork operations, submit a revised

construction schedule for approval. Do not apply erosion control materials in adverse weather conditions which could affect their performance.

3.03 WATER QUALITY CONTROL:

A. Contractor shall comply with the "Colorado Water Quality Control Act", the "Protection of Fishing Streams", the "Clean Water Act", and all other applicable regulations.
   1. In the event of conflicts between Federal and State water quality control laws, rules, or regulations, the more restrictive laws, rules, or regulations shall apply.

B. This Work shall include measures needed for the purpose of minimizing water pollution, erosion, and sedimentation during and after the construction activity.

C. This section shall be followed to minimize the pollution of any watercourse, wetland, or water impoundment area.

3.04 CONSTRUCTION ENTRANCE:

A. Provide a minimum of 8-inches thick, at points of vehicular ingress and egress on the construction site. Construction entrances shall be cleared and grubbed, and then excavated a minimum of 3-inches prior to placement of the filter fabric and aggregate. The aggregate shall be placed in a manner that will prevent damage and movement of the fabric. Place fabric in one piece, where possible. Overlap fabric seams a minimum of 12-inches.

B. Maintain entrance in a condition that minimizes tracking of sediment. Add stone or make other repairs as conditions demand to maintain clean surface, mountable berm, and specified dimensions. Immediately remove stone and/or sediment spilled, dropped, or tracked onto adjacent roadway by vacuuming, scraping, and/or sweeping. Washing roadway to remove mud tracked onto pavement is not acceptable unless wash water is directed to an approved sediment control structure.

3.05 DUST CONTROL:

A. Contractor shall minimize dust from construction operations.

B. During the performance of the Work, Contractor shall furnish labor, equipment, and materials to control dust at all times, including evenings, holidays, and weekends.

C. Contractor shall be liable for any damage resulting from dust originating from Contractor's operations.

3.06 TURF REINFORCEMENT MAT:

A. Prepare soil before installing turf reinforcement mat including applying fertilizer, seed, and amendments in accordance with CCoB Standards and Specifications.

B. Install turf reinforcement mat in areas shown on the Drawings in accordance with Section 216.05 of CDOT Standard Specifications for Road and Bridge Construction and CDOT Standard Plan No. M-216-1.

C. Only rubber-tired equipment may drive on the mat. No sharp turns are allowed.

3.07 RIPRAP:

A. Place rip rap to the lines and grades shown on the Drawings.

B. Riprap shall be installed in accordance with Section 506.03 of the CDOT Standard Specifications for Road and Bridge Construction.

3.08 FINISHED GRADE:

A. Verify that finished grades are as indicated on the Drawings; complete finish grading and compaction in accordance with Section 31 20 00 Site Preparation and Earthwork. Due to the grade changes during the development of the project, the Contractor shall be responsible for adjusting the erosion control measures in order to prevent erosion.

3.09 CLEAN-UP:

A. Dispose of excess material, debris, and waste materials offsite at an approved landfill or recycling center. Clear adjacent paved areas. Immediately upon completion of the installation in an area, protect the area against traffic or other use by erecting barricades as required, or as directed.

3.10 RAIN GARDEN

A. Install rain garden in area show on the Drawings in accordance with the Bioretention Systems from Section T-3 in Chapter 4 of the MHFD Criteria Manual Volume 3.

B. Contractor shall install all media and rain garden components in accordance with the specifications in the Drawings.

END OF SECTION 31 32 11

SECTION 31 63 29 – DRILLED SHAFT FOUNDATIONS

PART 1 - GENERAL

1.01 SUMMARY:

A. Work under this Section consists of furnishing all supervision, labor, equipment, materials, and quality control necessary to install all drilled shafts the Broomfield Pump Station.
B. Work under this Section shall conform to all requirements of ACI 336.1 published by the American Concrete Institute, Farmington Hills, Michigan, except as modified herein.
C. Drilled shafts shall be embedded to depths as indicated on the Drawings.
D. Contractor shall visit the Site prior to bidding to observe and review specific Site conditions and requirements for equipment, methods, and costs to install drilled shafts.
E. Contractor shall verify the location of all underground conduits, piping, duct banks and utilities prior to installing drilled shafts.
F. Contractor shall retain a Geotechnical Representative as defined herein.

1.02 RELATED REQUIREMENTS:

A. Section 03 10 00 – Concrete Formwork.
B. Section 03 20 00 – Concrete Reinforcement.
C. Section 03 30 00 – Concrete.
D. Section 03 30 05 - Void Forms.
E. Section 03 41 00 - Precast Concrete.

1.03 REFERENCE STANDARDS:

A. General:
    1. Standards listed by reference, including revisions by issuing authority, form a part of this Section to extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
    2. Where specifications and reference documents conflict, the specification shall govern.
    3. Unless otherwise noted, the latest revision of the following reference standards shall apply to this Section.
B. Applicable Standards:
    1. American Concrete Institute (ACI):
        a. 336.1 - Specification for the Construction of Drilled Piers.
    2. American Petroleum Institute (API):
        a. 13A - Specification for Drilling-Fluid Materials.
    3. ASTM International (ASTM):
        a. D698 – Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3).
        b. D2487 – Classification of Soils for Engineering Purposes (Unified Soil Classification System).
        c. D4253 – Maximum Index Density of Soils Using a Vibratory Table.
        d. D4254 – Minimum Index Density of Soils and Calculation of Relative Density.

1.04 DEFINITIONS:

A. Bearing Stratum - The formation(s) or layer(s) of soil or rock that support the shaft and loads imposed on it.

B. Geotechnical Representative – The Geotechnical Representative is responsible for observation and recording of material verification, drilled shaft installation sequence and methods, and other quality control documentation.
   1. The Geotechnical Representative shall be provided by the Contractor and shall be a geotechnical engineer, geologist, or geotechnical technician provided the technician has at least five years of relevant experience with the observation of drilled shaft installation.

C. Pumping of Concrete - Concrete placed under water or through slurry conveyed by pressure through a rigid pipe or flexible hose and discharged directly to bottom of shaft. Pressure is applied by piston pumps, pneumatic compressed air, or squeeze pressure pumps in accordance with ACI 336.1. NOTE: Placement of concrete under water or through slurry will not be permitted during construction of drilled shafts which bear upon or are socketed into rock.

D. Rock Excavation – Intact rock material encountered in excavating drilled shafts which cannot be removed with a conventional earth auger, and which requires a rock auger, core barrel, or hand labor using air-powered tools and/or other special excavation procedures. Refusal of the earth auger shall be defined as a penetration rate equal to, or less than, 1 foot per 10-minute period with the full torque and crowd continuously applied. Earth, clay, coal seams, boulders, cobbles, rock fragments, soft fractured materials, or voids encountered between rock units will not be considered rock excavation.

E. Slurry - Method of advancing drilled shaft hole where bentonite (sodium montmorillonite in accordance with API 13A) or anionic polymer is mixed with clean water or water within shaft to produce a slurry mixture capable of maintaining the stability of shaft walls and bottom in potentially caving and/or water-bearing soils. Slurry is also used to increase density of fluid within shaft to offset exterior hydrostatic pressure and to facilitate removal of coarser grained soils by mixing and incorporation into the slurry mixture. NOTE: The use of slurry will not be permitted during construction of that portion of drilled shafts which bear upon or are socketed into rock.

F. Socket - Advancement of the drilled shaft into sandstone and claystone bedrock without visible voids, generally exhibiting a relatively unweathered medium hard to hard, massive, and solid appearance around the full perimeter of the socket excavation. Unless specifically identified above, socket shall not exhibit or contain clay seams, voids, solution cavities, cobbles, boulders, or broken, rubbly, or weathered rock conditions. Cobbles and boulders, as defined by ASTM D2487, or portions of irregular rock contact along the shaft side wall shall not be considered for purposes of developing a minimum embedment for socket. Socket may or may not be considered cumulative along the side wall of the shaft, depending upon the size, extent, location and frequency of cracks, crevices, and clay seams that can be cleaned and filled by dental work. Geotechnical Representative shall evaluate extent of irregularities and their effect upon detrimental settlement in defining adequate socket.

G. Tremie - Concrete placed under water or through slurry by means of gravity flow through a rigid pipe. NOTE: The use of the tremie method of placing concrete will not be permitted. Pumping will be required when placing concrete under water or through slurry.

H. Unclassified Excavation - All materials encountered from the top of concrete or drilled shaft cutoff elevation to the tip-bearing elevation, exclusive of rock excavation as described above.

1.05 EXPERIENCE QUALIFICATIONS:

A. Drilled Shaft Contractor
   1. A minimum of 5 years' experience in drilled shaft construction, including experience with similar subsurface materials, water conditions, shaft dimensions, and special techniques as required.

2. Submit a written description of equipment and techniques proposed for use on this Contract, and the name of three similar projects successfully completed in the last 5 years.
3. The experience statement of past work and description of equipment and techniques proposed for use shall be submitted at time of Bid and will be considered in the evaluation of bids.

B. All other guidelines for submitting information shall be followed in accordance with that specified in "INSTRUCTIONS TO BIDDERS."

1.06 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Bid Submittals:
1. Proposed drilled shaft rig name, model number, maximum continuous torque rating (ft-lb), maximum downward force ("crowd"), proposed earth and rock auger attachments, and proposed special techniques and equipment. Submittals shall reflect any Contractor modifications that affect the torque and crowd ratings.
2. Proposed method(s) of construction – dry and uncased, temporary casing, or other procedure.

C. Pre-Construction Submittals: Submit the following items two (2) weeks prior to start of Work. Work shall not begin until all the submittals have been received and approved by the Owner. The Contractor shall allow the Owner two (2) weeks to review, comment, and return the submittal package after a complete set has been received. All costs associated with incomplete or unacceptable submittals shall be the responsibility of the Contractor.
1. Detailed procedures for each anticipated method of construction - dry and uncased, temporary casing, or other procedure including:
   a. Sequence of excavation, concrete placement, rebar cage placement, and placement of embedded items such as anchor bolts.
   b. Method of concrete placement (i.e., free-fall, pump, or other).
   c. Methods to prevent segregation of concrete during placement.
   d. Methods to prevent caving, if necessary.
   e. Equipment and procedures for cleanout of bottom of drilled shaft and walls of rock socket.
   f. Equipment and procedures for installation of shear rings in walls of rock socket as described in part 3.02-F of this Section.
   g. Procedures for supporting rebar cage during concrete placement, including type, size and material construction of spacers to be used.
   h. Procedures for supporting anchor bolts or other embedded items (as applicable).
   i. Procedures for, and sequence of, installation and removal of temporary casing.
   j. Procedures for emergency cold joint construction in the event concrete placement is unexpectedly interrupted.
   k. Procedures for placement and mix design for controlled low strength material (CLSM) mix, as applicable to backfill rejected drilled shaft foundations.
2. Backfill material and procedures.

D. Construction and Closeout Submittals:
1. Drilled Shafts: Submit at the completion of each day, drilled shaft construction logs similar to the form at the end of this Section and which contain the following information, where applicable.
   a. Identification number.
   b. Shaft dimensions.

c. Ground surface elevation.
d. Bottom of concrete elevation.
e. Top of concrete elevation.
f. Description of soils and rock encountered during drilling and the depths at which transitions occur.
g. Bearing stratum description.
h. Nature and location of obstructions.
i. Water conditions during drilling and concrete placement.
j. Amount of unclassified excavation.
k. Amount of rock excavation and length of socket.
l. Method of construction - dry and uncased, temporary casing, or other.

2. As-built shaft location and elevation data.
3. Detailed description of any remediation performed to resolve non-conforming work as described in Part 3.07 of this Section.
4. Geotechnical Representative shall provide a report at the end of drilled shaft installation activities including, but not limited to, the following:
   a. A general discussion of the activities observed.
   b. Installation records as required by this SECTION.
   c. Verification that drilled shafts were installed in general conformance with the specifications.
   d. A list of drilled shafts not installed in accordance with the specifications and a discussion of what action was taken to resolve issues.

PART 2 - PRODUCTS

2.01 CONCRETE:

A. As specified in SECTION 03 30 00, except as follows:
   1. Minimum compressive strength of 4,500 psi at 28 days.
   2. Slump requirements for concrete placed in drilled shafts shall be based on the construction method used, as follows:
      a. For dry uncased excavations: 4 to 6 inches.
      b. For temporarily cased excavations: 6 to 8 inches.
      c. For slurry excavations or placement of concrete under water: 7 to 9 inches.

2.02 CONCRETE REINFORCEMENT:

A. As specified in SECTION 03 20 00.

2.03 CONCRETE FORMS:

A. As specified in SECTION 03 10 00.

2.04 CASING:

A. Temporary casing shall be steel and of sufficient strength to prevent collapse or cave-in of the excavation and prevent soil and water from entering the excavation during drilling, field observation, and concrete placement.

2.05 DRILLING EQUIPMENT:

A. Excavate drilled shafts with an auger rig capable of drilling, as a minimum, the diameter and depth of foundations, including sockets, as shown on the Drawings in the subsurface materials present. Contractor is responsible for selecting appropriate drilling equipment and procedures

as required to install the drilled shafts as indicated and in the subsurface conditions present. Rock excavation should be anticipated during drilling. Other methods of excavation shall not be permitted.

PART 3 - EXECUTION

3.01 GENERAL EXCAVATION:

A. Unless otherwise approved in advance, construction of each drilled shaft shall be completed during one working day, including full excavation and placement of concrete.

B. Keep the ground surface for a minimum of 2 feet from the edge of the excavation clean and level.

C. Dispose of materials removed from the excavation at an off-site location unless otherwise directed.

D. Locate drilled shaft as indicated within the following tolerances. Deviations in excess of these tolerances shall be corrected at Contractor's expense, including additional costs for engineering, redesign, and inspection:
   1. Centerline: Within 3 inches or 4 percent of shaft diameter, whichever is less, of location indicated.
   2. Diameter: Plus 3 inches, minus 1 inch.
   3. Plumb: 1.0 percent of the length, 12.5 percent of shaft diameter, or 15 inches total, whichever is less.
   4. Cutoff Elevation: Plus 1 inch or minus 1 inch from cutoff elevation indicated.

E. Provide temporary casing with a minimum inside diameter equal to the nominal diameter of the drilled shaft and a sufficient strength to withstand the soil pressure. Provide casing on Site prior to start of excavation. At minimum, install temporary casing under the following conditions:
   1. To control seepage.
   2. To prevent collapse of the walls.

F. When casing is installed to control seepage or prevent collapse of the walls, casing shall be advanced in intimate contact with the surrounding soils and ahead of any excavation.

G. Casing shall not be permanently left in place.

H. Remove all material regardless of classification within the shaft at which time Geotechnical Representative will field observe the excavation or drilling spoils and determine whether the excavation has reached the required bearing layer. Excavate shaft bottom to a level plane.

I. Cleanout and remove all loose material and spoil from sides and bottom of the shaft to the degree determined by the Geotechnical Representative, and prior to placing concrete. In no case shall the average thickness of sediments on the shaft bottom exceed one-half inch, with a maximum thickness of one inch.

J. Drilled shafts which are overexcavated without Geotechnical Representative's approval shall have the overexcavation filled with unreinforced concrete, provided shafts do not require reinforcing steel for lateral or uplift loadings at depth, at Contractor's expense. If loads on shaft require reinforcing steel, provide steel with adequate lap splice at Contractor's expense.

K. Take all precautions necessary to prevent blowouts and disturbance of the sides or bottom of the excavation.

3.02 SOCKET EXCAVATION

A. Sockets shall be excavated as indicated on the Drawings and defined herein.

B. All soft, weathered, and broken rock shall be removed to establish socket depths into the specified material as indicated.

C. Socket depth shall be measured along the side of least dimension where penetration occurs into sloping socket strata.
D. Blasting shall not be permitted.
E. Clean sides of socket of any loose material and rock paste to provide full bond between concrete and undisturbed socket material.
   1. Hand clean sides of socket or use other equipment approved by Geotechnical Representative.
   2. Water shall not be used for cleaning if detrimental to the integrity of the socket material.
F. Rock sockets shall include shear rings 3 inches high and 3 inches deep in the lower 6 feet of the socket. The shear rings shall be installed as horizontal grooves at 18-inch centers or helical grooves with an 18-inch pitch, along the portion of the socket length as indicated.
G. During cleaning and inspection of each drilled shaft socket, lower the casing only to the top of the socket. Once socket has been cleaned and inspected, casing shall not be lowered into any portion of the socket where skin friction is utilized.

3.03 BACKFILLING:

A. Restore the ground surface to required grade in the lateral direction around the drilled shaft with on-site soils, to replace any soils that have collapsed or sloughed as a result of the Work.
B. Prior to any backfilling operations, submit proposed methods and materials for approval.
C. Placement and compaction of soils required to restore the ground surface to required grade shall be completed in accordance with the following:
   1. Cohesive Soils:
      a. Materials include silts and clays generally exclusive of topsoil, sands and gravel. Materials for which impact compaction will produce a well-defined moisture-density relationship curve.
      b. Compaction shall achieve a minimum of 95 percent of maximum density with a moisture content plus or minus 3 percent of optimum moisture per ASTM D698.
   2. Cohesionless Soils:
      a. Materials include gravels, gravel-sand mixtures, sands, and gravelly sands exclusive of topsoil, clayey and silty materials. Materials which are free-draining and for which impact compaction will not produce a well-defined moisture-density relationship curve and for which the maximum density by impact methods will generally be less than by vibratory methods.
      b. Compaction shall achieve a minimum of 70 percent relative density as per ASTM D4253 and D4254.
   3. Bedrock: Replace with concrete with minimum compressive strength of 4,500 psi.

3.04 CONCRETE FORMWORK:

A. As specified in SECTION 03 10 00.
B. Form the drilled shaft with round forms with an inside diameter equal to the drilled shaft's nominal diameter and of sufficient strength to restrain the concrete without deformation or settlement. Mushrooming at the top of the drilled shaft shall not be permitted.
C. Construct forms to be removable without marring concrete surface.
D. Surface of forms shall provide smooth, dense, plane surface to finished concrete where exposed to view.
E. Contractor shall be responsible for structural adequacy of formwork.
F. Do not remove forms and supports until at least 24 hours after completion of concrete placement (this period is a cumulative number of hours, not necessarily consecutive, during which the temperature of the concrete surface is above 50°F).

3.05 CONCRETE STEEL REINFORCEMENT:

A. As specified in SECTION 03 20 00.
B. Unless otherwise indicated or approved, welding on concrete steel reinforcement is not permissible.
C. Wet setting of anchor bolts shall not be permitted.
D. Splice concrete steel reinforcement only as indicated.
E. Support or tie off the rebar cage to prevent downward movement.
F. Concrete steel reinforcement shall be fabricated as indicated prior to completion of excavation.
G. Provide spacers of sufficient quantity, design and material construction to maintain appropriate clearance from the side walls or casing and shaft bottom. Spacers shall be located at the top, bottom, and at every 10 feet vertical interval between. A minimum of one spacer per foot of shaft diameter shall be spaced equally around the perimeter of the reinforcing cage at each vertical interval.

3.06 CONCRETE PLACEMENT:

A. Wet forms with clear, potable water prior to placing concrete.
B. Prior to placement of concrete, center reinforcing cages in the drilled shaft excavation and suspend or tie them off in an approved manner to cutoff elevation.
C. Place concrete immediately after final inspection and approval by Geotechnical Representative.
D. Concrete not placed within 90 minutes from batch time shall be rejected.
E. Fill entire volume of drilled shaft with concrete to the cutoff elevation in one continuous operation. Cold joints and construction joints are not permitted unless otherwise indicated on the Contract Drawings. Complete concreting within the same working day in which drilled shaft is excavated. If concrete is not placed within 4 hours of completion of excavation, the bottom of the excavation shall be re-augured to remove any softened bearing material and re-inspected by the Geotechnical Representative.
F. Where practical, and without compromising the stability of the excavation, dewater excavation before placing concrete. Hold the water level in the bottom of the excavation prior to concreting at a nominal depth not to exceed 2 inches.
G. In dry excavations, place concrete with an approved drop pipe or funneling device. Approval of the funneling device shall be dependent upon Contractor's demonstrated ability to direct concrete flow so as not to fall or strike against the sides of the temporary casing, the sides of the drilled shaft excavation, or steel reinforcement before reaching the bottom. Use an extension pipe to limit the maximum concrete free-fall distance to 15 times the cage diameter.
H. Place concrete in a manner that will not cause segregation of the particles or permit infiltration of water or any other occurrence which would tend to decrease the strength of the concrete or the capacity of the finished drilled shaft. Placement of concrete underwater or through slurry shall not be permitted.
I. Do not disturb the temporary casing, until a sufficient depth of concrete has been placed in the shaft excavation such that no voids will occur in the shaft due to intrusion of soil or water as the temporary casing is being withdrawn. If a known void is present along the sides of the drilled shaft, sufficient concrete shall be placed prior to disturbing the temporary casing such that sufficient concrete will remain above the bottom of casing after the void is passed.
J. Coordinate the withdrawal of temporary casing with concrete placement to maintain a minimum concrete head of 5 feet above the casing bottom or until a sufficient depth of concrete has been placed to prevent intrusion of soil or water into the shaft concrete as the temporary casing is being withdrawn. Keep the temporary casing plumb and withdraw with a smooth, vertical motion, without jerks.

K. Should soil, rock, or water enter the excavation and contaminate the concrete, remove the contaminated concrete before completing pour.
L. Place concrete in accordance with applicable practices recommended by ACI.
M. Conveying:
    1. Convey concrete from the mixer and deposit in place by methods which will prevent the segregation or loss of materials.
    2. Equipment for chuting, pumping, and pneumatically conveying concrete shall be of such size and design as to provide a practically continuous flow of concrete at the delivery end.
    3. Do not use aluminum conveying equipment.
N. Consolidation of Concrete:
    1. Provide an adequate number of vibrators of sufficient capacity to keep up with the maximum rate of concrete placement. Keep on hand adequate standby equipment in good operating condition.
    2. Vibrate concrete within the top 5 feet, only after temporary casing has been pulled or when casing is permanent.
    3. Vibrate concrete until the concrete is thoroughly consolidated and the voids filled as evidenced by the level appearance of the concrete at the exposed surface and the embedment of the surface aggregate. Do not over vibrate to avoid segregation of concrete aggregate from the cement paste.
O. Additionally, as specified in SECTION 03 30 00.

3.07 NON-CONFORMING WORK:

A. Contractor shall be solely responsible for full compliance with the Contract Documents regardless of if and when discrepancies are brought to their attention. Contractor shall be responsible for all re-work necessary to achieve full compliance with the Contract Documents. Repairs or replacement shall be at the sole expense of the Contractor, including the costs to redesign, as required.
B. Owner may employ one or more of their representatives for observation and testing services.
C. Owner or Geotechnical Representative may reject any shafts which, in their opinion, do not conform to the Contract Documents.
D. As directed by Owner, perform the following for rejected shafts at no additional cost to Owner:
    1. Leave shafts in place, cut off as directed, and install one or more replacement shafts in designated location(s).
    2. Withdraw the shaft and install a new shaft in the same location.
    3. Any holes which result from shaft withdrawal or excavation that results in unstable excavation shall be backfilled with controlled low strength material (CLSM) with strength characteristics equal to or greater than the material excavated. Contractor shall provide documentation of proposed CLSM mix planned for use.
    4. Pressure grouting to fill voids or restore sidewall or base soil conditions that have been disturbed due to the Work.
    5. Other remediation work, as directed.

END OF SECTION 31 63 29

Owner _____

Project Name _____

Project No. _____

Contract No. _____

Single Shaft

Record Report

Shaft No. _____

AS DESIGNED (Per Drawings)

Shaft Location/Area _____

Type/Diameter _____

Top Elevation (ft) _____

Length (ft) _____

Rebar Length (ft) _____

AS CONSTRUCTED

Started _____

Date/Time Completed _____

Diameter _____

Top Elevation (ft) _____

Bottom Elevation (ft) _____

Length (ft) _____

Tolerance _____

Plumbness _____

Concrete, Cy _____

Concrete Mix ID _____

Rebar Length _____

Socket Length (ft) _____

REMARKS

Bearing Material Description _____

_____

_____

Rebar - Size & Condition _____

_____

_____

Notes _____

_____

_____

_____

_____

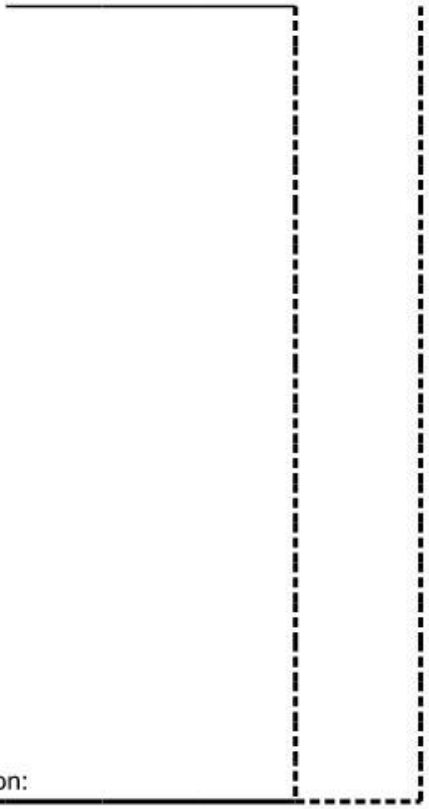
_____

_____

_____

Shaft Log *(INCLUDE: Ground Elevations, Size, Shaft Casing, Water Conditions, Drilling & Concreting, Nature & Location of Obstructions, & All Other Pertinent Information.)*

Elevation: _____



Elevation: _____

Time of Concrete

Placement Start _____

Finish _____

_____

Drilled Shaft Subcontractor

_____

General Contractor

_____

Observer Name & Company

DIVISION 32 – EXTERIOR IMPROVEMENTS

SECTION 32 11 23 - CRUSHED AGGREGATE BASE (SURFACE) COURSE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section consists of a base course composed of crushed aggregates constructed on a prepared course in accordance with these Specifications and in conformity to the dimensions and typical cross-sections shown on the Plans.

1.03 RELATED REQUIREMENTS:

A. Section 31 20 00 - Site Preparation and Earthwork.
B. Section 31 23 13 – Subgrade Preparation

1.04 REFERENCE STANDARDS:

A. The publications listed below form a part of this Specification to the extent referenced. The publications are referred to within the text by the basic designation only.
   1. ASTM International (ASTM):
      a. ASTM C29 - Unit Weight of Aggregate.
      b. ASTM C88 - Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
      c. ASTM C117 - Materials Finer than No. 200 (75-µm) Sieve in Mineral Aggregates by Washing.
      d. ASTM C131 - Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      e. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.
      f. ASTM D75 - Sampling Aggregate.
      g. ASTM D422 - Particle Size Analysis of Soils.
      h. ASTM D693 - Crushed Aggregate for Macadam Pavements.
      i. ASTM D698 - Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb. (2.49-kg) Rammer and 12-inch (305-mm) Drop.
      j. ASTM D1556 - Density of Soil in Place by the Sand-Cone Method.
      k. ASTM D1557 - Test for Laboratory Compaction Characteristics of Soil Using Modified Effort.
      l. ASTM D2167 - Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
      m. ASTM D2419 - Sand Equivalent Value of Soils and Fine Aggregate.
      n. ASTM D6938 - In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods.
      o. ASTM D3665 - Random Sampling of Construction Materials.
      p. ASTM D4318 - Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   2. State of Colorado Department of Transportation (CDOT)
      a. Standard Specifications for Road and Bridge Construction, latest edition.
   3. City and County of Broomfield (CCoB) Standards and Specifications
      a. Section 700 – Roadway Design, Traffic Control Devices and Street Lighting

b. Section 900 – Asphalt Mix Design and Construction

1.05 SUBMITTALS:

A. Submit the following in accordance with Division 01.
   1. Test results from laboratory testing of imported granular materials.

1.06 QUALITY ASSURANCE:

A. Equipment Approval:
   1. All plant, equipment, and tools used in the performance of the Work will be subject to approval before the Work is started and shall be maintained in satisfactory working condition at all times. Submit a list of proposed equipment, including descriptive data. Provide adequate equipment having the capability of producing the required compaction, meeting grade controls, thickness control, and smoothness requirements as set forth herein.

B. Sampling and Testing:
   1. Test to determine conformance with all requirements of this Specification for quality and properties of all Contractor-secured sources of materials shall be performed by an independent commercial laboratory retained and compensated by Contractor and approved by Engineer. In lieu of testing, Contractor may submit certified state test results indicating the aggregate meets Specification requirements to Engineer for approval.
   2. Obtain representative samples of material in accordance with ASTM D75/D75M for testing. Furnish laboratory sufficient material for testing from each sample at the time obtained. Copies of reports and certificates regarding tests and inspection of materials shall be distributed as specified in Division 01. Furnish specific schedule for sampling to provide Engineer the opportunity to observe sampling.
   3. When incorporating materials into the Work, quality control testing will be performed during construction by a testing laboratory retained and compensated by Owner.
   4. The Contactor shall engage services of an independent testing agency to test all aggregate base course placement. The Contractor shall be responsible for the scheduling of all testing.
   5. Sampling:
      a. Take samples for laboratory testing in conformance with ASTM D75/D75M. When deemed necessary, the sampling will be observed by the Engineer.
   6. Tests:
      a. Perform the following tests in conformance with the applicable standards listed.
      b. Sieve Analysis:
         (1) Make sieve analysis in conformance with ASTM C117 and ASTM C136. Sieves shall conform to ASTM E11. Particle-size analysis of the soils shall also be completed in conformance with ASTM D422.
      c. Liquid Limit and Plasticity Index:
         (1) Determine liquid limit and plasticity index in accordance with ASTM D4318.
      d. Moisture-Density Determinations:
         (1) Determine the laboratory maximum dry density and optimum moisture content in accordance with ASTM D1557 or AASHTO T 180, Method D and corrected with AASHTO T 224.
      e. Field Density Tests:

(1) Measure field density in accordance with ASTM D1556, ASTM D2167, or ASTM D6938.
(a) Submit certified copies of test results for approval not less than 30 days before material is required for the Work.
(b) Submit calibration curves and related test results prior to using the device or equipment being calibrated.
(c) Submit copies of field test results within 24 hours after the tests are performed.

f. Wear Test:
(1) Perform wear tests on aggregate base course material in conformance with ASTM C131.

g. Soundness:
(1) Perform soundness tests on GCA in accordance with ASTM C88.

1.07 ENVIRONMENTAL REQUIREMENTS:

A. Perform construction when the atmospheric temperature is above 35ºF. When the temperature falls below 35ºF, protect all completed areas by approved methods against detrimental effects of freezing. Correct completed areas damaged by freezing, rainfall, or other weather conditions to meet specified requirements.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General:
1. Crushed rock base and surface course shall consist of aggregate specified.

B. Aggregate:
1. Aggregates shall consist of clean, sound, durable particles of crushed stone, crushed gravel, or crushed slag and shall be free from coatings of clay, silt, vegetable matter, and other objectionable materials and shall contain no clay balls. Fine aggregate passing the No. 4 sieve shall consist of fines from the operation of crushing the coarse aggregate. If necessary, fine aggregate may be added to produce the correct gradation. The fine aggregate shall be produced by crushing stone, gravel, or slag that meets the requirements for wear and soundness specified for coarse aggregate.
2. Percentage of wear shall not exceed 45% when tested in accordance with ASTM C131. The sodium sulfate soundness loss shall not exceed 12% after 5 cycles when tested in accordance with ASTM C88.
3. Portion of aggregate which is retained on a 3/8-inch sieve shall contain 75% by weight of pieces with two or more fractured surfaces if the material is crushed gravel.
4. Portion of aggregate passing No. 40 sieve shall be as follows:
a. Liquid Limit: Not more than 25 determined by ASTM D4318
b. Plastic Index: Not more than 4 determined by ASTM D4318
c. The fine aggregate shall have a minimum sand equivalent value of 35 when tested in accordance with ASTM D2419.

C. Aggregate Surface Course:
1. Gradation shall not vary from low limit on one sieve to high limit on adjacent sieve or vice versa. Aggregate for Surface Course shall be Crushed Base Class 5 as specified in

Table 703-2 Classification for Aggregate Base Course of the CDOT Standard Specifications for Road and Bridge Construction.

D. Aggregate Base Course:
   1. Gradation shall not vary from low limit on one sieve to high limit on adjacent sieve or vice versa. Aggregate for Base Course shall be Class 6 Aggregate Base Course as Table 703-2 Classification for Aggregate Base Course of the CDOT Standard Specifications for Road and Bridge Construction.

PART 3 - EXECUTION

3.01 PREPARING UNDERLYING COURSE:

A. The underlying course shall be prepared in accordance with Section 31 23 13, checked, and accepted by the Engineer before placing and spreading operations are started. Any ruts or soft yielding places caused by improper drainage conditions, hauling, or any other cause shall be corrected at the Contractor's expense before the base course is placed thereon. Material shall not be placed on frozen subgrade.

3.02 MIXING:

A. The aggregate shall be uniformly blended during crushing operations or mixed in a plant. The plant shall blend and mix the materials to meet the Specifications and to secure the proper moisture content for compaction.

3.03 PLACING:

A. The crushed aggregate base material shall be placed on the moistened subgrade in layers of uniform thickness with a mechanical spreader.
B. The maximum depth of a compacted layer shall be 6 inches. If the total depth of the compacted material is more than 6 inches, it shall be constructed in two or more layers. In multi-layer construction, the base course shall be placed in approximately equal-depth layers.
C. The previously constructed layer should be cleaned of loose and foreign material prior to placing the next layer. The surface of the compacted material shall be kept moist until covered with the next layer.

3.04 COMPACTION:

A. Immediately upon completion of the spreading operations, the crushed aggregate shall be thoroughly compacted. The number, type, and weight of rollers shall be sufficient to compact the material to the required density.
B. The moisture content of the material during placing operations shall not be more than -2 percentage points below, or more than 2 percentage points above, the optimum moisture content as determined by ASTM D698.
C. Compact to 95% of maximum dry density.

3.05 ACCEPTANCE SAMPLING AND TESTING FOR DENSITY:

A. Aggregate base course shall be accepted for density on a lot basis. A lot will consist of one day's production where it is not expected to exceed 2,400 sq. yds. A lot will consist of one-half day's production where a day's production is expected to consist of between 2,400 and 4,800 sq. yds.

B. Each lot shall be divided into two equal sublots. One test shall be made for each sublot. Sampling locations will be determined by a random basis in accordance with statistical procedures contained in ASTM D3665.

C. Each lot will be accepted for density when the field density is at least 95% of the maximum density of laboratory specimens prepared from samples of the base course material delivered to the Job Site. The specimens shall be compacted and tested in accordance with ASTM D698. The in-place field density shall be determined in accordance with ASTM D1556 or D2167. If the specified density is not attained, the entire lot shall be reworked and/or recompacted and two additional random tests made. This procedure shall be followed until the specified density is reached.

D. In lieu of the core method of field density determination, acceptance testing may be accomplished using a nuclear gauge in accordance with ASTM D6938. The gauge should be field calibrated in accordance with Section 120 and ASTM Standards. Calibration tests shall be conducted on the first lot of material placed that meets the density requirements.

E. When using the nuclear method ASTM D6938 shall be used to determine the moisture content of the material. The calibration curve furnished with the nuclear gauges shall be checked in accordance with ASTM standards. The calibration checks shall be made at the beginning of a job and at regular intervals.

F. If a nuclear gauge is used for density determination, two random readings shall be made and averaged for each sublot.

3.06 FINISHING:

A. The surface of the aggregate base course shall be finished by blading or with automated equipment especially designed for this purpose.

B. In no case will the addition of thin layers of material be added to the top layer of base course to meet grade. If the elevation of the top layer is 1/2 inch or more below grade, the top layer of base shall be scarified to a depth of at least 3 inches, new material added, and the layer shall be blended and recompacted to bring it to grade. If the finished surface is above plan grade, it shall be cut back to grade and rerolled.

3.07 SURFACE TOLERANCES:

A. The finished surface shall not vary more than 3/8 inch when tested with a 16-foot straightedge applied parallel with or at right angles to the centerline. Any deviation in excess of this amount shall be corrected by the Contractor at the Contractor's expense.

3.08 THICKNESS CONTROL:

A. The completed thickness of the base course shall be within 1/2 inch of the design thickness. Four determinations of thickness shall be made for each lot of material placed. The lot size shall be consistent with that specified in Paragraph 3.05. Each lot shall be divided into four equal sublots. One test shall be made for each sublot. Sampling locations will be determined by a random basis in accordance with procedures contained in ASTM D3665. Where the thickness is deficient by more than 1/2 inch, the Contractor shall correct such areas at no additional cost by excavating to the required depth and replacing with new material. Additional test holes may be required to identify the limits of deficient areas.

3.09 MAINTENANCE:

A. The base course shall be maintained in a condition that will meet all specification requirements until the Work is accepted. Equipment used in the construction of an adjoining section may be routed over completed portions of the base course, provided no damage results and provided that the equipment is routed over the full width of the base course to avoid rutting or uneven compaction.

B. The Contractor shall remove all survey and grade hubs from the base courses prior to placing any bituminous surface course.

END OF SECTION 32 11 23

SECTION 32 12 15 – BITUMINOUS TACK COAT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes hot bituminous tack coat over previously prepared bituminous base course.

1.03 RELATED REQUIREMENTS:

1. Section 32 12 17 - Hot Mix Asphaltic Concrete Pavement

1.04 REFERENCE STANDARDS:

A. Applicable Standards:
   1. ASTM International (ASTM):
      a. ASTM D140 - Practice for Sampling Bituminous Materials.
      b. ASTM D633 - Volume Correction Table for Road Tar.
      c. ASTM D977 - Emulsified Asphalt.
      d. ASTM D1250 - Guide for Petroleum Measurement Tables.
      e. ASTM D2028 - Cutback Asphalt (Rapid-Curing Type).
      f. ASTM D2397 - Cationic Emulsified Asphalt.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M52 - Tar for Use in Road Construction.
   3. Asphalt Institute (AI):
      a. MS-6 Table IV-3 - Temperature-Volume Correction for Emulsified Asphalts.
   4. State of Colorado Department of Transportation (CDOT) Standard Specifications for Road and Bridge Construction
   5. City and County of Broomfield (CCoB)Standards and Specifications
      a. Section 900 – Asphalt Mix Design and Construction

1.05 SUBMITTALS:

A. Submit certificates as specified in Division 01.
B. Submit for material specified.
C. Submit for each batch of material.
D. Certificates shall be prepared by an Engineer approved testing laboratory and submitted to Engineer by Contractor for acceptance.

1.06 QUALITY ASSURANCE:

A. Sampling and Testing:
   1. Tests to determine conformance with all requirements of this Specification for quality and properties of all Contractor-secured sources of materials shall be performed by an independent commercial laboratory retained and compensated by Contractor and approved by Engineer. In lieu of testing, Contractor may submit certified state test results indicating that the aggregate meets Specification requirements to Engineer for approval.

PART 2 - PRODUCTS

2.01 BITUMINOUS MATERIAL:

A. General Requirements: Tack coat materials and construction shall comply with Section 407 of the CDOT Standard Specifications for Road and Bridge Construction and Section 900 of the CCoB Standards and Specifications.

2.02 EQUIPMENT:

A. General Requirements:
   1. Furnish and maintain all equipment, tools, and machines used in the performance of the work required by this Section in satisfactory working condition at all times.
   2. Equipment shall be subject to approval of Engineer.

PART 3 - EXECUTION

3.01 PREPARATION OF SURFACE:

A. Remove all loose and objectionable material from surface by sweeping with a power broom and/or airblasting.
B. Sprinkle surface with water immediately in advance of application if surface is excessively dry.
C. Obtain approval from Engineer prior to application of tack coat.

3.02 WEATHER LIMITATIONS:

A. Apply tack coat only when base course is dry enough to permit uniform distribution and desired penetration.
B. Apply only when atmospheric temperature is above 60ºF.
C. Do not apply or leave tack coat exposed in wet conditions.

3.03 APPLICATION TEMPERATURE:

A. The application temperature of the tack coat shall be 120ºF.

3.04 SAMPLING AND TESTING:

A. Conform to ASTM D140.
B. Furnish the Supplier's certified test reports for each truckload, or equivalent, of bituminous material shipped to the Site. Test reports shall be delivered to Contractor prior to application of material.

3.05 APPLICATION OF BITUMINOUS MATERIAL:

A. Apply by means of a bituminous distributor at the temperature, pressure, and in amounts approved by Engineer to obtain uniform distribution at all points of surface.

3.06 WAYBILLS AND DELIVERY TICKETS:

A. Submit daily to Contractor during the progress of the Work.

END OF SECTION 32 12 15

SECTION 32 12 17 – HOT-MIX ASPHALTIC-CONCRETE PAVEMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes hot-mix, asphaltic-concrete pavement materials, equipment, placement, and testing.

1.03 RELATED REQUIREMENTS:

A. Section 31 20 00 - Site Preparation and Earthwork.
B. Section 31 23 13 - Subgrade Preparation.
C. Section 31 23 33 - Trenching and Backfilling for Utilities
D. Section 32 11 23 - Crushed Aggregate Base Course
E. Section 32 12 15 - Bituminous Tack Coat

1.04 REFERENCES:

A. Applicable Standards:
   1. ASTM International (ASTM):
      a. ASTM C29/C29M - Test Method for Unit Weight and Voids in Aggregate.
      b. ASTM C117 - Test Method for Material Finer than 75 µm (No. 200) Sieve in Mineral Aggregates by Washing.
      c. ASTM C127 - Test Method for Specific Gravity and Absorption of Coarse Aggregate.
      d. ASTM C128 - Test Method for Specific Gravity and Absorption of Fine Aggregate.
      e. ASTM C131 - Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
      f. ASTM C136 - Method for Sieve Analysis of Fine and Coarse Aggregates.
      g. ASTM C183 - Practice for Sampling and the Amount of Testing of Hydraulic Cement.
      h. ASTM D75 - Practices for Sampling Aggregates.
      i. ASTM D140 - Practice for Sampling Bituminous Materials.
      j. ASTM D242 - Mineral Filler for Bituminous Paving Mixtures.
      k. ASTM D946 - Penetration-Graded Asphalt Cement for Use in Pavement Construction.
      l. ASTM D979 - Practice for Sampling Bituminous Paving Mixtures.
      m. ASTM D1559 - Test Method of Resistance to Plastic Flow of Bituminous Mixtures Using Marshall Apparatus.
      n. ASTM D3381 - Viscosity-Graded Asphalt Cement for Use in Pavement Construction.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. AASHTO M29 - Fine Aggregate for Bituminous Paving Mixtures.
      b. AASHTO T102 - Spot Test of Asphaltic Materials.
   3. State of Colorado Department of Transportation (CDOT)
      a. Standard Specifications for Road and Bridge Construction
   4. City and County of Broomfield (CCoB) Standards and Specifications
      a. Section 700 – Roadway Design, Traffic Control Devices and Street Lighting
      b. Section 900 – Asphalt Mix Design and Construction

1.05 SUBMITTALS:

A. Submit as specified in Division 01.

B. Samples: Furnish Samples as specified. Samples shall be delivered to the laboratory designated by Contractor. Sampling shall be under the observation of Engineer when required:

1. Furnish Samples of aggregates and asphalt cement to be used in the Work at least 30 days prior to beginning production of asphalt paving mixture. Sampling methods shall conform to the following:
   a. Asphalt Cement: ASTM D140.
   b. Coarse and Fine Aggregates: ASTM D75.
   c. Mineral Filler: ASTM C183, paragraphs 3, 4, and 6.
2. Furnish at least one Sample from each 272 metric tons (300 tons) of the mix being produced. Sampling method shall conform to ASTM D979.
3. Completed Pavement: Core or saw undamaged Samples of the size and number required by Engineer:
   a. Take Samples in sets of three at locations designated by Engineer.
   b. Replace pavement at Sample locations with fresh bituminous mixture and thoroughly compact repaired area.
4. Furnish additional Samples prior to and during construction of the number and size requested by Engineer.

C. Hot-Mix Formula:

1. Formula and mix type shall conform with the CCoB Standards and Specifications accepted mix types.
2. Formula shall indicate the definite percentage of each sieve fraction, percentage of asphalt, and the temperature of the completed mixture as it is to be discharged from the mixer.
3. Formula shall be furnished by Contractor 30 days prior to beginning production of paving mixtures and approved by Engineer following testing of the aggregates and bitumen before any bituminous mixtures are manufactured.
4. Formula shall permit adjustments of the bitumen content and aggregate gradation within the limits of the gradation table specified to improve the paving mixtures as required by Engineer.
5. Restrict formula to values so that application of the following tolerances will not cause the limits in the gradation table to be exceeded:

1.06 TESTING:

A. Contractor will test all materials and mixes to determine conformance with these Specifications. Tests will be performed without cost to Owner.

1.07 JOB CONDITIONS:

A. Weather Limitations: Do not mix or place hot-mix asphaltic concrete when the ambient temperature is below 40ºF.

PART 2 - PRODUCTS

2.01 EQUIPMENT:

A. General:

1. Includes all equipment to be used in the performance of the Work covered by this Section.

2. Maintain all equipment, tools, and machines in a satisfactory working condition at all times.
    a. Equipment that drips fuel, oil, or grease shall be removed from the Project until such leakage is corrected.
3. All equipment shall be subject to the approval of Engineer.

B. Haul Trucks:
1. Includes all vehicles used for the transportation of asphaltic concrete from the plant to the paving Site.
2. Trucks shall have tight metal bottoms and shall be free from materials which may affect the mix being hauled.
3. Provide trucks with covers to protect the load and to prevent cooling of the upper surface of the mix.

C. Truck Scales and Weigh House:
1. Provide truck scales and weigh house at the paving Site.
2. Scales shall be standard truck scales of the beam type of sufficient size and capacity to accommodate all trucks to be used by Contractor in handling the bituminous mixtures:
    a. Scales shall be tested and approved by an inspector of the State Inspection Bureau charged with scale inspection within the state in which the Project is located, or by Engineer when such inspection bureau is not available.
    b. Calibrate and reseal scales as often as necessary to ensure continuous accuracy.
    c. Keep on hand at all times the necessary number of standard weights for testing.
3. Weigh House:
    a. Provide a structure of a suitable size having a sliding window facing the scale platform, one end window, and a shelf desk at least 2 ft. wide by 6 ft. long.
    b. Structure shall be weatherproof and constructed in a manner that will afford adequate protection for the recording devices of the scales.

D. Blowers and brooms shall be of the power type suitable for cleaning the surface to be paved.

E. Pavers:
1. Pavers shall be of the self-propelled type, equipped with hoppers, distributing screws, adjustable screeds, and equalizing devices capable of spreading hot bituminous mixtures without tearing, shoving, or gouging.
2. Pavers shall be capable of producing a finished surface of specified evenness.
3. Pavers shall be designed to operate forward at variable speeds and in reverse at traveling speeds of not less than 100 ft. per minute. Equip paver with an approved control system capable of automatically controlling the elevation and transverse slope of the paver screed from all of the following references:
    a. An erected or traveling stringline on both sides of the paver actuating the control system on each side of the paver independently.
    b. An erected or traveling stringline operating on one side of the paver only.

F. Rollers:
1. Rollers shall be:
    a. Self-propelled, steel-wheel, vibratory, and pneumatic types with reversing mechanism.
    b. Friction clutch and brakes of ample capacity to permit smooth starting, stopping, and reversing.
    c. Adjustable scrapers, water tanks, and sprinkling apparatus to keep the wheels wet.

2. Pneumatic Rollers:
    a. Rollers shall consist of two axles on which are mounted not less than nine smooth wheels of equal size, diameter, and ply rating. Tracking wheels shall overlap by a minimum of 1/4 inch.
    b. Rollers shall be capable of exerting average contact pressures varying from 40 to 110 lbs. per inch² by adjusting ballast and tire inflation pressures.
    c. Contact pressure shall be uniform for all wheels.
    d. Wheels shall oscillate in a vertical plane but not wobble.
    e. Rollers shall be provided with a loading platform or body suitable for ballast loading of not less than 4.1 metric tons (4.5 tons).
3. Steel-wheel rollers may be either 3-wheel rollers, 2-axle tandem rollers, or 3-axle tandem rollers:
    a. Rollers shall weigh not less than 9 metric tons (10 tons) and develop contact pressures under the compression rolls of not less than 300 psi.
    b. Three-axle tandem rollers shall be so constructed, that when locked in position for all treads to be in one plane, the roller wheels are held with such rigidity that if either front or center wheel is unsupported, the other two wheels will not vary from the plane more than 1/4 inch.
    c. Roller wheels shall have no flat areas, openings, or projections which will mar the surface of the pavement.
4. Vibratory rollers may have either one or two smooth-surfaced steel wheels.
    a. Rollers shall be provided with a means of adjusting the resonance of the dynamic force.
5. Trench rollers shall have an auxiliary wheel (or roll) that operates outside the area to be compacted at such a distance from the pavement edge as to not cause any damage to the pavement edge:
    a. Auxiliary wheel shall be mounted upon an axle that is adjustable in height.
    b. Contact pressure per 1 inch of width of compression roll shall be not less than 300 lbs. nor more than 364 lbs..
    c. Minimum allowable width of compaction roll shall be 15 inches.

G. Hand Tampers: Weight of tamper shall be not less than 25 lbs., with a tamping face of not more than 50 inches².

H. Small Tools:
1. Furnish rakes, lutes, shovels, smoothing irons, pavement cutters, wheel-mounted wagons for heating small tools, wood sandals and stilt sandals of standard type, and other small tools as may be required.
2. Tools shall be available at all times in sufficient number to efficiently construct the bituminous pavements.

2.02 MIXES:

A. Asphalt mix shall be Residential (Parking Lot) mix design in accordance with CCoB Standards and Specifications Section 920.00 – Asphalt Pavement Mix Design.

PART 3 - EXECUTION

3.01 TRANSPORTATION OF MIXTURE:

A. Haul trucks shall be as specified in Part 2, this Section. Provide trucks of such size, operating speed, and condition to ensure orderly and continuous operation.

B. When necessary to prevent adhesion of mixture to truck beds, coat truck beds with a minimum quantity of paraffin oil, lime solution, or other approved material.
C. Haul trucks shall make no direct frame contact with the paver and shall not bear down on the paver during dumping operations.
D. Deliveries shall be made so that spreading and rolling of all the mixture prepared for a day's run can be completed during daylight.
E. Deliver to the area to be paved in such a manner that the temperature at the time of dumping into the spreader will not be less than hereinafter specified.
F. Hauling over freshly laid material will not be permitted.
G. Loads wet excessively by rain will be rejected.

3.02 PLACING MIXTURE:

A. Underlying Course:
   1. Clean of all foreign or objectionable matter with power blowers, power brooms, or hand brooms as approved by Engineer.
B. Temperature of mixture shall be within the range determined by Engineer and not be less than 235ºF when dumped into the mechanical spreader or it will be rejected.
C. Automatic screed controls shall be actuated by the following grade references installed by Contractor:
   1. An erected stringline on each side of the first lane placed in each course, independently actuating screed control mechanisms on each side of the paver.
   2. A traveling stringline operated on the adjacent completed lane, and an erected stringline on the subgrade or previously completed pavement course, independently actuating screed control mechanism on each side of the paver for the second and all successive lanes of each course.
   3. Erected stringlines will be required on only one side of the first paving lane of each course for all pavements having a width of 24 ft. or less providing automatic slope controls produce finish transverse slopes within the specified tolerances for smoothness and grade.
   4. Joint matching shoes operating on previously completed gutter sections shall be used for control reference on all paving lanes adjacent to curb-and-gutter sections.
D. Adjust spreader and regulate speed so the surface of the course is smooth and of such depth that when compacted it will conform to the cross section, grade, and contour as indicated.
E. Paving Strips:
   1. Begin along centerline of areas to be paved on a crowned section and on high side of a section of an area with a one-way slope.
   2. Place in strips with a minimum width of 10 ft..
   3. Roll, leaving a 6-inch unrolled strip adjacent to the area on which additional material is to be laid, except when the Work is to be discontinued.
   4. Place strips in succeeding order while the unrolled 6-inch section of the adjoining strip is hot and in a readily compactable condition, and roll.
   5. Paving strips shall be of such length as determined by Engineer, before placing the succeeding strips.
   6. Place material as nearly continuous as possible.
   7. Paving strips shall be as approved by Engineer where necessary to maintain traffic flow.
F. Handwork:
   1. Use a sufficient number of experienced shovelers and rakers following the spreading machine to produce a course that will conform to all requirements specified.

2. In areas where use of machine spreading is impractical, place mixture on dumpboards outside the area to be paved, distribute by hot shovels, and spread with hot rakes in a uniformly loose layer of such thickness that when compacted it will conform to the required grade and thickness.
3. Rakers shall not be permitted to stand in hot mix without stilt sandals.

G. Contact Surfaces:
1. Defined as previously constructed pavement curbs, manholes, and similar structures.
2. Coat with a thin coat of hot bituminous material prior to placing the bituminous mixture.

3.03 COMPACTION OF MIXTURES:

A. Rollers:
1. Use three-wheel, pneumatic, and steel-wheel rollers specified. Vibratory rollers may be used where approved by Engineer.
2. Begin as soon after placing as mixture will bear the roller without undue displacement. Delays in rolling freshly spread mixture will not be permitted.

B. Operation of Rollers:
1. Only competent and experienced persons shall operate rollers.
2. Do not exceed speeds of 3 miles per hour for steel-wheeled rollers and 5 miles per hour for pneumatic rollers, and at all times speed shall be slow enough to avoid displacement of the hot mixture.
3. Moisten wheels to prevent adhesion of the mixture to the wheels, but an excess of water will not be permitted.
4. Provide a minimum of one steel-wheeled roller and one pneumatic roller for each spreading machine in operation, with additional 9 metric ton (10 ton) rollers added if it is found that the pavement density specified is not obtained by the minimum number of rollers.
5. Pass over the unprotected edge of the course only when the laying of the course is to be discontinued for such length of time as to permit the mixture to become cold.

C. Roll pavement in the following order:
1. Transverse joints.
2. Longitudinal joints at adjacent completed paving lane or curb and gutter section.
3. Outside edge of first and last paving lanes not adjacent to completed pavement or curb and gutter sections.
4. Breakdown rolling beginning on the low side and progressing toward the high side.
5. Second rolling beginning at the low side and progressing toward the high side.
6. Finish rolling.

D. Joint Rolling:
1. Roll joints directly behind the paving operation.
2. Make first pass with approximately a 150-mm (6-inch) width of roll on the joint and the remainder supported by the previously completed mat.
3. Shift position of roll on joint in 150- to 200-mm (6- to 8-inch) increments on successive passes and continue rolling until a thoroughly compacted neat joint is obtained.

E. Breakdown Rolling:
1. Use either steel-wheeled or pneumatic rollers.
2. Operate with drive wheels or rolls nearest the paver.
3. Roll as close to the paver as possible without causing undue displacement of the mat.

F. Second Rolling:
1. Use pneumatic or vibratory rollers specified.

2. Accomplish while paving mix is still at a temperature that will result in maximum density and following breakdown rolling as closely as possible.
3. Continue rolling until the mix is thoroughly and uniformly compacted to the specified density but make no less than three complete coverages of the mat.

G. Finish Rolling:
1. Use two-axle or three-axle tandem rollers specified.
2. Roll while mat is of sufficient temperature to permit removal of roller marks.
3. Continue rolling until all roller marks have been removed and a uniform surface texture is obtained.

H. Hand Tampers:
1. Use in all places not accessible to the rollers.
2. Use while mixture is hot.

I. Repair:
1. Repair any mixture that becomes mixed with foreign material or is in any way defective.
2. Remove and replace with fresh mixture and compact to the density of the surrounding area.
3. Do not skin-patch an area that has been rolled.

3.04 JOINTS:

A. General Requirements:
1. Joints shall present the same texture, density, and smoothness as other sections of the course.
2. Carefully make joints in a manner that will ensure a continuous bond between the contact surface of the course.
3. Paint with a thin, uniform coat of hot bituminous material just before the fresh mixture is placed on all contact surfaces of previously constructed pavements.
4. Place so that the joint will not coincide with that of the lower course or courses but will be offset at least 1 ft..

B. Transverse Joints:
1. Pass roller over the unprotected end of freshly laid mixture only when the laying of the course is to be discontinued or when delivery of mixture is interrupted to the extent that the unrolled material may become cold.
2. Cut back previously laid course to expose an even, vertical surface for the full thickness of the course.
3. Rake fresh material against the joint, thoroughly tamping with hot tampers and smoothing with hot smoothers, followed by rolling.

C. Longitudinal Joints:
1. Prior to constructing the adjacent pavement, cut back edge to expose an even vertical surface for the full thickness of the previously laid course.
2. Rake fresh mixture against the joint, thoroughly tamping with hot tampers and smoothing with hot smoothers, followed by rolling.
3. Joints shall not be irregular, honeycombed, or poorly compacted.

3.05 PROTECTION OF PAVEMENT:

A. Protect pavement from all vehicular traffic of any kind until it has cooled and hardened, and in no case less than 6 hours.

3.06 SURFACE SMOOTHNESS:

A. Tests:
   1. Make tests after completion of the final rolling.
   2. Correct the irregularities that exceed the specified tolerances or that retain water on the surface, as requested by Engineer.

B. Tolerances:
   1. Measure with a 10-ft. straightedge, applied both parallel and at right angles to the centerline of the paved area.
   2. Smoothness tolerances shall be:
      a. Surface Course: ±1/8-inch.
      b. Base Course: ±1/4-inch.

3.07 DENSITY:

A. Density of completed base-course pavement shall be equal to or greater than the following percentage of the density of a laboratory specimen made from the same day's mixture and compacted in accordance with ASTM D1559:
   1. Base Course: 95%.
   2. Surface and Binder Courses: 97%.

3.08 WAYBILLS AND DELIVERY TICKETS:

A. Submit waybills and delivery tickets to Contractor for each load of paving mixture placed in completed portions of this Contract:
   1. Submit at the end of each day pavement is placed.
   2. Submit as each load is dumped in the hopper of the paver when requested by Contractor.

B. Submit waybills and refinery analysis for each load of bituminous material on the day received:
   1. Certificates shall indicate:
      a. Penetration.
      b. Specific gravity.
      c. Temperature.
      d. Net weight or volume of shipment.

END OF SECTION 32 12 17

SECTION 32 16 00 – CURBS, GUTTERS, SIDEWALKS, MEDIAN, AND PAVED DRAINAGE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Section includes concrete curbs, gutters, sidewalks, median, and paved drainage where indicated.

1.03 RELATED REQUIREMENTS:

A. Division 03 - Concrete.
B. Section 31 23 13 - Subgrade Preparation.

1.04 REFERENCE STANDARDS:

A. Applicable Standards:
   1. American Concrete Institute (ACI):
      a. ACI 306 - Cold Weather Concreting.
      b. ACI 305 - Hot Weather Concreting.
   2. ASTM International (ASTM):
      a. ASTM A615/A615M - Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
      b. ASTM A616/A616M - Rail-Steel Deformed and Plain Bars for Concrete Reinforcement.
      c. ASTM C309 - Liquid Membrane-Forming Compounds for Curing Concrete.
      d. ASTM D1751 - Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
      e. ASTM D1752 - Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
      f. ASTM D6690 - Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements.
   3. Colorado Department of Transportation (CDOT)
      a. Standard Specification for Road and Bridge Construction.
   4. City and County of Broomfield (CCoB) Standards and Specifications
      a. Section 800 – Concrete Mix Design and Construction
   5. Federal Specifications (FS):
      a. TT-S-00227 - Sealing Compound; Elastomeric Type, Multi-Component. (For caulking, sealing, and glazing in buildings and other structures.)

1.05 WEATHER LIMITATIONS:

A. Conform to ACI 306 when temperature is below 40ºF, or is likely to fall below 40ºF within a 24-hour period after placement of concrete.
B. Conform to ACI 305 when temperature is above 100ºF, or is likely to rise above 100ºF within a 24-hour period after placement of concrete.

PART 2 - PRODUCTS

2.01 CONCRETE:

A. Concrete as specified in Section 03 30 00.

B. Reinforcing steel as specified in Section 03 20 00.
C. Concrete slump reduced as necessary for slip-form construction, construction on steep slopes, and consolidation of concrete in curb back sections.
D. Concrete for curbs, gutters, and sidewalks should have fiber mesh per CDOT Standards and Specifications.

2.02 JOINT DOWELS:
A. Smooth round dowels having at least one-half the length of each dowel coated to ensure that no bond is developed between dowel and concrete.
B. Conform to ASTM A615M (A615), Intermediate Grade or ASTM A616M (A616), Regular Grade.

2.03 EXPANSION JOINT FILLER:
A. Preformed material cut and shaped to the required cross section.
B. Thickness of 1/2 inch unless otherwise indicated.
C. Conform to ASTM D1751 for all expansion joints except for those in sidewalks. Conform to ASTM D1752, Type II or Type III, for expansion joints in sidewalks.

2.04 JOINT SEALER:
A. Conform to ASTM D6690 for all joints required to be sealed except those in sidewalks.
B. For Expansion Joints in Sidewalks:
1. Conform to FS TT-S-00227.
2. Nontracking after initial cure.
3. Two-component, cold-applied.
4. Compatible with preformed expansion joint filler.
5. Black or gray color.

2.05 CURING COMPOUND:
A. Conform to ASTM C309, Type I or Type I-D.

2.06 FORMS:
A. Wood or metal.
B. Straight and strong enough to resist springing during placement of concrete.
C. Sufficient bearing surface to prevent tipping.
D. Height equal to full depth of section to be constructed.

PART 3 - EXECUTION

3.01 PREPARATION:
A. Subgrade preparation is as specified in Section 31 23 13.

3.02 INSTALLATION:
A. Forms:
1. Use flexible forms for all curved form lines except:
a. Curves having a radius of 200 ft. or greater may be formed in 10 ft. or shorter chords.
b. Curves having a radius of 100 ft. or greater may be formed in 5 ft. or shorter chords.

2. Thoroughly clean, oil, securely stake, brace, and hold forms to line and grade.
3. Remove forms from front face of curb section at the time necessary to permit finishing concrete. Leave other forms in place not less than 12 hours after placement of concrete.

B. Joints:
1. Contraction Joints:
   a. Construct at locations indicated and as follows:
      (1) Divide concrete curb, curb and gutter, median, and paved drainage into monolithic sections not greater than 10 ft. in length.
      (2) Match contraction joint spacing of adjacent Portland cement concrete pavement.
      (3) Divide sidewalks into approximately square areas.
   b. Form contraction joints by the following methods:
      (1) Place 1/8 inch-thick steel separators after concrete has taken its initial set, but before final finishing.
      (2) Cut a groove in the fresh concrete to a depth of at least one-fourth the section thickness by use of a jointer having a radius of 1/8 inch and thickness not exceeding 1/8 inch.
      (3) Saw the hardened concrete before shrinkage cracking occurs. Depth of cut not less than 1/4 the section thickness and width of key not to exceed 3/16 inch.
2. Expansion Joints:
   a. Construct at the following locations:
      (1) Locations as indicated.
      (2) All points of curvature and points of tangency of curves having a radius of 100 ft. or less, and at intervals not exceeding 60 ft. in tangent section.
      (3) Locations matching expansion joint spacing of adjacent Portland cement concrete pavement.
      (4) Locations where curb, curb and gutter, sidewalk, median, or paved drainage abut each other or other structures and slabs.
   b. Stake, support, and secure local transfer dowels and preformed joint filler in position to prevent displacement during placing and finishing operations.
   c. Round edges of joints with an edging tool of 1/4 inch radius.
3. Key Joints: Construct at locations indicated for paved drainage and curb and gutter adjacent to Portland cement concrete pavement.
4. Construction Joints:
   a. Locate to coincide with contraction, expansion, or key joints.
   b. When concrete placement is interrupted between joint locations for a sufficient time for the concrete to take its initial set, remove concrete to the nearest joint location before resuming placement.
   c. Make transverse construction joints in paved drainage having a thickness of 6 inches or greater by either key joints or expansion joints.

C. Concrete:
1. Placing Concrete:
   a. Place only on prepared and approved subgrade.
   b. Lightly moisten surface of dry subgrade before placing concrete.
   c. Deposit and compact concrete in manner to avoid displacement of forms and joint materials.

d. Tamp or vibrate concrete sufficiently to eliminate all voids and bring the mortar to the top for finishing.

2. Finishing Concrete:
   a. Edge concrete with proper edging tools.
   b. Tool radii as soon as possible after concrete has taken its initial set.
   c. Remove curb face forms and rub with rubbing block and water until all blemishes, forms, and tool marks have been removed.
   d. Float-finish with wood float or concrete rubbing block until concrete is true to line, grade, and cross section, and is uniform in texture.
   e. Brush with hairbrush as follows:
      (1) Curb and curb and gutter parallel to the line of curb.
      (2) Sidewalk and median perpendicular to their longitudinal axis.
   f. Do not use mortar topping or sand and cement dryer.

D. Tolerances:
   1. Applies to conventional and slip-form construction.
   2. Alignment deviation of finished concrete Work not to exceed 1/4 inch in 10 ft. from true line and grade.

3.03 CONCRETE CURING AND PROTECTION:

A. Curing:
   1. Spray all exposed surfaces after finishing with curing compound.
   2. Apply curing compound at a rate of not less than 1 gal. per 25 yds.^{2} of surface area.
   3. Apply second coat at a rate of not less than 1 gal. per 30 yds.^{2} 30 min. after first-coat application when the atmospheric temperature exceeds 100ºF.

B. Protection:
   1. Protect the finished Work from damage until Construction Acceptance.
   2. Repair, replace, or clean all concrete damaged or discolored prior to Construction Acceptance.

3.04 SEALING JOINTS:

A. Seal all expansion joints and contraction joints 1/4 inch or greater in width.
B. Do not seal portions of expansion joints located in vertical parts of curbs.
C. Remove curing compound and other material from joint surfaces before sealing. Joint shall be clean and surface dry at time of sealant application.
D. Apply joint sealant using methods and equipment necessary to ensure complete filling of the joint space without voids or air bubbles.
E. Apply sealant to conform to sealant manufacturer's instructions.
F. Apply finished sealant from 1/8 inch below to level with adjacent concrete surfaces.
G. Protect adjacent surfaces to prevent contamination with sealant material.
H. Protect sealant until it has set up or cured sufficiently to preclude pickup or tracking.

END OF SECTION 32 16 00

SECTION 32 31 00 – FENCES AND GATES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section covers procurement and installation of fences, gates, and other components.
B. Delivery, unloading and erection of the fence enclosure on the purchaser's property will be included.
C. The furnished materials shall be new and free from defects and shall include all components required hereafter.

1.02 RELATED REQUIREMENTS:

A. Division 03 - Concrete.
B. Division 28 – Electronic Safety and Security.
C. Section 31 20 00 - Site Preparation and Earthwork.

1.03 REFERENCE STANDARDS:

A. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      b. A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      c. A307 - Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      d. A428 - Weight of Coating on Aluminum-Coated Iron or Steel Articles.
      e. A563 - Carbons and Alloy Steel Nuts.
      f. A653 - Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanized) by the Hot-Dip Process.
      g. A924 - Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
      h. B117 - Practice for Operating Salt-Spray (Fog) Apparatus.
      i. D523 – Test Method for Specular Gloss.
      j. D822 – Practice for Conducting Tests on Paint and Related Coatings and Materials using Filtered Open-Flame Carbon-Arc Light and Water Exposure Apparatus.
      k. D1654 – Test Method for Evaluating of Painted or Coated Specimens subjected to Corrosive Environments.
      l. D2244 – Test method for Calculation of Color Differences from Instrumentally Measure Color Coordinates.
      m. D2794 – Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
      n. D3359 – Test method for Measuring Adhesion by tape Test.
      o. F626 – Fence Fittings.
      p. F900 - Industrial and Commercial Swing Gates.
      q. F1083 - Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
      r. F1184 - Industrial and Commercial Horizontal Slide Gates.
      s. C94/C94M - Ready-Mixed Concrete.
      t. F668 – Polyvinyl Chloride (PVC) Coated Steel Chain-Link Fence Fabric.
      u. F669 - Strength Requirements of Metal Posts and Rails for Industrial Chain-Link Fence.
      v. F1083 - Pipe, Steel, Hot Dipped, Zinc-Coated (Galvanized) Welded, for Fence Structures.
   2. Federal Specifications (FS):

a. FF-B-575 - Bolts, Hexagon and Square.
b. RR-F-191K/GEN - Fencing, Wire and Post, Metal and Gates, Chain Link Fence Fabric and Accessories and General Specifications.

3. City and County of Broomfield (CCoB) Standards and Specifications

1.04 SUBMITTALS:

A. Submit as specified in Division 1.
B. Includes, but not limited to, the following, for each fence type and gate to be installed:
   1. Product data: Manufacturer's technical data, specifications, and installation instructions for fence and gate posts, fabric, gates, and accessories.
   2. Shop Drawings: Showing layout, location of fence, gates, posts, and including details illustrating fence height, sizes of posts, rails, braces, gates, hardware list, and accessories.
   3. Mill certification that materials meet specification of member size, strength, wall thickness, and coatings.

1.05 QUALITY ASSURANCE:

A. Provide fences and gates as complete units, including necessary erection accessories, fittings, and fastenings, from a single source or manufacturer.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Fence and gate height and gate width shall be as indicated on Construction Drawings.
B. All materials, configurations, and installation shall be per manufacturer's standards and recommendations.

2.02 FABRICATION

A. Pickets, rails and posts shall be pre-cut to specified lengths. Rails shall be pre-punched to accept pickets.
B. Pickets shall be inserted into the pre-punched holes in the rails and shall be aligned to standard spacing using a specially calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by manufacturer, thus completing the rigid panel assembly (Note: The process produces a virtually seamless, spatter-free good-neighbor appearance, equally attractive from either side of the panel).
C. The manufactured panels and posts shall be subjected to an inline electrode position coating (E-Coat) process consisting of a multi-stage pretreatment/wash, followed by a duplex application of an epoxy primer and an acrylic topcoat. The minimum cumulative coating thickness of epoxy and acrylic shall be 2 mils (0.058 mm). The color shall be Black.
D. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Commercial weight fences under ASTM F2408.
E. Gates with an out to out leaf dimension less than and including 72 inches shall be fabricated using Montage Plus ornamental panel material and 1-3/4" sq. x 14ga. gate ends. Gate leafs greater than 72 inches shall be fabricated using ForeRunner rails, 17 gauge pickets, intermediate uprights, gussets and 1-3/4" sq. x 14ga. gate ends. All rail and upright intersections shall be joined by welding. All picket and rail intersections shall also be joined by welding.

2.03 CONCRETE:

A. As specified in DIVISION 3.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Site preparation and earthwork as specified in Section 31 20 00.

B. Grading: Perform final grading prior to installation of fence.

3.02 INSTALLATION:

A. Fence post shall be spaced according to the drawings, plus or minus ¼". For installations that must be raked to follow sloping grades, the post spacing dimension must be measured along the grade. Fence panels shall be attached to posts with brackets supplied by the manufacturer. Posts shall be set in concrete footers having a minimum depth of 36".

3.03 FENCE INSTALLATION MAINTENANCE:

A. When cutting/drilling rails or posts adhere to the following steps to seal the exposed steel surfaces; 1) Remove all metal shavings from cut area. 2) Apply zinc-rich primer to thoroughly cover cut edge and/or drilled hole; let dry. 3) Apply 2 coats of custom finish paint matching fence color. Failure to seal exposed surfaces per steps 1-3 above will negate warranty. Ameristar spray cans or paint pens shall be used to prime and finish exposed surfaces; it is recommended that paint pens be used to prevent overspray. Use of non-Ameristar parts or components will negate the manufacturers' warranty.

3.04 GATE INSTALLATION

A. Gate posts shall be spaced according to the manufacturers' gate drawings, dependent on standard out-to-out gate leaf dimensions and gate hardware selected. Type and quantity of gate hinges shall be based on the application; weight, height, and number of gate cycles. The manufacturers' gate drawings shall identify the necessary gate hardware required for the application. Gate hardware shall be provided by the manufacture of the gate and shall be installed per manufacturer's recommendations.

END OF SECTION 32 31 00

DIVISION 33 - UTILITIES

SECTION 33 05 61 – CONCRETE MANHOLES AND VAULTS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following structures and related appurtenances:
   1. Valve Vaults.
   2. Overflow Manholes

B. Furnish all labor, materials, equipment, and incidentals required to install the vault, frames and covers, vault rungs (steps), and appurtenances as shown on the Drawings and as specified herein. Specific attention should be made to details for dimensions, reinforcement requirements, etc.

C. Related Work Specified Elsewhere:
   1. Concrete: DIVISION 03.

D. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. A48 – Gray Iron Castings.
      b. C478 – Precast Reinforced Concrete Manhole Sections.
      c. C857 – Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
      d. C890 – Standard Practice for Minimum Structural Design Loading for Monolithic or Sectional Precast Concrete Water and Wastewater Structures
      e. C913 – Standard Specifications for Precast Concrete Water and Wastewater Structures.

1.02 QUALITY ASSURANCE

A. The quality of all materials, the process of manufacturer, and the finished sections shall be subject to inspection and approval by the Owner or Engineer. Such inspection may be made at the place of manufacturer, or on the work site after delivery, or at both places, and the materials shall be subject to rejection at any time on account of failure to meet any of the Specification requirements; even though samples may have been accepted as satisfactory at the place of manufacture. Material rejected after delivery to the job shall be marked for identification and shall be removed from the job at once.

B. At the time of inspection, the materials will be carefully examined for compliance with the latest ASTM designation and these specifications, and with the approved manufacturer's drawings. All vault sections shall be inspected for general appearance, dimension, "scratch-strength", blisters, cracks, roughness, soundness, etc. The surface shall be dense and close-textured.

C. Imperfections in manhole and vault sections may be repaired, subject to the approval of the Owner, after demonstration by the manufacturer that strong and permanent repairs result. Repairs shall be carefully inspected before final approval. Cement mortar used for repairs shall have a minimum compressive strength of 4,000 psi at 7 days and 5,000 psi at 28 days, when tested in 3"x6" cylinders stored in the standard manner. Epoxy mortar may be utilized for repairs subject to the approval of the Owner.

1.03 SUBMITTALS:

A. Submittals shall be provided prior to installation.

B. Submittals shall be made as required in, DIVISION 01. In addition, the following specific information shall be provided:

1. Structural Design Certification:

a. Properly identified with project name, location, and date, provide written certification of the precast manufacturer's compliance with the requirements specified herein.

b. The certification shall state that the precast units have been designed by a Professional engineer registered in the State of Colorado. The Engineer's seal shall appear on the certification.

c. Manufacturer to supply structural calculations and Professional Engineer's stamp certifying the capacity of the structure and indicating the structures ability to resist all loads.

d. Submit information for reinforcing, joints, connection to structures, vault rungs (steps), vault frames, vault covers, vault coatings, and vault joint sealant systems.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Concrete: Reinforced, 4,000 psi.

B. Mortar:

1. Conform to ASTM C270 Type M.
2. Type I/II portland cement.
3. Proportion 1 part portland cement to 1/4 part lime to not less than 2-1/4 nor more than 3 times the sum of the cement and lime used of loose damp sand.

C. Castings:

1. Vault Steps:

a. Acceptable Manufacturer

(1) M.A. Industries, Inc. Model PS2-PF.

(2) American Step Company Model ML.

(3) Engineer approved equal.

b. Design:

(1) Conform to Contract Drawings.

(2) Steel reinforcing shall be 3/8-inch diameter, grade 60 conforming to ASTM A615 or approved wiremesh and shall be continuous throughout the step. The portion of the legs to be embedded in the precast section shall have fins and be tapered to insure a secure bond.

(3) Copolymer Polypropylene coating shall meet ASTM D-4101.

(4) Non-sparking, non-conducting, and non-abrasive.

c. Steps shall be installed per ASTM C478.

d. Steps shall not be less than 12-inches wide.

2. Vault Frames and Covers:

a. Conform to requirements in Contract Drawings.

b. Shall show the word "Water" or "Reuse", as applicable.

c. Vault frame shall conform to applicable standard detail.

d. Frames and covers shall be of good quality, strong, tough, even-grained cast iron smooth, free from scales, lumps, blisters, sand holes and defects of any kind which render them unfit for the service for which they are intended.
e. Covers and frame seats shall be machined to a true surface to provide even seating.
f. Castings shall be thoroughly cleaned and subject to hammer inspection.
g. Before shipment from the foundry, castings shall be given one coat of coal tar pitch varnish which shall present a casting that is smooth and tough, but not brittle.
h. Interchangeable within same pattern.
i. Conform to Drawings in all essentials of design. Weight shall be within 10% of that listed for pattern.
j. Machine-bearing surfaces to provide even seating.
k. Reuse vault and manhole covers shall have triangular-shaped lids.

D. Precast Concrete Sections:
1. Precast concrete vault sections and transition top sections.
a. Precast concrete sections and transition top sections shall conform to Specifications for Precast Reinforced Concrete Manhole Sections, ASTM C478 and meet the following requirements:
b. The wall thickness shall not be less than that shown on the drawings or 5 inches for 48-inch or 54-inch diameter reinforced barrel sections, 6-inch for 60-inch diameter reinforced barrel sections, and 7-inch for 72-inch diameter reinforced barrel sections, whichever is greatest.
c. Barrel sections shall have tongue and groove joints.
d. All sections shall be cured by an approved method and shall not be shipped nor subjected to loading until the concrete compressive strength has attained 3,000 psi and not before 5 days after fabrication and/or repair, whichever is longer.
e. Precast concrete sections with precast top slabs and precast concrete transition sections shall be designed for a minimum of H-20 loading plus the weight of the soil above.
f. The date of manufacture and the name and trademark of the manufacturer shall be clearly marked on the inside of each precast section.
g. Set to be vertical and with section in true alignment with ¼-inch maximum tolerance allowed.
h. All materials shall conform to Drawings.
2. Concrete Footings:
a. Precast concrete footings shall be constructed and installed as shown on the Drawings. The thickness of the footing shall not be less than the manhole barrel sections or that called for specifically on Drawings.
b. See project details sheets for specific design requirements including reinforcement requirements for each structure to be installed under this project.

E. Jointing Precast Manhole/Vault Sections:
1. All precast joints shall be tongue and groove and shall be sealed.
2. Inside of joint to be filled with non-shrink mortar and finished flush with the adjoining surface.
3. Install in a manner that will result in watertight joints.
4. Holes in the concrete barrel sections required for handling or other purposes shall be plugged with a non-shrink grout in combination with concrete plugs and finished flush on the inside.
5. Tongue and groove joint sealing:

a. Tongue and groove joints of precast vault shall be sealed with:
(1) round rubber "O"-ring gasket or
(2) two (2) rows of preformed flexible SS-S-00210 butyl rubber joint sealant (Ramnek® or similar) combined with an external 6-inch joint seam wrap.
(a) Preformed flexible butyl rubber joint sealant:
1) Acceptable manufacturers:
1. Conseal – CS-102.
2. Kent Seal No. 2, as manufactured by Hamilton-Kent.
3. Rubber-Nek, as manufactured by K. T. Snyder company.
4. Or equal, on approval of the Owner or Engineer.
(b) External joint seam wrap:
1) Acceptable manufacturers:
1. Conseal - CS-212.
2. Or equal, on approval of the Owner or Engineer.

F. External Waterproofing Coating:
1. Waterproofing shall be installed on all exterior buried concrete structure walls.
a. Exterior structure wall waterproofing acceptable manufacturers:
(1) Carboline – Bitumastic 300 M
(2) Internation – Interturf 100
(3) Tnemec – HB Tnemecol 45-464
(4) Or equal, on approval of the Owner or Engineer.
b. Apply coating in two coats to minimum 12-mil dry-film thickness per coat.

G. Pipe Connections to Manhole:
1. Manhole pipe connections may be accomplished in the following ways:
a. A tapered hole filled with non-shrink waterproof grout after the pipe inserted is acceptable, providing the grout is placed carefully to completely fill around the pipe. If this method is used, place concrete encasement to assure a total 12 inches of concrete including manhole thickness around the pipe stub. A rubber gasket will be put around the pipe prior to grouting.
b. The "Lock Joint Flexible Manhole Sleeve" shall be cast in the precast manhole base. The stainless steel strap shall be protected from corrosion with a bituminous coat.
c. "A-Lok" shall be a rubber-like gasket cast in the precast manhole base. The rubber gasket shall be cast into a formed opening in the manhole.
d. "KOR-N-SEAL" joint shall be installed as recommended by the manufacturer. The stainless steel clamp shall be protected from corrosion with a bituminous coat.
e. "Res-Seal" shall be a rubber-like O-ring set in a formed opening in the manhole. Once the pipe is in place, the "O"-ring and pipe shall be secured in place by means of a cast iron follower or compression flange. All exposed metal shall be protected from corrosion with a bituminous coat.

H. Pipe penetration thru vault wall:
1. Pipe penetrations shall be closed in the following ways:
a. Acceptable Manufacturers:
(1) Link-Seal Modular pipe penetration seal
(2) Or equal, on approval of the Engineer.
b. Provide seals on both the inside and outside wall penetration, as shown on the construction drawings
c. The "Link Seal" shall be installed between the pipe and precast manhole base, after the insertion is acceptable. The bolts should be tightened in proper sequence and to

the manufacturers torque requirements. The formed gasket shall be tight fitting and waterproof.

d. Grout around pipes (inside and outside) with nonmetallic, nonshrink grout.

I. Warning Signs:
   1. Warning signs shall be installed in every unventilated vault. A plastic warning sign shall be permanently affixed on the inside wall between the top two steps. The sign will be inscribed with the words: "CAUTION - VENTILATE BEFORE ENTERING" in clear, large lettering. Attach the sign to the concrete with four Type 316 stainless steel screws.

J. Valve operator access thru vault ceiling:
   1. All valve operators, whether indicated on the construction drawings or not, shall be accessible with a valve key.
      a. Provide core drills thru vault top as required in the field.
         (1) Do not provide precast or factory applied penetrations so that adjustment can be made to align directly over valve operators.

K. Vent Pipes:
   1. Conform to Contract Drawings.
   2. Above-ground vent pipe shall be 6-inch nominal outside diameter seamless painted aluminum. ASTM Standard Designation A-53.
      a. 20 gage vent body
   3. Below-ground vent piping shall be 6-inch diameter, Schedule 80 PVC with glued joints.
   4. Shall be field routed.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Conform to Drawings.

B. Caulk and repair any leaks or remove entire Work and rebuild to obtain watertight construction.

C. Protect against flooding or floatation.

D. Backfilling shall be done in a careful manner, bringing the fill up evenly on all sides. If any leaks appear in the manholes, the inside joints shall be sealed.

E. Manhole Frames and Cover:
   1. Set frame level to proper grade on full bed of mortar.

F. Cleaning of Structures:
   1. Prior to Construction Acceptance, remove all accumulated construction debris, rocks, gravel, sand, silt, and other foreign material from the vault.

END OF SECTION 33 05 61

SECTION 33 11 00 – PRESSURE PIPE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes all interior and buried pressure pipe, fittings, specials, and appurtenances.

B. Related Work Specified Elsewhere:

1. Section 09 90 00 - Protective Coatings.
2. Section 33 11 50 - Gravity Pipe
3. Section 33 12 16 - Valves and Accessories.
4. Section 33 31 50 - Pipe Installation.

1.02 REFERENCE STANDARDS:

A. Applicable Standards:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Water Works Association (AWWA):
   a. C104 - Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110 - Ductile-Iron and Gray-Iron Fittings.
   c. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115 - Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   e. C116 – Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings
   f. C150 - Thickness Design of Ductile-Iron Pipe.
   g. C151 - Ductile-Iron Pipe, Centrifugally Cast, for Water.
   h. C153 - Ductile-Iron Compact Fittings.
   i. C200 - Steel Water Pipe 6 Inches (150 mm) and Larger.
   j. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch and Larger - Shop Applied.
   k. C207 - Steel Pipe Flanges for Waterworks Service, Sizes 4 Inch Through 144 Inch (100 mm Through 3,600 mm).
   l. C208 - Dimensions for Fabricated Steel Water Pipe Fittings.
   m. C213 – Standard for Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings
   n. C219 – Bolted, Sleeve Type Couplings for Plan End Pipe
   o. C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In. (100 Mm Through 1,500 Mm)
   p. M11 - Steel Pipe - A Guide for Design and Installation.
3. American National Standards Institute (ANSI):
   a. 372 – Drinking Water System Components – Lead Content
   b. B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   c. B16.21 - Nonmetallic Flat Gaskets for Pipe Flanges.
4. American Society for Testing and Materials (ASTM):
   a. F477 – Standard Specification for Elastomeric Seals
5. American Society of Mechanical Engineers (ASME)
   a. ASME A13.1- Scheme for the Identification of Piping Systems
6. National Sanitation Foundation (NSF):
   a. 61 – Drinking Water System Components – Health Effects.
7. Steel Plate Fabricators Association (SPAA)

1.03 SUBMITTALS:

A. Submit as specified in Division 01.

B. Submit the following for acceptance prior to fabrication:
   1. Pipe and joint details.
   2. Special, fitting, and coupling details.
   3. Laying and installation schedule.
   4. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.
   5. Manufacturer's design calculations including, but not limited to, wall thickness and deflection under specified live and dead loads.
   6. Submit welding certifications prior to performing any work as specified.
   7. Pipe label drawings and data sheets.

C. Certificates and Affidavits: Furnish the Following Prior to Shipment:
   1. Affidavit of compliance with applicable standard.
   2. Positive material identification (PMI) testing must be conducted on all foreign flanges at both the factory and upon receipt in the USA. Certificates for the PMI testing shall be submitted to Engineer for review.
   3. Test certificates.

1.04 QUALITY ASSURANCE:

A. Manufacturers shall be experienced in the design and manufacture of pipe, fittings, specials, or appurtenances for a minimum period of 5 years.

B. All pipe manufactured to AWWA C200 series specifications shall be furnished by a manufacturer certified by the SPAA for steel pipe fabrication.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Ship all material to the Site and store in assigned laydown areas or as directed by Engineer.

B. Supplier shall provide adequate strutting to protect pipe and fittings during handling, storage, hauling, and installation. Pipe and fittings shall be shipped with capping or other means on each opening for protection of the pipe.

C. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe and fittings. Pipe and fittings shall not be dropped. Pipe and fittings shall be examined prior to delivery.

D. In handling the pipe, wide cushioned slings shall be used or other devices and methods acceptable to the Contractor. No uncushioned ropes, chairs, wedges or levers shall be used in handling the pipe, fittings, and couplings.

E. Materials shall be stored using appropriate means to isolate from ferritic materials and to prevent damage and contamination from ground.

F. Ship spare material separately packaged and tagged as spare parts. Spare part tags shall identify type, size, material, and other related information.

PART 2 - PRODUCTS

2.01 PIPE REQUIREMENTS:

A. Furnish pipe of materials, joint types, and sizes as indicated or specified.

B. Pipe Marking: All pipe and fittings shall be marked conforming to the applicable standard specification under which the pipe is manufactured and as otherwise specified.

C. Pipe shall be designed to withstand all stresses resulting from external loads and internal pressures plus applicable allowance for surge unless otherwise specified:

Table 1. Pipe Summary Table

Pipe System	Nominal Pipe Size (in)	Interior Material (Including Vaults)	Buried Material	Lining (Metal Pipe Only)	Working Pressure (psi)	Test Pressure (psi)
Potable Tank Fill	20”, 30”	Steel or DIP	PVC	Cement Mortar	100	150
Potable Tank Discharge/Pump Suction	18”, 30”	Steel or DIP	PVC	Cement Mortar	15	150
Potable Pump Discharge	16”, 30”	Steel or DIP	PVC	Cement Mortar	100	150
Potable Tank Drain	18”	Steel or DIP	PVC	Cement Mortar	15	150
Potable Tank Overflow	24”, 30”	Steel or DIP	PVC	Cement Mortar	15	150
Reuse Tank Fill	18”	Steel or DIP	PVC	Cement Mortar	45	150
Reuse Tank Discharge/Pump Suction	14”, 18”	Steel or DIP	PVC	Cement Mortar	15	150
Reuse Pump Discharge	12”, 18”	Steel or DIP	PVC	Cement Mortar	60	150
Reuse Tank Drain	18”	Steel or DIP	PVC	Cement Mortar	15	150
Reuse Tank Overflow	18”	Steel or DIP	PVC	Cement Mortar	15	150
Combined Reuse/Potable Drain/Overflow	30”	N/A	PVC	N/A	15	150

2.02 DUCTILE-IRON PIPE:

A. Design and Manufacture of Pipe:

1. Ductile-iron pipe shall conform to AWWA C115, C150 and C151 except as otherwise specified.
2. Dimensions: The minimum thickness shall be:

Pipe Size	Minimum Pressure Class
All Non-Potable Lines	350
4”-12”	350
>12”	200

for non-potable water lines shall be Pressure Class 350.

3. With laying condition Type 4 for ductile iron for load requirements tabulated herein.
   a. Use E' of 700 and bedding angle of 90º.
   b. 3% deflection limit.
   c. Add service allowance and standard casting tolerances of AWWA C150 and AWWA C151.
   d. Select standard pressure class thickness next above total calculated thickness.
4. Minimum thickness for ductile-iron pipe threaded for screw-on flanges shall be in accordance with AWWA C115.

B. Joints:

1. Mechanical and Push-On Type:
   a. Provide mechanical or push-on-type joints for all buried pipe less than 30 inches in diameter unless otherwise specified or indicated. Provide push-on-type joints for sizes 30 inches in diameter and greater.
   b. Joints shall conform to AWWA C111.
2. Flanged:
   a. Provide flanged joints for all interior pipe except where otherwise specified or indicated.
   b. Flanges for pipe shall be ductile iron and conform to the applicable provisions of AWWA C110 and C115 and shall be drilled ANSI B16.1 Class 125.
3. Sleeved or Coupled:
   a. Provide for sleeves or couplings where indicated.
   b. Furnish pipe ends suitable for receiving style of sleeve or coupling indicated or specified.
   c. Provide anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated.
4. Restrained:
   a. Furnish for all fittings and where joint restraint is required to offset internal pipeline forces.
   b. Provide restrained joints of following approved types:
      (1) Restrained mechanical joint.
      (2) Restrained push-on joint.
         (a) Flex-Ring by American,
         (b) TR Flex by US Pipe,
         (c) Approved equal.
   c. Mechanical joint retainer glands shall not be used where joint restraint is required unless indicated. When indicated, retainer glands shall be Megalug manufactured by EBAA Iron, Inc. or approved equal.

C. Fittings:
   1. Fittings shall conform to AWWA C110 or C153 and City and County of Broomfield Specifications and shall have a pressure rating of not less than that specified for pipe.
   2. Fittings shall be flanged ductile iron, unless otherwise required or indicated.
   3. Fittings for pipe with mechanical joint shall have mechanical joints.
   4. Fittings shall be lined with fusion-bonded epoxy in accordance with AWWA C116.
   5. Include all specials, taps, plugs, flanges, and wall fittings as required.
   6. Provide openings for air valve, drain, sampling, sensing, testing, and other connections with threaded bosses or flange outlets sized and located where indicated.

D. Lining:
   1. All pipe shall be cement-mortar lined in accordance with AWWA C104.

E. Coating:
   1. All buried ductile iron fittings shall be fusion bonded epoxy coated per AWWA C115.
   2. All interior piping shall be coated according to SECTION 09 90 00.
   3. Flange faces shall be coated in accordance with AWWA C115.

2.03 STEEL PIPE:

A. Materials: Steel grade may be optional with the fabricator or producer.

B. Design of Pipe: Design shall conform to AWWA C200, AWWA M11, and as specified except that hydrostatic test of fittings after fabrication will not be required. Fittings shall be tested by dye penetrant method.
   1. Size indicated or specified shall mean the nominal pipe size.
   2. The minimum thickness as defined by pressure class shall be as indicated in 2.01.C.
   3. External Loading:
      a. Earth dead load cover at 120 pcf plus AASHTO H-20 live loads.
      b. Use 100% of earth prism above the pipe.
      c. 2% initial deflection limit and 1.5 time lag factor.
      d. Bedding condition as indicated.
   4. Use E' of 700 and bedding angle of 90^{o}.
   5. Allowable design stresses for steel shall be as follows:
      a. 50% of minimum yield stress when subjected to working pressure.
      b. 70% of minimum yield stress when subjected to working pressure plus surge.
   6. Allowable design deflection shall be 2% of mean diameter.
   7. Deflection lag factor shall be 1.25.

C. Joints:
   1. Flanged:
      a. Provide flanged joints for all interior pipe except where otherwise specified or indicated.
      b. Joints shall conform to AWWA C200 and AWWA C207.
      c. Flanges shall have a pressure rating not less than that required for pipe. Flanges shall be Class D and be drilled ANSI B16.1 Class 125.
   2. Restrained: Furnish for all joints.
   3. Welded:
      a. Provide pipe prepared for lap joints for field welding, beveled ends for field-butt welding, or butt strap joint field welding.
      b. Lap welded joints to be prepared for fillet welding on outside of the pipe.

D. Fittings and Specials:
   1. Fabricate from tested pipe to conform to AWWA C208 except where otherwise indicated or specified.

2. Provide flanged fittings where indicated.
3. Design to withstand internal and external loading specified for pipeline in which located.
4. Reinforce tees, laterals, and outlets conforming to applicable provisions of AWWA M11.
5. Include all adapters, outlets, taps, plugs, and other specials as required to complete installation as specified or indicated.
6. Provide openings for air valve, drain, sampling, sensing, testing, instrumentation, and other connections with threaded bosses or flanged outlets sized and located where indicated.

E. Test Plugs:
1. Provide pressure test plugs where required to test the installation.
2. Design test plugs to withstand the internal and external loading.
3. Join test plug to pipe and tie as required to sustain internal and external loading.

F. Lining:
1. All pipe and fittings shall be lined with cement mortar to conform to AWWA C205. Thickness of lining shall conform to AWWA C205.
2. Termination of lining at ends shall be as follows:
a. End of steel on spigot, flanged, or plain end.
b. Anticipated termination of mating spigot on bell end of push-on type joints.

G. Coating:
1. All pipe and fittings for exposed interior installation shall be shop prime coated and field finished coated as specified in Section 09 90 00.
2. All pipe and fittings for buried service shall be coated in accordance with Section 09 90 00.
3. Flange faces shall be coated with one of the following rust preventive compounds:
a. Houghton "Rust Veto 344."
b. Rust-Oleum "R-9."
c. Engineer-approved equal.

2.04 PVC PIPE:

A. Materials:
1. Materials shall conform to AWWA C900.
2. Gaskets shall conform to ASTM F477 and be synthetic rubber.

B. Design of Pipe: Design shall conform to AWWA C900 and as specified. Pipe sizes 12-inches and smaller shall be pressure class 200 psi, DR 21 minimum. Pipe sizes 14-inches and greater shall be pressure class 165 psi, DR 25 minimum or 235 psi, DR 18, as determined by the design conditions. DR 25 pipe shall be embedded in CLSM 20-feet below grade or deeper. DR 18 pipe shall be embedded in CLSM 30-feet below grade or deeper.
1. External Loading:
a. Earth dead load cover at 120 pcf plus AASHTO H-20 live loads.
b. 5% deflection limit.
c. Bedding condition as indicated.
2. Use E' of 700 and bedding angle of 90°.

C. Dimensions: As specified in section 2.01C.

D. Diameters: PVC pressure pipe shall have Cast-Iron-Pipe-Equivalent (CI) outside diameters.

E. Joints: Pipe shall be furnished with integral bell-type pipe ends designed for joint assembly using elastomeric gaskets.

F. Fittings:
1. Fittings shall conform to AWWA C110 or C153 and be ductile iron. Fittings shall be mechanical joint or push-on-type joint.

2. Provide openings for air valve, drain, sampling, sensing, testing, and other connections via saddle connection or tee located where indicated.
3. All buried ductile iron fittings shall be fusion bonded epoxy coated per AWWA C116.

G. Marking: Identification markings on pipe shall conform to AWWA C900.

2.05 PIPE LABELS:

1. Provide preprinted, color-coded labels with lettering indicating service and arrows showing flow direction.
2. Label colors shall conform to ASME A13.1.
3. Labels shall be one of the following types:
   a. Printed plastic with contact-type, permanent-adhesive backing.
   b. Pretensioned labels with precoiled, semirigid plastic formed to cover full circumference of pipe and to attached to piping without fasteners or adhesive.

2.06 SLEEVES AND COUPLINGS:

A. Sleeves:
   1. AWWA C110 mechanical joint ductile-iron solid-sleeve type:
      a. Pipe end space shall not exceed one-third of the sleeve laying length.
      b. Interior, exposed, exterior, or buried service as indicated.

B. Couplings:
   1. Center sleeve and compression gland-type end ring conforming to AWWA C219.
   2. Center sleeve shall be without pipe stop.
   3. Couplings for joining steel pipe shall be steel.
   4. Couplings for exposed interior iron pipe may be steel or iron.
   5. Center sleeve and end rings shall be:
      a. Ductile or malleable iron for iron couplings.
      b. Steel for steel couplings.
   6. Lining and Exterior Coating:
      a. Use for all steel couplings intended for direct bury, exposed exterior, vault or pit installations.
      b. Completely coat center sleeve and end rings.
      c. Two-part epoxy or nylon fuse-coated to a minimum 0.25 mm (10 mils) thickness.
      d. Line interior of all steel couplings intended for exposed-interior installations. Coat exterior with normal shop coating.

C. Expansion Joints:
   1. Single-sphere EPDM nonmetallic molded expansion joints with control unit assembly and compression sleeve.
   2. Gaskets shall meet the requirements of NSF/ANSI 372.
   3. Proco Style 240 with limiting rods or approved equal.

D. Insulated Couplings:
   1. Couplings shall be insulated to prevent electrical conductivity where indicated.
   2. Insulated coupling design shall be otherwise conforming to the standard types and styles specified.

E. Dismantling Couplings: (Dismantling Joint):
   1. Design
      a. Dismantling Joint shall have a pressure rating not less than that of the connecting pipe.

b. Consists of a mechanical joint fitting located between two pipe flanges with restraining rods across the mechanical joint section, providing a restrained system with integral space for removal of adjacent equipment.
c. Shall conform to AWWA C-219.
d. Install insulating flange kit when required to prevent corrosion due to dissimilar metals.
e. Flanges shall be Class D and be drilled ANSI B16.1 Class 125.

2.07 GASKETS AND BOLTING MATERIALS:

A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings, and specials complete and ready for service.
B. Gaskets for flanged joints shall conform to ANSI B16.21, 1/8-inch thick Garlock Blue Gylon Style 3505 gasket, or engineer approved equal. Provide full-face gaskets for all pump and equipment connections.
C. Gaskets for ductile iron flanged pipe and fittings 12 inch and smaller shall have "nominal" inside diameters, not the larger inside diameters per ANSI B16.21.
D. All nuts and bolts shall be 304 Stainless Steel. Nut and bolt heads shall be hexagonal.
E. Gaskets for other than flanged joints shall be as otherwise specified for pipe and pipe joints.
F. Provide flange isolation kits for all flanges connecting piping, equipment, and valves with dissimilar materials.
    1. The retainer shall consist of G-10 material, seal shall be nitrile, sleeve shall be mylar, and washer shall be G-10 material

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Specified in Section 33 31 50.

3.02 FIELD TESTING:

A. Specified in Section 33 31 50.

3.03 PROTECTIVE COATINGS:

A. Specified in Section 09 90 00.

END OF SECTION 33 11 00.

SECTION 33 11 50 - GRAVITY PIPE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes all gravity pipe, fittings and specials.

B. Related Work Specified Elsewhere:

1. Concrete Manholes and Vaults: SECTION 33 05 61.
2. Pipe Installation: SECTION 33 31 50.

1.02 REFERENCES:

A. Applicable Standards:

1. American Society for Testing and Materials (ASTM):
   a. D3034 – Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
   b. D3212 - Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
   c. F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
   d. F679 - Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
   e. F794 - Poly(Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter.
   f. F949 Poly(Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings.
2. American Water Works Association (AWWA):
   a. C900 – Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 12 In. (100 Mm Through 300 Mm), For Water Transmission and Distribution

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Submit the following for acceptance prior to fabrication:

1. Pipe and joint details.
2. Special, fitting and coupling details.
3. Laying and installation schedule.
4. Specifications, data sheets, and affidavits of compliance for protective shop coatings and linings.
5. Manufacturer's design calculations including, but not limited to, wall thickness and deflection under specified live and dead loads.

C. Certificates and Affidavits:

1. Submit as specified in DIVISION 1.
2. Furnish the following prior to shipment:
   a. Affidavit of compliance with applicable standard.
   b. Test certificates.

1.04 QUALITY ASSURANCE:

A. Manufacturer:

1. Experienced in the design, manufacture and commercial supplying of the specific material for a minimum period of five years.
2. Experienced in the design, manufacture, and commercial supplying of the specific size of pipe for a minimum period of three years.

3. Certify to above minimum experience requirements.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Ship all material to the Site and store in assigned laydown areas or as directed by Engineer.
B. Ship spare material separately packaged and tagged as spare parts. Spare part tags shall identify type, size, material, and other related information.
C. Handling and storage shall be in accordance specification requirements.
D. Supplier shall provide adequate strutting to protect pipe and fittings during handling, storage, hauling, and installation. Pipe and fittings shall be shipped with capping or other means on each opening for protection of the pipe.
E. Care shall be taken in loading, transporting, and unloading to prevent injury to the pipe and fittings. Pipe and fittings shall not be dropped. Pipe and fittings shall be examined prior to delivery.
F. In handling the pipe, wide cushioned slings shall be used or other devices and methods acceptable to the Engineer. No uncushioned ropes, chairs, wedges or levers shall be used in handling the pipe, fittings, and couplings.
G. Materials shall be stored using appropriate means to isolate from ferritic materials and to prevent damage and contamination from ground.

PART 2 - PRODUCTS

2.01 PIPE REQUIREMENTS:

A. Furnish pipe of materials, joint types, sizes, and strength classes indicated or specified. Higher strengths may be furnished at Contractor's option. Furnish maximum pipe lengths of 14.5 feet, except service tees and closure pieces.
B. Pipe shall be designed to withstand all stresses resulting from external loads as listed in the following table:

Table 1. Pipe Summary Table

Description	Nominal Pipe Size (inches)	Material	Live Load	Design Internal Working Pressure (psi)	Design Maximum Test Pressure (psi)
Sanitary Sewer	4	PVC	H-20	10	20

C. Pipe Bedding: As specified and as indicated.
D. Pipe Marking:
   1. All pipe, fittings and specials shall be marked conforming to the applicable standard specification under which the pipe is manufactured and as otherwise specified.
   2. Mark field location of fittings and specials by station.
E. Pipe Gaskets: All elastomeric gaskets and seals shall be synthetic rubber.

2.02 PVC SEWER PIPE:

A. Dimensions: The pressure class for all PVC pipe shall be SDR-35, unless otherwise approved by the Owner.

B. Materials and Manufacture: All PVC pipe sizes shall conform to ASTM D3034 and ASTM F679 for pipes with smooth interior and exterior. All PVC piping shall be as specified and modified herein.
   1. Minimum pipe stiffness, when measured at 5% deflection, shall be as follows:
      a. 45 psi for ASTM D3034 pipes.
   2. Joints:
      a. Compression-type with the elastomeric ring gasket confined in the annular space between the bell end or socket and the spigot end of pipe.
      b. Elastomeric gasket ring joints shall conform to the requirements of ASTM D3212 or ASTM F477. Gaskets shall be neoprene or other synthetic rubber material.
      c. Plain end of pipe shall be marked with a reference line to facilitate assembly inspection.
   3. Fittings: Tee or wye connections suitable for assembly to 4-inch or 6-inch house or building sewers shall be one of the following types.
      a. Reducing-branch tee or wye fittings with elastomeric-gasket joints same as pipe. Service line connection shall be bell-end with an elastomeric ring-gasket and a minimum wall thickness of SDR35.
      b. Saddle-type fittings with an elastomeric ring-gasketed bell-end service connection and minimum wall thickness of SDR35. Saddle-type fitting to be supplied with a rubber sealing gasket and stainless steel straps for connection to pipe.
      c. Furnish permanent plugs for future service line connections and testing.
   4. Connections: Furnish any special flexible couplings required for manhole tie-ins or connections to other rigid structures.

C. Inspection and Testing:
   1. Primarily by manufacturer's testing laboratory and quality control personnel.
   2. Perform to avoid, insofar as possible, delivery of defective pipe.
   3. May be witnessed by Owner, Engineer, or approved independent testing laboratory.
      a. Independent testing laboratory, when used, shall be retained by Owner at no expense to Contractor.
      b. Contractor and manufacturer shall cooperate with Owner's inspection and test personnel. Permit unrestricted access, furnish reasonable space and facilities, and provide 5 working days advance notice of test schedule.
   4. Contractor shall provide 3 copies each of certified test reports to Engineer.
      a. Include stiffness and deflection, dimension, and hydrostatic joint tests per ASTM D3034, D3212, F679, F794, and F949.
      b. Furnish prior to delivery.

D. Handling and Delivery:
   1. Do not deliver until tests on representative specimens have been performed.
   2. Use equipment and methods adequate to preserve quality of pipe and to protect joint elements.

2.03 GASKETS AND BOLTING MATERIALS:

A. Provide all gaskets, bolts, lubricant, and other accessories required to install pipe, fittings and specials complete and ready for service.

B. Gaskets and bolts for other than flanged joints shall be as otherwise specified for pipe and pipe joints.

PART 3 - EXECUTION

SECTION 33 11 50 – GRAVITY PIPE: continued

3.01 INSTALLATION: Specified in SECTION 33 31 50.

3.02 FIELD TESTING: Specified in SECTION 33 31 50.

END OF SECTION 33 11 50

SECTION 33 12 16 - UTILITY VALVES AND ACCESSORIES

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes all valves and accessories.

B. Related Work Specified Elsewhere:

1. Pipe Installation: SECTION 33 31 50.
2. Protective Coatings: SECTION 09 90 00.

C. Provide all valves required to complete the piping systems as indicated. All valves of a particular type shall be furnished by the same manufacturer.

D. The valves required include the following:

1. Generally, valves 2-1/2 inches and larger indicated on the Drawings and the Valve List.
2. Generally, valves 2 inches and smaller indicated on the Drawings and are not included in the Valve List.

E. The Valve List is included in the Drawings. This list identifies the numerical designation, size, and type.

1.02 REFERENCES:

A. Applicable Standards:

1. American National Standards Institute (ANSI):
   a. B16.1 - Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
   b. B16.42 – Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
2. American Society for Testing and Materials (ASTM):
   a. A276 - Stainless and Heat Resisting Steel Bars and Shapes.
   b. A536 - Ductile Iron Castings.
   c. B62 – Standard Specification for Composition Bronze or Ounce Metal Castings.
   d. D2000-BG – Standard Classification System for Rubber Products in Automotive Applications.
3. American Water Works Association (AWWA):
   a. C111 - Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C207 - Steel Pipe Flanges for Waterworks Service - Sizes 4 Inch Through 144 Inch.
   c. C504 - Rubber-Seated Butterfly Valves.
   d. C508 - Swing-Check Valves for Waterworks Service, 2 Inch through 24 Inch NPS.
   e. C509 – Resilient-Seated Gate Valves for Water Supply Service
   f. C512 - Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   g. C540 - Power-Actuating Devices for Valves and Sluice Gates.
   h. C550 - Protective Epoxy Interior Coatings for Valves and Hydrants.
   i. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   j. C606 - Grooved and Shouldered Joints.
4. National Sanitation Foundation (NSF):
   a. 61 – Drinking Water System Components – Health Effects.

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Included, but not limited to, the following:

1. Catalog data or illustrations showing principal dimensions, parts, and materials.
2. Spare parts list referenced to illustration of parts.
3. Assembly and disassembly or repair instructions.

4. Dimensions of the clearance required for butterfly valve discs.

C. Certificates and Affidavits: Furnish prior to shipment. Include the following:
   1. Test certificates.
   2. Affidavit of compliance with applicable AWWA Standard.
   3. Operation and Maintenance Manuals in accordance with SECTION 01 33 00.

1.04 QUALITY ASSURANCE:

A. Manufacturers shall be experienced in the design and manufacture of specific valves and accessories for a minimum period of 5 years.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Ship all valves with suitable end covers to prevent entrance of foreign material into valve body.
B. Protect valve threads, flanges, stems, and operators from damage.
C. Ship valves 2-1/2-inch and larger to the Project Site tagged with the valve number shown on the Drawings. Tag smaller valves to show the piping system in which it is to be used.

1.06 RESPONSIBILITY:

A. Actuators, their controls, and accessories shall be the responsibility of the valve manufacturer for sizing, assembly, certification, field testing, and any adjustments necessary to operate the valve as specified.

PART 2 - PRODUCTS

2.01 BUTTERFLY VALVES:

A. Acceptable Manufacturers:
   1. DeZurik, a unit of General Signal Corporation.
   2. Henry Pratt Company.
   3. Val-Matic Valve & Manufacturing Company
   4. Engineer Approved Equal.

B. Design:
   1. Conform to AWWA C504, AWWA C540, and as specified.
   2. Suitable for type of installation specified.
   3. Conform to criteria indicated in Design Data and Valve Schedule Tables.
   4. All valve end flanges shall conform to the following:
      a. ANSI B16.1, Class 125 for cast-iron body, Class 25A through Class 150B valves.
   5. Valves with a stop or lug cast integrally or mechanically secured to the body for the purpose of limiting disc travel will not be acceptable.

C. Materials and Construction:
   1. Body shall be of cast iron for Class 25A through Class 150B valves.
   2. Shafts shall be ASTM A276 Type 304 or 316 stainless steel for Class 25A through Class 150B valves.
   3. Disc shall be cast or ductile iron for Class 25A through Class 150B valves.
   4. Seats shall be EPDM and be disc or body mounted. Provide field replaceable and adjustable seat accessible from down pressure side of valve for sizes 30-inch and larger. Mating seat surface shall be stainless steel or Monel. Sprayed or plated mating surfaces are not acceptable. Metal to metal surfaces are not acceptable.
   5. Shaft seals shall be designed for use of standard self-adjusting split-V-type packing or standard O-ring seals. Pull-down packing is not acceptable.

D. Actuators:
   1. Manual Actuators:
      a. All potable valves shall open counterclockwise (left) with a handwheel or two (2) inch square nut conforming to AWWA C509, as indicated on the Drawings. All reuse valves shall be purple in color and open clockwise (right) with a handwheel or two (2) inch square nut conforming to AWWA C509, as indicated on the Drawings.
      b. All actuators for valves in vaults shall include a two (2) inch square nut conforming to AWWA C509.
      c. All actuators for direct bury valves shall be provided with a bevel gearbox installed and tested by the manufacturer prior to shipment to orient square nut into the vertical position centered over the pipe. Valve shafts shall be oriented vertically.
         (1) Bevel Gearbox Acceptable Manufacturers
            (a) Auma GmbH & Co.
            (b) Engineer Approved Equal
      d. Provide indicators to show position of disc. Provide handwheels with raised cast arrow and word OPEN on rim oriented to specified opening direction.
      e. Actuators shall be oil or grease-lubricated, totally-enclosed compound lever, traveling nut type to provide characterized closure. Actuator shall be self-locking at all variable opening positions.
      f. Travel limiting stop nuts or collars installed in the actuating mechanisms shall be field adjustable and shall be locked in position by means of a removable roll pin, cotter pin, or other positive locking device. Clamps or setscrews are not acceptable.
      g. Actuators and handwheels shall be located in positions indicated or as otherwise determined when manufacturer's drawings are submitted.
   2. Electric Motor Actuators:
      a. Provide factory-mounted electric motor actuators conforming to AWWA C542 for open-close or modulating service to operate on 480VAC, 60-hertz, ac supply.
      b. Motor shall be as specified in DIVISION 46.
      c. Actuator shall move disc from fully-open to fully-closed position, or reverse, in approximately the following:
         (1) 12” or smaller – 25-30 seconds
         (2) 12-24” – 60 seconds
         (3) 24-28” – 120 seconds
      d. Provide indicator to show position of disc.
      e. Furnish complete with integral motor starter (push button station and L/R selector switch). Motor, starter, and accessories shall conform to DIVISION 26.
      f. Products of the following manufacturers shall be acceptable for open/close service:
         (1) Auma Actuators, Inc.
         (2) Beck Actuators, Inc.
         (3) Rotork Controls, Incorporated
         (4) Engineer Approved Equal.
E. Valve Controls:
   1. Operate valve actuator to perform control function required.
      a. Open or close valve.
F. Testing: Furnish certified copies of results of performance, leakage, and hydrostatic tests performed in compliance with Section 5, AWWA C504.

G. Valve Schedule: See Drawings.
H. Shop Painting: Paint exterior surface of valves in compliance with AWWA C504 for installation as noted. Apply interior coating conforming to AWWA C550 to exposed ferrous metal surfaces. Provide affidavit or certificate of compliance per AWWA C550.

2.02 CHECK VALVES:

A. Acceptable Manufacturers:
   1. Picardie Valves Industries.
   2. Val-Matic Valve & Manufacturing Corporation
   3. Engineer Approved Equal.
B. Acceptable Models:
   1. CLASAR High Dynamic Response Check Valve.
   2. Surgebuster Check Valve.
   3. Engineer Approved Equal.
C. Design:
   1. Conform to AWWA C508 and as specified.
   2. Rated working pressure:
      a. 2" to 24" 250 psi at 150 degrees F.
   3. Full port flow area with seating surface on 45 degree angle and 35 degree disc stroke.
   4. Check mechanism one-piece precision molded flexible elastomeric disc with alloy steel and nylon reinforcement, integral O-ring sealing surface.
   5. Certification:
      a. Operation: Tested by an independent laboratory for 1,000,000 cycles in accordance with AWWA C508 without leakage, wear, cracking, or distortion.
      b. Headloss: Tested by an independent laboratory.
   6. Factory testing: All valves hydrostatically tested in accordance with AWWA C508.
D. Materials and Construction:
   1. Body and cover shall be ductile iron ASTM A536 grade 65-45-12.
   2. Flanges shall be drilled in accordance with ANSI B16.1, Class 125 bolt pattern.
   3. Flexible valve disc shall be Buna N, ASTM D2000-BG with steel and nylon reinforcement and warranted for 25 years.
E. Shop Coating:
   1. Apply interior and exterior fusion bonded epoxy coating conforming to AWWA C550. Provide affidavit of certificate of compliance per AWWA C550.

2.03 ALTITUDE VALVES:

A. Summary: Valve is located on the tank fill piping inside the pump station. This valve needs to be able to control the amount of water that is provided to the water storage tanks.
B. Acceptable Manufacturers:
   1. Cla-Val Company.
   2. GA Industries, Inc.
   3. Ross Valve Manufacturing Company.
   4. Singer Valve.
   5. Watts Automatic Control Valve Company.
   6. Engineer-approved equal.
C. Operational Requirements – Potable Storage Tanks (Valve Tag FCV-100):
   1. Operational Requirements are to be confirmed in the field, in the presence of Owner staff and valve supplier, prior to filling the tank with the new valve.
   2. Maximum controlled water level - El. 5468 ft.

3. Minimum controlled water level - El. 5444.2 ft.
4. Centerline of altitude valve - El. 5420.98 ft.
5. Flow Rate:
    a. Minimum: 1.2 MGD
    b. Maximum: 17 MGD
6. Valve shall not be fully open during filling, as the valve shall sustain upstream pressure to the following setpoint:
    a. Upstream Pressure: 40 psi
7. Valve shall close at a water level 6 inches below maximum controlled water level and open when inlet pressure drops below static head.

D. Operational Requirements – Reuse Storage Tank (Valve Tag FCV-200):
1. Operational Requirements are to be confirmed in the field, in the presence of Owner staff and valve supplier, prior to filling the tank with the new valve.
2. Maximum controlled water level - El. 5466 ft.
3. Minimum controlled water level - El. 5436 ft.
4. Centerline of altitude valve - El. 5420.89 ft.
5. Flow Rate:
    a. Minimum: 0.6 MGD
    b. Maximum: 6.63 MGD
6. Valve shall close at a water level 6 inches below maximum controlled water level and open when inlet pressure drops below static head.

E. Design:
1. Provide single seated, diaphragm actuated, pilot-controlled globe valve(s).
2. Valve shall seal by means of a corrosion-resistant seat and resilient, rectangular seat disc.
3. Alignment of the body, bonnet, and diaphragm assembly shall be by precision dowel pins.
4. Submit calculations for cavitation and provide means for reducing cavitation if calculations show they are necessary, via anti-cavitation trim or downstream orifice plate.
5. Parts shall be replaceable in the field without removing valve from the line.
6. The main valve and its control system shall contain no packing glands or stuffing boxes.
7. Valve stem shall be guided top and bottom by integral bushings.
8. Diaphragm shall not be used as a seating surface nor shall pistons be used as an operating means.
9. Pilot system shall be furnished complete and installed on the main valve and shall include Y-strainer, opening speed controls, solenoid valve, and ball valves for isolating the control system from the main valve.
10. Provide valve manufacturer’s standard pressure gauges, furnished with isolation and bleed valve integral to the pilot for gauge testing.
11. Provide valve integral strainer blow down valve for strainer flushing.
12. Valve shall provide indicator to show degree of opening at all times.

F. Valve Controls:
1. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, cylinders, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory assembled on valve body.
    a. Small control valves shall be bronze or brass; piping shall be copper.

G. Testing:

1. Factory test valves at a hydrostatic pressure of not less then 150 psi and check leakage across the valves at a pressure of not less than 150 psi. Set valves to operate at the pressures specified previously.
2. Submit copies of all test results.

2.04 PRESSURE REDUCING VALVES:

A. Summary: Valve is located on a recirculation line inside the pump station. The valve shall have the capability to recirculate flow from the pump discharge to the suction header to provide pressure relief.

B. Acceptable Manufacturers:
1. Cla-Val Company.
2. GA Industries, Inc.
3. Ross Valve Manufacturing Company.
4. Singer Valve.
5. Watts Automatic Control Valve Company.
6. Engineer-approved equal.

C. Operational Requirements – Potable System (Valve Tag: FCV-134):
1. Max Flow: 17 MGD
2. Pressure Set Point: 100 psi
3. Outlet Pressure: 33 psi

D. Operational Requirements – Reuse System (Valve Tag: FCV-234):
1. Max Flow: 6.63 MGD
2. Pressure Set Point: 85 psi
3. Outlet Pressure: 31 psi

E. Design:
1. Valve shall be single-acting nonthrottling type.
2. Internal components shall be designed such that there are no metal- to-metal contacts.
3. Valve shall be suitable for a normal operating pressure of 70 psi.
4. Valve shall be designed to prevent water hammer and include needle valve for adjusting closing speed, with a quick opening and 120-second or longer closing speed.
5. Closure shall be regulated by a 3-way pilot valve.
6. Valve shall provide indicator to show degree of opening at all times.

F. Valve Controls:
1. Include all pilot valves, needle valves, strainers, interconnecting piping, fittings, cylinders, positioners, solenoid valves, limit switches, and other accessories essential to valve function factory assembled on valve body.
    a. Small control valves shall be bronze or brass; piping shall be copper.

G. Testing:
1. Factory test valves at a hydrostatic pressure of not less then 150 psi and check leakage across the valves at a pressure of not less than 150 psi. Set valves to operate at the pressures specified previously.
2. Submit copies of all test results.

2.05 AIR RELEASE VALVES

A. Acceptable manufacturers:
1. Apco Williamette Valve and Primer Corporation.
2. Crispin Valves, Multiplex Manufacturing Company.
3. Val-Matic Valve and Manufacturing Corporation.

4. Engineer Approved Equal.

B. Design: Conform to AWWA C512 and as specified.
   1. Valve shall be single body air relief valve, water style.
   2. Body and cover shall be cast or ductile iron.
   3. Float shall be stainless steel.
   4. All internal parts shall be stainless steel.
   5. Seal shall be 316 SST with Buna-N seal.
   6. External fasteners shall be stainless steel.
   7. Valve interiors and exteriors shall be coated with an epoxy coating in accordance with AWWA C550.

C. Operation:
   1. Release air when filling line.
   2. Release accumulated air while pipeline is full and operating under pressure.
   3. Valve shall close upon liquid entry.

D. Connection:
   1. Connect air valves 2 inches and smaller to pipeline through corporation stops.
   2. Connecting fittings and pipe shall be bronze, brass, or copper rated for 150 psi service.
   3. Isolation valves shall be provided for all air valves and shall be bronze gate valves, Crane No. 424 or Engineer approved equal for sizes 3-inches and smaller unless otherwise noted.
   4. Couplings or unions indicated between pipeline and air valve piping shall be of the same pipe material. The outlet pipe shall be PVC.

E. Valve Schedule: See Drawings.

2.06 CONTROLLED-VENTING VACUUM RELIEF VALVES

A. Acceptable Manufacturers:
   1. Apco Williamette Valve and Primer Corporation.
   2. Val-Matic Valve and Manufacturing Corporation.
   3. Cla-Val Company.
   4. Engineer Approved Equal.

B. Acceptable Models:
   1. Val-Matic 201C
   2. Val-Matic 100ST
   3. APCO S-1500TC
   4. Cla-Val Series 37-WS

C. Design: Conform to AWWA C512 and as specified.
   1. Valve shall be single body controlled-venting vacuum relief valve, water style.
   2. Body and cover shall be cast or ductile iron.
   3. Float shall be stainless steel.
   4. All internal parts shall be stainless steel.
   5. Seal shall be 316 SST with Buna-N seal.
   6. External fasteners shall be stainless steel.
   7. Valve interiors and exteriors shall be coated with an epoxy coating in accordance with AWWA C550.

D. Operation:
   1. Provide full airflow into the pipeline during vacuum conditions to prevent vapor pockets from forming.
   2. Release air when filling line.
   3. Release accumulated air while pipeline is full and operating under pressure.

4. Valve shall close upon liquid entry.

E. Connection:
1. Connect air valves 2 inches and smaller to pipeline through corporation stops.
2. Connecting fittings and pipe shall be bronze, brass, or copper rated for 150 psi service.
3. Isolation valves shall be provided for all air valves and shall be bronze gate valves, Crane No. 424 or Engineer approved equal for sizes 3-inches and smaller unless otherwise noted.
4. Couplings or unions indicated between pipeline and air valve piping shall be of the same pipe material. The outlet pipe shall be PVC.

F. Valve Schedule: See Drawings.

2.07 RESTRAINED FLANGED COUPLING ADAPTER:

A. Acceptable Manufacturers
1. Romac Model RFCA-PVC
2. Smith Blair Model 911 with Cam-Loc joint restraint
3. Engineer Approved Equal
a. All flanged adapters shall be of the restrained type (RFCA).
b. The flange and flange gasket shall of the full face type. Use of ring gasket type is not allowed.
c. Conform to AWWA C111 and AWWA C207.
d. Flanged adapters shall be made of steel per ASTM A36, Grade C or ductile iron conforming to ASTM A536
e. Flanged end bolt circle, bolt size, and spacing shall conform to the applicable provisions of ANSI B16.1 and shall be drilled Class 125.
f. Restraint for the flange adapter shall consist of a plurality of individual actuated gripping wedges. Torque limiting actuating screws shall be used to insure proper initial set of gripping wedges.
g. Shall be capable of deflection during assembly, and to permit lengths of pipe to be field cut.
h. The adapter shall have a pressure rating not less than the connecting pipe.
i. Anchor studs shall not be used where joint restraint is required. Furnish adapters with tie rod harness assemblies where indicated.
j. Lining and Exterior Coating for Adapters:
k. Two-part epoxy or nylon fuse-coated to a minimum 10 mils thickness.
l. Completely coat adapter sleeve and end follower gland plus line interior for adapters intended for exposed exterior, vault or pit installations.
m. Line interior of all adapters intended for exposed interior installations. Coat exterior with normal shop coating.

2.08 COMBINATION AIR VALVE

A. Acceptable Manufacturers:
1. Apco Williamette Valve and Primer Corporation.
2. Crispin Valves, Multiplex Manufacturing Company.
3. Val-Matic Valve and Manufacturing Corporation.
4. Engineer Approved Equal

B. Design: Conform to AWWA C512 and as specified.
1. Valve shall be heavy-duty combination air release and air/vac, water style.
2. Body and cover shall be cast or ductile iron.
3. Float shall be stainless steel.

4. All internal parts shall be stainless steel.
5. External fasteners shall be stainless steel
6. Valve interiors and exteriors shall be coated with an epoxy coating in accordance with AWWA C550.

C. Operation:
1. Release accumulated air from the pump casing while pipeline is full and operating under pressure.

D. Connection:
1. Connect to pump casing through corporation stops.
2. Connecting fittings and pipe shall be bronze, brass, or copper rated for 150 psi service.
3. Isolation valves shall be provided for all air valves and shall be bronze gate valves, Crane No. 424 or Engineer-approved equal.

E. Valve Schedule: See Drawings.

2.09 DUCKBILL CHECK VALVES

A. Acceptable Manufacturers:
1. Proco
2. Tideflex
3. Engineer Approved Equal.

B. Design:
1. Conform to Contract Drawings.

2.10 SHOP PAINTING:

A. Prepare surfaces and paint or coat all valves, valve boxes, corporation stops, and all related accessories standard of the manufacturer unless otherwise specified herein.

B. Paint and coatings shall be suitable for the service intended.

C. Submit type of paint or coating proposed with drawings and data for Engineer approval prior to fabrication.

2.11 WATER QUALITY SAMPLE TAP ASSEMBLY:

A. Provide each water quality sample assembly as described in the drawings.

B. Each assembly shall have a sample tap with ball valve near the tapped pipe or sample pump and instruments.

C. Pressure Reducing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Cash Acme.
b. Conbraco Industries, Inc.
c. Honeywell Water Controls.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig.
4. Size: As indicated on drawings.
5. Design Flow Rate: As indicated on drawings.
6. Design Inlet Pressure: As indicated on the drawings.
7. Design Outlet Pressure Setting: 10 psi.
8. Body: Bronze with chrome-plated finish for NPS 2 and smaller.
9. End Connections: Threaded for NPS 2 and smaller.

D. Rotameters:
   1. Supply variable area flow meter as follows:
      a. Visual, direct-read type, suitable for liquid service. Products requiring reference charts will not be accepted.
      b. Measurement range suitable for the attached instruments.
      c. Borosilicate glass or polycarbonate body with stainless steel metallic parts.
      d. Integral needle valve for flow control.
      e. Suitable for working pressure of 125 psi.
   2. Acceptable Manufacturers:
      a. Dwyer Instruments.
      b. Design-Builder approved equal.

E. Ball Valves
   1. Quantity required shall be determined from the Drawings.
   2. Acceptable Manufacturers:
      a. Chemtrol, Celanese Piping Systems, Inc., TU Series.
      b. Plasts-O-Matic.
      c. Spears.
      d. Design-Builder approved equal.
   3. Suitable for working pressure of 125 psi.
   4. All PVC Type 1 Grade 1.
   5. 3-inch and smaller valves:
      a. Seals shall be EPDM O-rings.
      b. Shall be double union design which permits removal of valve from line without cutting or disassembling pipe.
      c. Shall have socket ends.
      d. Seats shall be Teflon.
      e. Body shall have full unrestricted circulat inlet and outlet with diameter equal to rated size of valve.
      f. Have totalley enclosed operating mechanism mounted on an dattached to valve body.
      g. Have moveable ball having unobstructed circular opening.
      h. Shall be provided for each instrument, operations lab sample line, and sample tap.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Comply with provisions of AWWA C600 and as specified.

B. Thoroughly clean and remove all shipping materials prior to setting. Operate all valves from fully opened to totally closed.

3.02 FIELD PAINTING:

A. Surface preparation and finish painting are specified in SECTION 09 90 00.

3.03 FIELD TESTING:

A. Perform on piping and valves as specified in SECTION 33 31 50 and for the following:
   1. Butterfly valves.
   2. Check valves.
   3. Air valves.

B. Altitude, Pressure Reducing Valves, and Controlled-Venting Vacuum Relief Valves:

1. Furnish services of manufacturer's engineer to perform field tests to determine that the valve will operate as specified and to make any adjustments required to improve operation of the valves.
2. Furnish all instruments required to record pressure during tests when any combination of pumps are started or stopped to simulate possible occurrences under actual operating conditions. Instruments will remain property of the manufacturer.
3. Field tests shall be witnessed by Engineer.

END OF SECTION 33 12 16

SECTION 33 12 40 - HORIZONTAL SPLIT-CASE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers the furnishing and installation of variable-speed, horizontal split-case centrifugal pumping units, base plates and accessories.

B. Related Work Specified Elsewhere:
   1. Initial Operation and Testing - DIVISION 01.
   2. Utility Valves & Accessories: DIVISION 33
   3. Piping and Accessories: DIVISION 33.
   4. Motors: DIVISION 46.
   5. Variable Speed Drives: DIVISION 26.
   6. Process Integration: DIVISION 40.

1.02 REFERENCES:

A. Applicable Standards:
   1. American Iron and Steel Institute (AISI).
   2. American Bearing Manufacturer's Association (ABMA).
   3. American National Standards Institute (ANSI).
   4. Hydraulic Institute Standards (HIS).
   5. Institute of Electrical and Electronic Engineers (IEEE).
   6. National Electrical Manufacturer's Association (NEMA).
   7. Occupational Safety and Health Administration (OSHA).
   8. National Sanitation Foundation (NSF)
   9. Institute of Electrical and Electronics Engineers (IEEE).
   10. National Fire Protection Association (NFPA):
      a. 70 - National Electrical Code (NEC).

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Submittals shall include, but not be limited to, the following:
   1. Standard performance curves from shutoff to incipient cavitation at minimum available net positive suction head (NPSH).
   2. Curves for the following parameters as a function of pump capacity and speed at design temperature:
      a. Total developed head.
      b. Pump efficiency.
      c. Required brake horsepower.
      d. Net positive suction head required.
      e. Head-capacity curves for variable speed units at all design points. Provide additional variable speed curves for 50, 60, 70, 80, 90, and 100 percent pump design speed. Curves shall indicate minimum and maximum stable flow at each design speed.
   3. Mechanical details including impellers, bearings, couplings, and seals.
   4. Submit layout, dimensional, and cross-section drawings.
   5. Materials of construction.
   6. Manufacturer's standard protective coating system.
   7. Motor performance data and results of shop test.
   8. Equipment instruction books.
   9. Nameplate data.

10. Submit shop test reports and performance data specified in SECTION 01 33 00 and herein.
11. Base plate details.
12. Weights:
    a. Total each unit.
    b. Pump.
    c. Motor.
    d. Base plate.
13. Field testing startup reports for each condition evaluated, including, but not limited to:
    a. Flow
    b. Total Dynamic Head
    c. Input Power
    d. Vibration Results
14. Operation and Maintenance Manual in accordance with Section 01 33 00.
    a. Description sheet for each piece of equipment that lists the following:
        (1) Equipment tag number
        (2) Equipment description and function
        (3) Manufacturer name, address, and contact information
        (4) Local vendor name, address, and contact information
        (5) Nameplate data
        (6) Required spare parts
        (7) Periodic maintenance required
        (8) Lifecyle length (in years or hours of runtime)

C. Submit test curves run at the actual test temperature and test speed and the calculations for corrected curves shown at the specified temperatures, viscosity, density, and rated speeds.

D. Report of factory tests.

1.04 QUALITY ASSURANCE:

A. All equipment described in this section shall be furnished by a single manufacturer, who shall assume full responsibility for the proper operation of the pumps and associated equipment.

B. Factory Pump Tests:
1. Conducted at manufacturer's factory test facility or approved testing facility.
2. Conform to Hydraulic Institute Standards except as otherwise specified.
3. Perform tests for capacity, power requirements, and efficiency at specified rated head, shutoff head, operating head extremes, and at as many other points as necessary for accurate performance curve plotting. Calculate curves for variable speed pumps operating at reduced speeds corresponding to all design points.
4. Test at minimum available NPSH conditions and determine where cavitation occurs.
5. Include hydrostatic head of at least 150% of shutoff head.
6. Actual tests cover all data called for with the anticipated performance curves.
7. Perform tests at rated speed from shutoff head to incipient cavitation.
8. Submit a written test report and graphic representation(s) of the test results as a Submittal as specified in DIVISION 01.
9. Perform standard tests on all motors in accordance with IEEE.

1.05 FACTORY ASSEMBLY:

A. Pump/motor units shall be completely shop assembled and aligned prior to shipping.

B. After completion of the specified factory tests, pumps shall be prepared for shipment with the minimum amount of disassembly, and such that no field disassembly, cleaning, or flushing is required.

C. Any components removed for shipping shall be match-marked prior to removal and shipment.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. Shall be as specified in DIVISION 1.

1.04 WARRANTY:

A. As specified in SECTION 01 78 36 and herein.
B. The manufacturer shall warrant that all Equipment shall be free of defects caused by faulty material or workmanship and shall replace those parts for at least a period of two (2) years from the date of Construction Acceptance.
C. Multiple warranties for individual components shall not be acceptable.
D. Suction and discharge piping configuration shall not be used as a basis for voiding warranty.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Pumps:
   1. Fairbanks Morse Div., Colt Industries.
   2. Aurora
   3. Engineer Approved Equal.

2.02 GENERAL REQUIREMENTS:

A. Pump controls provided with the pump shall be as specified in Division 40.
B. Pumps shall meet the provided minimum efficiency requirements at primary design points.
C. Pump head-capacity curve shall be continuously falling from shutoff head.
D. Pumps shall be easily removeable for inspection or service.

2.03 PUMPS:

A. Operating Conditions:
   1. Liquid to be pumped is potable and reuse water with a temperature ranging from 40°F to 90°F.
   2. Pumping operations may be continuous.
   3. Pump station will be normally unattended. It will be monitored and controlled on site and remotely.
   4. Pumps shall be operated independently and in parallel.
   5. Pumps shall be designed for variable speed operation.
   6. Design each potable pump to conform to the following:
      a. Number Required: 3
      b. Pump Tags: P-101, P-102, P-103
      c. Primary Design Point
         (1) Capacity: 5.67 MGD
         (2) Design TDH (ft): 187’
         (3) Minimum Allowable Efficiency: 75%
      d. Secondary Design Points Met with Speed Adjustment
         (1) Secondary Design Point A
            (a) Capacity: 5.67 MGD
            (b) Design TDH: 77’
         (2) Secondary Design Point B
            (a) Capacity: 0.75 MGD
            (b) Design TDH: 25’
      e. Maximum Motor Size: 300 hp
      f. Shutoff Head Range: (223 – 235) ft
      g. Maximum nominal speed (rpm): 1800 rpm

h. Maximum Allowable NPSH required for all Design Points: 20 ft.

7. Design each reuse pump to conform to the following:
   a. Number Required: 3
   b. Pump Tags: P-201, P-202, P-203
   c. Primary Design Point
      (1) Capacity: 3.32 MGD
      (2) Design TDH (ft): 102’
      (3) Minimum Allowable Efficiency: 75%
   d. Secondary Design Points Met with Speed Adjustment
      (1) Secondary Design Point A
         (a) Capacity: 3.32 MGD
         (b) Design TDH: 40’
      (2) Secondary Design Point B
         (a) Capacity: 0.60 MGD
         (b) Design TDH: 30’
      (3) Secondary Design Point C
         (a) Capacity: 0.95 MGD
         (b) Design TDH: 78’
   e. Maximum Motor Size: 100 hp
   f. Shutoff Head Range: (120 – 130) ft
   g. Maximum nominal speed (rpm): 1800 rpm
   h. Maximum Allowable NPSH required for all Design Points: 20 ft.
8. Brake horsepower of motors furnished shall not be exceeded at any point on the head-capacity performance curves.
9. Provide pump curves with efficiencies at corresponding speeds for each design point.

B. Design:
   1. General:
      a. Centrifugal, single-stage.
      b. Double suction.
      c. Single volute.
      d. Side suction, side discharge.
      e. For mounting with shaft horizontal.
      f. Capable of withstanding reverse rotation at runaway speed caused by flow at pressure equal to rated head.
      g. Capable of withstanding high torque caused by across-the-line starting of motor.
      h. Complete pumping units, including motor mounted on a single base plate.
      i. Pump materials in contact with water shall meet the requirements of NSF 61.
   2. Casing:
      a. Mechanite or similar cast-iron with minimum tensile strength to withstand 150% of shutoff head.
      b. The casing shall be of the horizontal split case configuration. Casing halves shall be flange bolted with spot facing for bolt heads, nuts, and tapered dowels for proper alignment.
      c. Castings shall not have been repaired by plugging, welding, or other methods.
      d. Axially split to permit removal of impeller assembly without disturbing lower casing, piping, or motor setting.
      e. Suction and discharge nozzles flanged and drilled for ANSI Class 125 standard bolting without raised faces and to match the connecting pipe flanges.
      f. Fitted with renewable stainless steel or bronze wearing rings locked to casing.
      g. Lifting eyes or other devices suitable for handling casing in horizontal position.

h. Supporting feet, bearing arms, and nozzles shall be either cast integrally or bolted and doweled on the lower half casing.
i. NPT threaded outlets shall be provided for draining, priming, and venting the casing, draining the seal leakage, and suction and discharge pressure gauge connections. Casing vent shall include an air release valve assembly in accordance with SECTION 33 12 16.
j. Drain connections shall be piped to the base drain connection.
k. The lower casing shall have tapped and plugged holes for priming, vent and drain.
l. The lower half of the casing shall be furnished with cored passageways from the high pressure area of the volute to each seal box for positive lubrication.
m. A flushing line from the discharge side of the casing to the upper seal box shall be provided as required by manufacturer.

3. Pump Shafts:
   a. Type 416 stainless steel.
   b. Proportioned to transmit all loads and torque without bending or twisting.
   c. Removable stainless steel or bronze shaft sleeves extending from the impeller through each stuffing box, with spacer sleeves as required.
   d. Shaft sleeves locked to shaft in a manner to withstand rotation in either direction and designed to prevent leakage between shaft and sleeve.
   e. Tapered shafts to facilitate removal of bearings and couplings. Coupling members secured with lock nuts and keys.
   f. Ample diameter to assure that first critical speed will occur at not less than 150% of rated pump speed.
4. Impellers:
   a. One-piece stainless steel or bronze casting machined on all exterior surfaces.
   b. Enclosed type, double suction design.
   c. Keyed to shaft locking the impeller and shaft sleeves against rotation on the shaft.
   d. Removable without special tools.
   e. Balanced statically and dynamically to eliminate vibration, and hydraulically to minimize end thrust.
   f. Castings shall not have been repaired by plugging, welding, or other methods.
   g. Fitted with renewable bronze wearing rings.
5. Bearings:
   a. Renewable, grease-lubricated anti-friction type.
   b. Design conform to ABMA Standards.
   c. Rated L10 life of 50,000 hours when operated continuously at design rpm and sustaining all normal loads to be incurred by this application.
   d. Thrust bearings capable of taking radial load and total thrust loads of rotating assembly and which may be imposed in either direction by flexible couplings and any unbalanced hydraulic loads.
   e. Radial bearings capable of taking maximum radial loads. Protected from dirt and moisture with devices proven capable of positive protection both while pump is running and idle.
   f. Grease lubricated bearings equipped with facilities for grease gun application to all contact surfaces.
6. Stuffing Boxes:
   a. Suitable for incorporation of mechanical seals.
   b. Each stuffing box shall be furnished with mechanical seals. All metal parts of the seal shall be stainless steel with “Buna-N” elastomers, Ni-Resist, Ceramic, or Silicon Carbide seat and carbon washer.

c. Each stuffing box shall be furnished with a one-piece O-ring sealed gland to securely hold the mechanical seals in place.
d. Provide any necessary drip boxes, fittings, and drain piping to base drain.
e. Provide bolts and nuts of brass or stainless steel.

7. Couplings:
   a. Statically balanced flexible type with basic rating required for the intended service.
   b. Lubricated or nonlubricated pin and rubber bush, rubber coupling, or all-metal gear type.
   c. Lubricated type sealed to prevent loss of lubricant.
   d. Provide coupling guard in compliance with OSHA standards.
8. Base Plate:
   a. Complete pumping unit and motor mounted on a common base plate.
   b. Continuous box type of cast or welded steel construction, presenting a pleasing appearance, and adequately braced and reinforced so that distortion will not develop during shipment or installation.
   c. An adequate number of holes provided in top for placement and compaction of grout. Provide sufficient vent holes to eliminate voids in grouting.
   d. Drip base drain connection.
      (1) 3/4-inch type L hard temper copper tubing.
      (2) Piped to floor drains.

2.04 MOTORS:

A. Provide inverter duty motors and accessories as specified in DIVISION 46.
B. Provide Totally Enclosed Fan Cooled (TEFC) Motor.

2.05 PROTECTIVE COATINGS:

A. Shop Painting:
   1. Manufacturer shall prepare surfaces, prime, and finish paint all iron and steel surfaces with manufacturer's standard coating system suitable for service intended.
   2. Coordinate color with Owner and Engineer.
   3. All nameplates, bronze or stainless steel surfaces shall not be painted.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Installation, start-up, and testing of all Equipment and associated construction shall conform to manufacturer's recommendations.
B. Manufacturer's field representative shall meet with Contractor to provide guidelines for installation of Equipment.
C. Manufacturer's field representative shall inspect Equipment after the Equipment has been installed and prior to start-up. A written report of the inspection shall be submitted to Owner (with copy to Engineer).
D. Provide all necessary lubrication for initial start-up, testing, and as required for final acceptance.
E. Provide a complete unit with all materials, components, and adjustments as required for successful operation.
F. Do not place grout for pump pedestal bases until pumps are completely aligned.
G. All pump drainage shall be directed to the nearest sump inside the pump station by means of field-routed flexible tubing. The tubing shall be routed in such a way that it does not create a trip hazard.

H. Install pipe and pipe appurtenance supports to minimize stresses being placed on pump nozzles.

3.02 FIELD TESTING:

A. As specified in Section 01 75 00.
B. Conduct in the presence of Owner and Engineer.
C. Equipment Tests:
   1. Check performance of all components as a functioning unit.
   2. Verify factory tests as well as possible with facilities available at the Site of installation.
   3. Check Vibration: Equipment vibration velocity shall be less than identified in Figure 9.6.4.2.5.1a of ANSI/HI 9.6.4 2009 – American National Standard for Rotodynamic Pumps for Vibration Measurements and Allowable Values.
      a. If Equipment vibration exceeds that indicated and determined to be caused by Equipment furnished under this Contract, the defect shall be corrected by Contractor.
      b. Submit written report to Owner and Engineer regarding tests performed and test results.
D. Operational Tests:
   1. Conduct such operational tests as necessary to determine that the performance of equipment and controls is as specified.
      a. Operational testing shall be performed for at least one (1) day to verify that the installed pump operates as expected over a variety of changing flow conditions.
      b. Coordinate with the City to ensure that the pumps can be operated as required by the operational testing.
   2. Tests will generally consist of placing Equipment in operation under varying conditions and observing performance.
E. Make all necessary Equipment adjustments and corrective work indicated by tests.
F. Submit a written test report to Owner (with one copy to Engineer) in a letter form showing operations performed and results obtained for each unit.

3.03 OWNER TRAINING

A. As specified in DIVISION 01.
B. Provide a miminum four (4) hour field training course for designated operating and maintenance staff members. The training shall include operation of pumps, maintenance needs and procedures, safety issues and emergency procedures, control and alarm features, and trouble shooting equipment and control problems.
C. Training shall be provided during normal working time and shall start after the system is functionally complete but prior to full start-up.
D. Field training shall cover all of the items contained in the operating and maintenance manuals.
E. Pump vendor shall be required to provide classroom and hands-on operating instruction specific to their equipment. Training shall be provided to the individuals selected by the Owner.
F. Provide video recording of all classroom training session to Owner.
G. Upon completion, submit certificates indicating the designated personnel have received training specified and have successfully operated the installed pumps.

3.04 FIELD PAINTING:

A. Touch Up:
   1. For complete protection, prepare surfaces and touch up coatings damaged during shipment and installation.
   2. Obtain an adequate quantity of touch-up paint from pump manufacturer.

3.05 INSPECTION:

A. Recheck all units for alignment after Equipment has been placed in operation for approximately 30 days.

B. An inspection of each pumping unit by Equipment manufacturer's representative shall be coordinated with the Owner to be performed when the pump station is in service, at the end of the season within 60 days prior to date of warranty expiration.

1. Ascertain or appraise the following:
    a. Status of Equipment and installation after normal usage.
    b. Adherence to manufacturer's recommended operation and maintenance of Equipment.
2. Check the following:
    a. Alignment.
    b. Vibration.
3. Make adjustments as necessary to restore Equipment within original tolerances.
4. Submit a written report within seven days to Owner (with copy to Engineer) covering all inspection items and including recommendations when applicable.

END OF SECTION 33 12 40

SECTION 33 16 34 – GROUND-LEVEL AWWA D115 POST-TENSIONED CONCRETE WATER STORAGE TANKS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This specification section includes requirements related to the tank contractor's responsibilities for design and construction of an AWWA D115 type internal tendon prestressed concrete tank
B. The work performed under these specifications includes furnishing all engineering design, supervision, labor, materials, equipment, tools, inspection and testing necessary for the construction.
C. The tank shall have a bi-axially prestressed concrete floor and roof each cast in single placements, and a cast-in-place bi-axially prestressed wall cast in full-height sections.
D. Furnish all labor, materials, equipment, and incidentals required to complete the work to the limits shown on the drawings and as specified herein.
E. Furnish and install appurtenances including inlet and outlet piping, overflow piping, wash down piping, piping supports, roof vents, access ladders, railings, and hatches as shown on the drawings.

1.03 RELATED REQUIREMENTS

A. Related project specification sections include but are not necessarily limited to:
    1. Division 03: Concrete and Reinforcing.
    2. Division 05: Metal guardrails, supports, and miscellaneous framing.
    3. Division 06: FRP Assemblies and Framing
    4. Division 09: Protective Coatings.
    5. Division 13: Disinfection and Testing.
    6. Division 31: Site preparation, excavation, fill, backfill, grading.

1.04 REFERENCE STANDARDS:

A. The materials, design, fabrication, erection and inspection of the tank and foundation, shall conform to the latest editions of the following Standards, Codes, and Guides:
    1. American Concrete Institute (ACI):
        a. 301 - Specification for Structural Concrete.
        b. 305 – Hot Weather Concreting.
        c. 306 – Cold Weather Concreting.
        d. 309R – Guide for Consolidation of Concrete.
        e. 318 - Building Code Requirements for Structural Concrete and Commentary.
        f. 350 – Code Requirements for Environmental Engineering Concrete Structures and Commentary.
        g. 350.1 - Tightness Testing of Environmental Concrete Structures
        h. 350.3 - Seismic Design of Liquid Containing Concrete Structures and Commentary.
        i. 506.2 – Specification for Shotcrete
        j. 506R – Guide to Shotcrete.
    2. American Society for Testing and Materials (ASTM)
        a. A185 - Specification for Steel Welded Wire, Fabric, Plain for Concrete.

b. A416 - Standard Specification for Steel Strand, Uncoated Seven- Wire for Prestressed Concrete.
c. A475 - Standard Specification for Zinc-Coated Steel Wire Strand.
d. A615 or A615M - Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
e. A821 - Specification for Steel Wire, Hard Drawn for Prestressing Concrete Tanks.
f. A1008/A1008M - Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
g. C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
h. C33 - Standard Specification for Concrete Aggregates.
i. C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
j. A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
k. A421/A421M - Standard Specification for Uncoated Stress-Relieved Steel Wire for Prestressed Concrete
l. A615/A615M - Standard Specification for Deformed and Plain Carbon Steel Bars for Concrete Reinforcement.
m. A653/A653M - Standard Specification for Steel Sheet, Zinc-coated (Galvanized) or Zinc-iron Alloy-coated (Galvanealed) by Hot Dip Process
n. A706/A706M - Standard Specification for Low-alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
o. C231 - Test Method for Air Content of Freshly Mixed Concrete by Pressure Method
p. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 Ft. – lbf/ft^3) (600 KN-M/M^3)
q. C618 – Type F Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
r. C920 – Specification for Elastomeric Joint Sealants.
s. D1056 – Standard Specification for Flexible Cellular Materials – Sponge or Expanded Rubber.
t. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
u. D1557 – Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 Ft. – lbf/ft^3) (2700 KN-M/M^3).
v. D2000 - Classification System for Rubber Products in Automotive Applications.

3. American Society of Civil Engineers (ASCE)
   a. ASCE7 – Minimum Design Loads for Buildings and Other Structures
4. American Society of Mechanical Engineers (ASME)
   a. B31.1- Code for Pressure Piping - Power Piping.
5. American Water Works Association (AWWA):
   a. C219 – Bolted, Sleeve-type Couplings for Plain-End Pipe
   b. C652 – Disinfection of Water Storage Facilities
   c. D115 – Tendon Prestressed Concrete Water Tanks
6. International Code Council (ICC):
   a. International Building Code 2021 Edition with local amendments.

7. National Fire Protection Association (NFPA)
    a. NFPA 22 – Standard for Water Tanks for Private Fire Protection.
8. Post-Tensioning Institute (PTI):
    a. Post-Tensioning Manual.
    b. Manual for Certification of Plants Producing Unbonded Single Strand Tendons.
    c. Post-Tensioned Commercial and Industrial Floors.
    d. Design of Post-Tensioned Slabs Using Unbonded Tendons.
    e. Field Procedures Manual for Unbonded Single Strand Tendons.
    f. Specification for Unbonded Single Strand Tendons.
    g. Specification for Grouting of Post-Tensioned Structures.
    h. Guide Specification for Grouted Post-Tensioning.
    i. Manual for Certification of Plants Producing Unbonded Single Strand Tendons.

1.05 QUALITY ASSURANCE

A. Tank Contractor Qualifications:
    1. Shall have the skill, reliability, and financial resources and stability to construct and warranty the tank in accordance with the contract documents. The tank contractor shall be responsible for the design, construction, and warranty of the internal tendon prestressed concrete tank.
    2. Shall provide a full-time, on-site superintendent that has been responsible for the construction of at least two concrete tanks in the last five (5) years that are giving satisfactory service. Qualifications for the superintendent shall be submitted to the owner for approval; the owner reserves the right to have the individual replaced if experience requirements are inadequate.

B. Tank Design Engineering Firm:
    1. Shall have ten (10) years minimum experience in design and field construction of internal tendon prestressed concrete tanks and shall have been responsible for the design of at least three internal tendon prestressed concrete tanks in the last five (5) years.
    2. Shall be in responsible charge of engineering work to be done for the tank design, construction, and testing.
    3. Shall provide sealed calculations and drawings by licensed professional engineer in the project state.

C. Post-Tensioning Subcontractor:
    1. Post-tensioning systems shall be produced by a Post-Tensioning Institute (PTI) Certified Plant owned and operated by the post-tensioning subcontractor.
    2. The subcontractor that supplies the post-tensioning system shall provide a superintendent and be responsible for placement of both the post-tensioning and mild reinforcing steel.
    3. The superintendent shall be a full-time employee of the post-tensioning supplier/installer and be on the project full-time during all placing, stressing and grouting operations, and shall have superintended the construction of at least three prestressed concrete tendon tanks in the last five years. The superintendent shall be a holder of a current Certified Grouting Technician certificate from the American Segmental Bridge Institute or be PTI level 2 certified in Multistrand/Grouted Prestressing. The superintendent's qualifications shall be submitted to the owner for approval; the owner reserves the right to have the individual replaced if experience requirements are inadequate.
    4. The post-tensioning subcontractor shall employ a full-time professional engineer with a minimum of ten (10) years' experience in the construction of internal tendon prestressed concrete tanks available to assist in technical issues as required for the success of the

project. The engineers' qualifications shall be submitted to the owner for approval; the owner reserves the right to have the individual replaced if experience requirements are

D. It is the express intent of this specification to create a singular responsibility for the design and construction of the AWWA D115 tank. The design construction of all aspects of the foundation, floor slab, wall, post-tensioning, shotcrete, roof and appurtenances of the tank shall be performed by the manufacturer.

E. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
   2. AWS D1.3, "Structural Welding Code - Sheet Steel."
   3. AWS D1.4, "Structural Welding Code - Reinforcing Steel."

F. Pipe Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

G. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

H. Concrete Stain Subcontractor:
   1. Manufacturer Qualifications: Minimum 10 years of documented experience producing the specified products.
   2. Installer Qualifications: Minimum 5 years of documented experience with work of similar scope and complexity required by this Project and acceptable to, or certified by, concrete stain manufacturer.
   3. Regulatory Requirements: Products to comply with United States Clean Air Act for maximum Volatile Organic compound (VOC) content as specified in this Section.
   4. Material Source Limitations: Obtain each specified material from the same source.
   5. Notification: Give a minimum 7 calendar days' notice to manufacturer's authorized field representative before date established for commencement of concrete stain work.

I. Concrete Stain Mockup:
   1. Construct a 4 foot by 4 foot mockup for color approval by Owner.
   2. Provide individual mockups for each color required.
   3. Construct mockup using materials, processes, and techniques required for the work, including curing procedures. Incorporate representative control, construction, and expansion joints according to Project requirements. Installer for the work to construct mockup.
   4. Mockup to be stained and sealed by the Installer who will actually perform the work for the Project. Record the amount of chemical stain needed per square foot of application to establish coverage rates for the work.
   1. Notify Architect and Owner a minimum of seven calendar days in advance of the date scheduled for each mockup construction.

1.06 SUBMITTALS

A. Submit as specified in Division 01.

B. Submit the following with the bid.
   1. The following information shall be included in the tank contractor's bid submittal. Failure to meet the requirements of Section 1.05 shall result in the bid being considered non-responsive and cause for rejection.
      a. Resumé of the proposed on-site superintendent responsible for the construction with list of qualifying projects.

b. Resumé of the proposed engineer in responsible charge of the project with list of qualifying projects.
c. Resumé of the proposed post-tensioning subcontractor‘s superintendent with list of qualifying projects.
d. Resumé of the proposed post-tensioning subcontractor’s professional engineer in responsible charge.

C. Construction submittals shall include, but are not limited to the following:
1. Structural design calculations and detailed construction drawings, seals by the professional engineer in responsible charge.
2. Technical data including product manufacturer’s information, specifications, and installation instructions.
3. Shop drawings for mild steel reinforcement, formwork, post-tensioning systems, piping, appurtenances, etc.
4. Design calculations with clear indications of loads used in design. Calculations shall be sealed by a professional engineer licensed in the State of Colorado.
5. Reinforcing shop drawings showing fabrication and placement and including mill certificates for mild reinforcing, prestressing steel, and any other steel components.
6. Concrete design mixes, including all admixtures, and placement procedures.
7. Weld certificates.
8. Bacteriological test results.
9. Operation and maintenance manuals.
10. Tank surface finishes and coating materials.
11. Field quality control and test results.
12. Warranty documents.
13. Safety program.

D. Approval by the Engineer of the drawings and calculations submitted by the Contractor will not in any way relieve the Contractor of full responsibility for the accuracy and completeness of the drawings and calculations.

E. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
1. Obstruction lighting.
2. Lightning protection.
3. Cathodic protection.
4. Tank heaters.

F. Submit as-constructed drawings at completion in accordance with Division 1 and as follows:
1. Submit one (1) 22”x34” computer source copy of as-constructed drawings in PDF format.

G. Survey: Contractor shall provide survey of the tank to the Owner and the Engineer. See 3.08.D Field Quality Control this Section.

1.07 PREINSTALLATION MEETINGS:

A. Preinstallation Conference: Conduct conference at Project Site or remotely at Contractor’s option.

1.08 PERFORMANCE REQUIREMENTS:

A. The prestressed, post-tensioned concrete tank shall be designed and constructed in accordance with the provisions of AWWA D115, Tendon Prestressed Concrete Water Tanks, ACI 318 and ACI 350.

B. Tendons shall be continuous. Discontinuous tendons or strands will not be allowed.
C. Required dimensions and capacities:
    1. Tank Capacity:
        a. Potable Tanks: 3 million gallons (active storage).
        b. Reuse Tank: 4 million gallons (active storage).
    2. Tank Dimensions: As indicated on Drawings.
    3. Vent Capacity Requirements:
        a. Potable Tanks
            (1) Maximum Fill Rate: 1578.1 cfm.
            (2) Maximum Draw Down Rate: 1578.1 cfm.
        b. Reuse Tank
            (1) Maximum Fill Rate: 615.5 cfm.
            (2) Maximum Draw Down Rate: 615.5 cfm.
    4. Overflow Design Capacity: Designed to accommodate maximum fill rate as indicated.
D. Structural Performance: Surface water-storage tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of the following loads:
    1. Dead Loads: Estimated of all permanent imposed loads.
    2. Live Loads: Weight of all the liquid when the reservoir is filled to overflowing. Unit weight of liquid 62.4 pounds per cubic foot.
    3. Roof Live Loads: 100 psf plus the weight of soil on roof.
    4. Ground Snow Loads: 40 psf.
    5. Wind Loads: As required by ASCE 7
        a. Ultimate Design Wind Speed: 140 mph.
    6. Backfill Soil Pressure: 55 pcf.
    7. Geotechnical Requirements: As indicated on Drawings.
    8. Seismic Performance: Surface water-storage tank, including structural reinforcement and foundation, shall be capable of withstanding the effects of earthquake motions determined according to authorities having jurisdiction.
        a. Risk Category: IV
        b. Mapped Spectral Accelerations for Short Periods, S_s: 0.204
        c. Mapped Spectral Accelerations for 1-Second Period; S_1: 0.057
        d. Site Class: C
        e. Long-period Transition Period, TL: 4 sec.
        f. Sloshing Height: The sloshing height shall be calculated using AWWA D115, but need not exceed the fluid displacement calculation when determined using ACI 350.3, TID 7024 or ASCE 7. The effects of the "sloshing wave" shall be accounted for by increasing the freeboard between the normal operating surface and the underside of the roof, or a roof capable of resisting the uplift of such a wave designed. A minimum freeboard height of 11 inches above the design liquid level shall be utilized. Any confined portion of the convective (sloshing) mass shall be calculated and applied as an additional impulsive mass.
        g. Dynamic Effects of Backfill: Seismic design shall consider the additive effects of the dynamic backfill loading.
    9. Construction Loads: In addition to the design loads listed above, the following load cases shall be considered for the Potable and Reuse Tanks:
        a. Potable North and South Tank:
            (1) Case 1: Partially buried, empty tank
            (2) Case 2: Leak test, No backfill, full tank

(3) Case 3: Partially buried (one-half exposed), full tank

b. Reuse Tank:

(1) Case 1: Partially buried, empty tank

(2) Case 2: Leak test, No backfill, full tank

E. Thermal Movements: Surface water-storage tank, including structural reinforcement and foundation, shall allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120ºF (67ºC), ambient; 180ºF (100ºC), material surfaces.

F. The Tank Contractor shall design the concrete wall and joints in combination with vertical mild steel reinforcement based on the following design criteria and requirements:

1. The prestressed tank wall shall be considered as a cylindrical shell with partial edge restraint.
2. The prestressed tank wall shall be reinforced vertically by deformed steel reinforcing bars as required.
3. No reduction in ring compression or tension in the wall will be taken due to restraint at the bottom.
4. The long-term prestressing losses caused by shrinkage, creep, and relaxation in the prestressed reinforcement of the tank walls shall not be assumed less than 25,000 psi.
5. Lateral soil pressures shall not be considered in resisting seismically generated shear forces between the wall footing and the wall.

G. Floor Slab

1. The floor slab shall be designed as a structural floor slab. Construction joints will only be allowed as shown on the shop drawings and as approved by the Engineer. Construction joints shall incorporate a horizontal 6-inch PVC waterstop.
2. If required, the floor shall have thickened regions to facilitate transitions from under slab concrete pipe encasements into the floor, appurtenance loadings and temporary bracing requirements.
3. Minimum cross sectional area ratio of floor reinforcement to concrete shall be in accordance with ACI 350.
4. Polypropylene or cellulose fibers may be used at the Tank Contractor's discretion.

H. Roof Slab:

1. The roof shall be fixed to the tank wall and supported by interior columns as required.
2. The roof shall be of post-tensioned construction with a minimum thickness of 4".
3. Minimum cross sectional area ratio of roof reinforcement to concrete shall be in accordance with ACI 350.
4. Polypropylene or cellulose fibers may be used at the Tank Contractor's discretion.

1.09 WARRANTY:

A. The tank contractor shall warranty the tank structure against any defective materials or workmanship for a period of two years from the date of tank acceptance. If any materials or workmanship, including piping and appurtenances, prove to be defective within the two year period, they shall be repaired or replaced by the tank contractor at no additional cost to the owner.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General Requirements:
   1. All materials shall comply with AWWA D115, ACI, and PTI.

B. Concrete
   1. Concrete shall conform to ACI 301.
   2. Cement shall be Portland cement conforming to ASTM 150 Type I/II.
   3. Admixtures, other than air-entraining, superplasticizers, shrinkage reducing and water reducing admixtures will not be permitted unless approved by the Engineer.
   4. Concrete for tank wall, roof construction shall have a minimum compressive strength of 4,500 psi at twenty-eight days.
   5. Concrete for the tank floor, footings, pipe encasement, and all other work shall have a minimum compressive strength of 4,500 psi at twenty-eight days, shall not be air-entrained, unless exposed to freeze thaw conditions.
   6. Concrete indicated to be air-entrained with an air content of 5% +/- 1.5% per ASTM C173.
   7. The coarse and fine aggregate shall meet the requirements of ASTM C33 with a maximum coarse aggregate size of 1".
   8. If fibers are used, they shall be virgin poly-propylene or cellulose fibers, Microfiber by Grace, Fibermesh 150 by Propex, UltraFiber 500 by Buckeye, or equal. Fiber lengths shall be a maximum of ¾ inches. The amount of fibers added to the concrete mix shall conform to the Manufacturer's recommendations.
   9. Proportioning for concrete shall be in accordance with ACI 301.
      a. The allowable w/(c+p) range shall be .36-.41.
      b. Class F fly ash content shall be 20%-25% of (c+p) weight.
      c. Concrete slump at maximum w/(c+p) shall be 5" -7" maximum per ASTM C143.
      d. The water shall be potable, clean, and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete, reinforcing steel, or other embedded items.
   10. All concrete shall have a maximum water soluble chloride ion concentration of 0.06% by weight of cementitious material.
   11. All concrete mix designs shall be submitted to the engineer for approval. Alternate mixes cold weather conditions, or self-consolidating concrete shall be considered.
   12. Dry shrinkage shall not exceed 0.040 percent when tested in accordance to ASTM C157 for concrete used in liquid and chemical retaining structures.

C. Shotcrete:
   1. Shotcrete shall conform to ACI Standard 506, except as modified herein.
   2. The wet mix process shall be employed for shotcreting.
   3. Shotcrete shall consist of not more than four parts sand to one part Portland cement by weight. Polypropylene fibers shall be included in the shotcrete used for the finish cover coat. Fibers shall be Fibercast 500 by Propex, Fibermesh or equal. Fibers shall be virgin polypropylene and comply with ASTM C-1116 performance level I. Fiber length shall be ¼ inch. The amount of the fibers added to the shotcrete used for the finish cover coat shall conform to the Manufacturer's recommendations. Fly ash may be incorporated into the finish cover coat. Fly ash shall conform to ASTM C618, Type F. Shotcrete shall have a minimum strength of 4,500 psi at twenty-eight days and have a maximum water to cementitious ratio of 0.42.

4. Rebound material shall not be reused in any form for shotcrete.
5. If used by the Tank Contractor, the total volumetric air content of the shotcrete before placement shall not exceed 7% (±1%) as determined by ASTM C-173 or ASTM C-231.
6. Fine Aggregates:
    a. The fineness modulus shall be between 2.7 and 3.0. A well-graded coarse sand shall be used for all shotcrete applications.
    b. The gradation for the fine aggregates shall adhere to the "Grading No. 1" requirements listed in "Table 1.1 – Grading Limits for Combined Aggregates" of ACI 506.
7. All shotcrete shall have a maximum water soluble chloride ion concentration of 0.06% by weight of cementitious material.

D. Reinforcing Steel:
1. Mild reinforcing steel shall be new billet steel conforming to ASTM A615, Grade 60.
2. Reinforcing steel shall be accurately positioned on supports, spacers, hangers, or other reinforcing and shall be secured in place with wire ties or suitable clips. Rebar chair supports may be either steel with plastic tips, turned up legs, or plastic.
3. Continuous reinforcing is required through floor and roof cast-in-place construction joints.

E. Post-Tensioning Systems:
1. All post-tensioning components and systems shall be furnished by a PTI certified plant.
2. Strand shall be low relaxation, seven wire strand, having a guaranteed minimum ultimate tensile strength of 270,000 psi, per ASTM Designation A416, low relaxation.
3. Bonded Tendons:
    a. Anchorages must develop at least 95 percent of the guaranteed ultimate tensile strength (GUTS) of the prestressing steel, tested in an unbonded state, without exceeding anticipated wedge seating. Anchorages shall include details that completely encapsulate the post-tensioning steel with mechanical connections; friction-type connections will not be allowed. Anchorages shall be VSL type ECI, type VSLAB, and type SO, or approved equals.
    b. Duct for bonded tendons shall be manufactured from polypropylene materials that completely encapsulate the post-tensioning steel and include mechanical type couplers. Duct shall be VSL type PT-Plus or approved equal.
    c. Grout for injection grouting of bonded tendons shall be Prepackaged Class C per PTI Specifications.

F. Strand for Seismic Cables:
1. ASTM A416, grade 270 low-relaxation before galvanizing. Galvanize in accordance with ASTM A 475. Only hot-dipped galvanizing shall be permitted; cold galvanizing shall not be permitted.

G. Elastomeric Materials:
1. Bearing pads shall be furnished with the dimensions, material properties, and elastomer grade as required by the drawings per ASTM D 2240 or D2000, Type A Shore, 30 to 60 Durometer. Prepare concrete surfaces and adhere pads to concrete per manufacturer's recommendations.
2. Neoprene Sponge filler conforming to ASTM D1056 or D1752. Prepare concrete surfaces and adhere sheet to concrete per manufacturer's recommendations.

H. Water stops:

1. PVC, hydrophilic rubber, and chemical grout waterstops shall be furnished and installed with the dimensions, material, and type as required by the drawings and per the manufacturer's recommendations.

I. Exterior Stain:
   1. A decorative stain shall be applied to the exterior roof surface using one coat of a cementitious based damp-proofing product such as "Tamoseal" or equal, and one coat of a non-cementitious, high build, 100% acrylic resin polymer such as "Tammscoat Smooth" textured protective coating, "Tnemec Envirocrete 156" or equal. A decorative coating shall be applied to the above grade exterior wall surfaces using two coats of a non-cementitious, high build, 100% acrylic resin polymer such as "Tammscoat Smooth" textured protective coating, "Tnemec Envirocrete 156" or equal.

J. Appurtenances:
   1. The Tank Contractor shall provide and install all appurtenances as shown on the drawings. Appurtenances shall include the following:
      a. Inlet-Outlet Piping.
      b. Overflow Piping and Weir.
      c. Roof Hatch: A 42 inch square aluminum hatch with lockable, hinged cover and curb frame. The hatch shall have a lift handle, padlock tab, padlock and a cover hold open mechanism. All hardware shall be aluminum or stainless steel. Locate hatch as shown on drawings.
      d. Roof Ventilator: Fiberglass or Aluminum, with fiberglass insect screen with maximum openings of 0.07 inches and a minimum diameter 2 feet. Vent must open downward and be either candy cane, mushroom style, or where no portion of the vent screen is visible from a horizontal position.
      e. Interior Ladder: The ladder shall extend from the floor to the hatch. The ladder shall be FRP and have an OSHA-approved Stainless Steel fall prevention device (if required) consisting of a sliding, locking mechanism and safety belt. Location as shown on the drawings.
      f. Exterior Ladder: The ladder shall extend from 8 feet above the final grade to the tank roof. The ladder shall be made out of 6061-T6 Aluminum and have an OSHA-approved Stainless Steel fall prevention device (if required) consisting of a sliding, locking mechanism and safety belt. Location as shown on the drawings.
      g. Access Manway: A circular 25 inch diameter Type 304 stainless steel wall manway with a hinged cover. A Type 304 stainless steel grab bar and an aluminum ladder shall be installed at the manway location. Locate access manway as shown on drawings.
      h. Floor Sump: If shown on drawings, a minimum of one 2 feet square x 6 inch deep sump shall be provided in the tank floor. The sump may be at a drain pipe, outlet pipe or separate from the floor piping. Location of the sump as shown on the drawings.Dome Handrail: Handrails shall be located as shown on contract drawings. As a minimum handrails shall be provided for a distance of 10 feet to each side of the exterior ladder. All posts and rails shall be 6061-T6 or 6005-T6, Schedule 80, anodized aluminum pipe. All fittings shall be Hollaender Speed-Rail system or equal. Beveled toe board shall be installed at the front edge of handrail only and shall be attached using Hollaender clips or equal.
      i. Dome Safety Tie-Off Anchors: Provide three (3) permanent, OSHA compliant, anchorage connectors for a single employee to tie-off to shall be installed. The anchorages shall be located on the dome surface within 1.5 feet of the exterior

ladder egress point, within 1 foot of the dome hatch and within 2 feet of the dome vent. Anchorages shall be Model 417 SS D-Bolt Anchors by Miller Fall Protection or approved equal. D-Bolts to be anchored to concrete using 316 SS high strength threaded rods, 316 SS Hex head nuts and suitable epoxy adhesive.

PART 3 – EXECUTION

3.01 EXCAVATION AND BACKFILL:

A. Refer to DIVISION 31 – Earthwork.

3.02 FLOOR:

A. All aspects of tank construction shall comply with AWWA D115.
B. Prior to placement of the floor reinforcing, a polyethylene moisture barrier shall be placed over the void form. Joints in the polyethylene shall be overlapped a minimum of 6 inches and be taped.
C. Prior to placement of the floor concrete, all piping that penetrates the floor, shall be set and encased in concrete.
D. The vertical waterstop shall be placed and secured in position so that the bottom of the center bulb is at the elevation of the top of the footing. The waterstop shall be secured without puncturing any portion of the waterstop unless it is manufactured with holes for tying. The waterstop shall be spliced using a thermostatically controlled sealing iron and each splice shall be successfully spark tested prior to encasement in concrete.
E. The floor may be poured monolithically or divided into roughly equal segments with appropriate water stop detail at each joint.
F. The floor shall be cured by flooding with water and shall remain saturated for a minimum of 7 days.
G. For crack control in the floor, the minimum reinforcement in each direction in the horizontal plane shall be as recommended by ACI 350.

3.03 ROOF:

A. All aspects of tank construction shall comply with AWWA D115.
B. The floor may be poured monolithically or divided into roughly equal segments with appropriate water stop detail at each joint. Joint locations and sequencing shall be approved by the Engineer.
C. Construction joints, if required, shall include appropriate water stop detail at each joint. Joint locations are subject to the approval of the engineer.
D. The floor shall be cured by flooding with water and shall remain saturated for a minimum of 7 days.
E. For crack control in the floor, the minimum reinforcement in each direction in the horizontal plan shall be as recommended by ACI 350.
F. Prior to placement of concrete, all piping and appurtenances that penetrate wall or roof shall be set and securely tied in place.

3.04 WALL CONSTRUCTION AND ERECTION:

A. All aspects of tank construction shall comply with AWWA D115.
B. Construction joints, if required, shall include appropriate water stop detail at each joint. Joint locations are subject to approval of engineer.

C. Prior to placement of concrete, all piping and appurtenances that penetrate wall or roof shall be set and securely tied in place.
D. No holes for form ties, nails, or other punctures will be permitted in the wall.
E. Temporary wall openings may be provided for access and removal of construction materials from the tank interior subject to the approval of the Engineer.
F. See Division 03 for additional requirements.

3.05 CONCRETE

A. All concrete shall be conveyed, placed, finished, and cured as required by pertinent ACI standards.
B. Weather Limitations:
   1. Unless specifically authorized in writing by the Engineer, concrete shall not be placed without special protection during cold weather when the ambient temperature is below 35 degrees Fahrenheit and when the concrete is likely to be subjected to freezing temperatures before initial set has occurred and the concrete strength has reached 500 psi. Concrete shall be protected in accordance with ACI 306. The temperature of the concrete shall be maintained in accordance with the requirements of ACI 301 and ACI 306. All methods and equipment for heating and for protecting concrete in place shall be subject to the approval of the Engineer.
   2. During hot weather, concreting shall be in accordance with the requirements of ACI 305.
   3. Placement of concrete during periods of low humidity (below 50%) shall be avoided when feasible and economically possible, particularly when large surface areas are to be finished. In any event, surfaces exposed to drying wind shall be covered with polyethylene sheets immediately after finishing, or flooded with water, or shall be water cured continuously from the time the concrete has taken initial set. Curing compounds may be used in conjunction with water curing, provided they are compatible with coatings that may later be applied, or they are degradable.
C. Finishes:
   1. The tank shall be given the following finishes:
      a. The floor slab shall receive a bull float finish or Fresno finish. The top of the wall footing, exterior to the waterstop, shall receive a steel trowel or magnesium trowel finish.
      b. The interior surfaces of the wall and underside of the roof shall receive a form finish.
      c. The exterior of the roof shall receive a light broom finish.
      d. Bug holes, form tie holes, and other imperfections to be repaired per procedure recommended by tank designer. Submit repair procedure to engineer for approval.
      e. Exterior shotcrete shall receive a natural gun / nozzle finish.
D. Curing:
   1. Concrete shall be cured using water methods, sealing materials, or curing compounds. Curing compounds shall not be used on surfaces to which decorative coatings, mortar, or shotcrete is to be applied. Curing compounds used within the tank shall be suitable for use with potable water.
E. Testing:
   1. For concrete placed in the floor, walls, or roof, two sets of five cylinders for the first 50 cubic yards, and one set of five cylinders for every 100 cubic yards thereafter placed in the same day. Two cylinders shall be tested at seven days, two at twenty-eight days, and one held as a spare.

2. Slump, air content and temperature testing shall be performed on each truck where cylinders are taken.
3. All concrete testing shall be in accordance with ASTM C31 and C39.
4. An independent material testing service for field testing shall be selected as required in the General Conditions. The material testing service shall furnish test equipment, test cylinder molds, and certified personnel to perform all required field tests, make the required concrete test cylinders, and deliver test cylinders to the testing laboratory.

F. Shotcrete:
1. Shotcrete shall conform to ACI Standard 506, except as modified herein.
2. The wet mix process shall be employed for shotcreting.
3. Shotcrete shall consist of not more than three parts sand to one part Portland cement by weight. Additional coats of shotcrete shall consist of not more than four parts sand to one part Portland cement by weight. Polypropylene fibers shall be included in the shotcrete used for the finish cover coat. Fibers shall be Fibercast 500 by Propex, Fibermesh or equal. Fibers shall be virgin polypropylene and comply with ASTM C-1116 performance level I. Fiber length shall be ¼ inch. The amount of the fibers added to the shotcrete used for the finish cover coat shall conform to the Manufacturer's recommendations. Fly ash may be incorporated into the finish cover coat. Fly ash shall conform to ASTM C618, Type F. Shotcrete shall have a minimum strength of 4,500 psi at twenty-eight days and have a maximum water to cementitious ratio of 0.42.
4. Rebound material shall not be reused in any form for shotcrete.
5. If used by the Tank Contractor, the total volumetric air content of the shotcrete before placement shall not exceed 7% (±1%) as determined by ASTM C-173 or ASTM C-231.
6. Fine Aggregates:
   a. The fineness modulus shall be between 2.7 and 3.0. A well-graded coarse sand shall be used for all shotcrete applications.
   b. The gradation for the fine aggregates shall adhere to the "Grading No. 1" requirements listed in "Table 1.1 – Grading Limits for Combined Aggregates" of ACI 506.
7. All shotcrete shall have a maximum water soluble chloride ion concentration of 0.06% by weight of cementitious material.

3.06 DECORATIVE FINISHES

A. Basis of Design: Provide products specified herein manufactured by Sika Corporation Water-Based Reactive Chemical Concrete Stain: Penetrating reactive water-based staining product that chemically bonds to cured concrete or cementitious topping substrates to produce permanent translucent color effects. Less than 100 g/L VOC content.
1. Product: "LITHOCHROME Tintura Stain, Sika Corporation."
2. Color: Taupe from LITHOCHROME Tintura Stain Color Selection Options. Color shall be approved by Owner.
3. Sealer: Provide one of the following concrete curing compounds or approved equal:
   a. Scofield Cureseal 350, Sika Corporation.
   b. Scofield Cureseal W, Sika Corporation.

3.07 CONNECTIONS:

A. Piping installation requirements are specified in Division 33 sections. Drawings indicate general arrangement of piping, fittings, and specialties.
B. Connect tanks to water-distribution piping.

C. Connect drains to storm-drainage piping.
D. Ground equipment according to Division 26, Section "Grounding and Bonding for Electrical Systems."
E. Connect wiring according to Division 26, Section "Low-Voltage Electrical Power Conductors and Cables."

3.08 APPURTENANCE INSTALLATION:

A. Install and adjust water-level control valves, piping, and alarms.
B. Install obstruction lighting according to authorities having jurisdiction.
C. Install lightning protection according Division 26, Section "Lightning Protection for Structures."
D. Install cathodic protection according to Division 26, Section “Cathodic Protection” and AWWA D104.
E. Install tank heaters according to NFPA 22.

3.09 FIELD QUALITY CONTROL:

A. Leak Test:
   1. Upon completion of the tank the tank manufacturer shall perform water tightness testing of the tank.
      a. Water for testing shall be supplied by the Owner.
      b. Leak test to be conducted to the level of the overflow.
      c. The procedures and criteria for watertightness testing and acceptance shall be as defined in ACI 350.1. The maximum allowable loss is 0.0125% of the tank volume per day.
      d. Repair leaks and retest until no leaks exist.
      e. All labor and materials required for testing and evaluation, except for fill water, shall be furnished by the tank supplier.
B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
C. Foundation soil support: Place no concrete for floor until the subgrade is approved by the Geotechnical Engineer.
D. Survey: Contractor shall complete a survey of the tank foundation slab for documentation of the tank elevation.
   1. Survey Data: Provide a minimum of 8 equally spaced data points along the perimeter of the tank on the interior side of the tank wall.
   2. Dates of Acquisition:
      Initial Pour: Survey of the tank foundation slab 24 hours after foundation slab pour completion.
   3. Tank Completion: Survey of the tank foundation slab after completion of all concrete work for the tank. Each data point shall include one survey point at the previous foundation slab survey point and one survey point at the top of concrete tank wall.

3.10 CLEANING:

A. Clean interior and exterior of surface water-storage tanks.
B. Disinfect surface water-storage tanks per Section 13 08 41.

END OF SECTION 33 16 34

SECTION 33 31 50 - PIPE INSTALLATION

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes handling, installation and testing of steel, DIP, PVC, HDPE pipe, fittings, specials, and appurtenances as indicated or specified.

B. Related Work Specified Elsewhere:

1. Concrete Manholes and Vaults: SECTION 33 05 61.
2. Pressure Pipe: SECTION 33 11 00.
3. Gravity Pipe: SECTION 33 11 50.
4. Valves and Accessories: SECTION 33 12 16.
5. Protective Coatings: SECTION 09 90 00.

1.02 REFERENCES:

A. Applicable Standards:

1. American Water Works Association (AWWA):
   a. C105 – Polyethylene Encasement for Ductile-Iron Pipe Systems
   b. C205 - Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 Inch and Larger - Shop Applied.
   c. C206 - Field Welding of Steel Water Pipe.
   d. C213 - Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   e. C222 – Polyurethane Coatings and Linings for Steel Water Pipe and Fittings
   f. C600 - Installation of Ductile-Iron Water Mains and Their Appurtenances.
   g. C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
   h. C651- Disinfecting Water Mains.
   i. M11 - Steel Pipe - A Guide for Design and Installation.
   j. M23 – PVC Pipe-Design and Installation.
2. American Society of Mechanical Engineers (ASME)
   a. Boiler and Pressure Vessel Code, Section IX
3. American Welding Society (AWS).

1.03 SUBMITTALS:

A. Submit as specified in DIVISION 01.

B. Shall be approved before installation may begin.

C. Submittals required shall include, but are not limited to, the following:

1. Welding procedures and welder certification.
2. Solvent cement joint erection procedures and erector certification.
3. Butt fused joint erection procedures and erector and equipment certification.
4. Interior coating repair material.
5. Exterior coating repair material.
6. Protective marking tape.
7. Material data sheets on pipe marking tape, polyethylene encasement, and field coatings.
8. Test reports required by code and for coating application.
9. Methods and procedures for field testing of pipe joints.
10. Laying schedules for piping showing locations for each joint, fitting, special, and connection.

1.04 QUALITY ASSURANCE:

A. Procedures and Qualifications:
   1. Welding:
      a. Welders shall be qualified in conformance with either the applicable AWS Standard Qualification Procedures or the ASME Boiler and Pressure Vessel Code, Section IX.
      b. Qualification tests shall be certified by an independent party approved by Engineer.
      c. All costs incident to qualification tests shall be paid for by Contractor.
      d. Welding procedures and welder certifications shall be submitted to Engineer for approval prior to welding.
   2. Butt Fused Joints for Polyethylene Pipe:
      a. Butt fused joint erection procedure shall be in accordance with pipe manufacturer's standards and erection equipment.
      b. Qualification tests shall be conducted by the pipe manufacturer's erection supervisor. Qualification tests shall include, but is not limited to, erection of butt fused joint test samples.
      c. Qualification test and erection equipment shall be certified by the pipe manufacturer's erection supervisor.
      d. Butt fused joint erection procedure and certifications shall be submitted to Engineer for approval prior to pipe installation.

1.05 DELIVERY, STORAGE AND HANDLING:

A. Handle in a manner to ensure installation in sound and undamaged condition.
   1. Do not drop or bump.
   2. Use slings, lifting lugs, hooks, and other devices designed to protect pipe, joint elements, linings, and coatings.
B. Ship, move, and store with provisions to prevent movement or shock contact with adjacent units.
C. Handle with equipment capable of work with adequate factor of safety against overturning or other unsafe procedures.
D. If any defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe by the Supplier, at the Supplier’s own expense. All pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until they are put into service.
E. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps in place through shipping, storage, and handling to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.
F. Where possible, store pipe, fittings, and equipment inside and protected from weather. Where necessary to store outside, elevate well above grade and enclose with durable waterproof wrapping. Protect material not suitable for outdoor storage to prevent damage during periods of inclement weather, including subfreezing temperature, precipitation, and high winds. Store materials susceptible to deterioration by direct sunlight under cover and avoid damage due to high temperatures. Do not store materials directly on the ground.
G. If special precautions are required, prominently and legibly stencil instructions for such precautions on outside of equipment or its crating.
H. Protect all material from dirt and dust, or other contaminants.
I. Handle equipment in such a manner as to ensure delivery to final location in sound, undamaged condition. Make satisfactory repairs to damaged material(s) at no cost to Owner.
J. Carry and do not drag materials.
K. Inspect materials delivered to site for damage; unload and store with minimum handling.

L. Prevent contact with adjacent units during shipping, moving, and storage.
M. Block the ends of all pipe and accessories stored outdoors at least 6 inches above the ground.

PART 2 - PRODUCTS Specified in respective Sections, this Division.

PART 3 - EXECUTION

3.01 INSTALLATION - GENERAL:

A. Use equipment, methods, and materials ensuring installation to lines and grades indicated.
   1. Maintain within tolerances specified or acceptable laying schedule.
      a. Alignment: +/- 1 inch per 100 feet in open cut or tunnel.
      b. Grade: +/- 1 inch per 100 feet.
   2. Do not lay on blocks unless pipe is to receive total concrete encasement.
   3. Accomplish horizontal and vertical curve alignments with bends, bevels, and joint deflections.
      a. Limit joint deflection in DIP pipe to:
         (1) 5% with mechanical joint or 75% of the manufacturer's allowable, whichever is more stringent.
         (2) 3% with bell and spigot-rubber gasket joint 75% of the manufacturer's allowable, whichever is more stringent.
      b. Limit joint deflection in PVC pipe to:
         (1) 3% with mechanical joint or 75% of the manufacturer's allowable, whichever is more stringent.
         (2) 0.5% with bell and spigot-rubber gasket joint or 75% of the manufacturer's allowable, whichever is more stringent.
      c. Use short specials preceding curves as required.
   4. Obtain acceptance of method proposed for transfer of line and grade from control to the Work.
B. Install pipe of size, materials, strength class, and joint type with embedment indicated for plan location.
C. Insofar as possible, commence laying at downstream end of line and install pipe with bell ends in direction of laying. Obtain Engineer approval for deviations therefrom.
D. Clean interior of all pipe, fittings, and joints prior to installation. Exclude entrance of foreign matter during installation and at discontinuance of installation.
   1. Close open ends of pipe with snug-fitting closures.
   2. Do not let water fill trench. Include provisions to prevent flotation should water control measures prove inadequate.
   3. Remove water, sand, mud, and other undesirable materials from trench before removal of end cap.
E. Brace or anchor as required to prevent displacement after establishing final position.
F. Perform only when weather and trench conditions are suitable. Do not lay in water.
G. Observe extra precaution when hazardous atmospheres might be encountered.
H. All field joints shall be inspected prior to backfilling.
I. Utilize anti-seize lubricant during bolt installation to prevent galling.
J. The Contractor shall coordinate to ensure that all pipe, fittings, and supports are in accordance with the specifications and ensure that all pipe and fittings are installed true to grade and alignment and pipe anchorage and/or restraint shall be provided where required.
K. To assemble the joints in the field, thoroughly clean all joint surfaces and gaskets, if any, with soapy water before assembly. Bolts shall be tightened alternately, evenly to the manufacturer's

specified torques. Under no condition shall extension wrenches or pipe-over-handle ratchet wrenches be used to secure greater leverage. All electrical bonding or insulation shall be installed as joints are made up.

3.02 EXCAVATION, BEDDING AND BACKFILL:

A. Conform to Section 31 23 33 and as follows:
   1. Limit trench excavation ahead of last pipe installed to not more than 50 feet.
   2. Over-excavate unsuitable material as determined by Engineer and backfill to bottom of bedding grade with approved compacted material, at no additional expense to Owner.
   3. Maintain trenches in a dewatered condition from start of trench to completed backfill.
   4. Use, install, and remove sheeting as specified in Section 31 23 33.
   5. Backfill all pipe installations promptly after receiving Engineer's approval to do so and prior to specified hydrostatic or air tests. Engineer's approval to backfill includes, but is not limited to, satisfactory joint tests as specified, and holiday detection tests on coated pipe and joints.
   6. Limit open trench behind pipe installation to not more than 50 feet.
   7. Ensure that the embedment material is carefully worked and compacted under the haunches of the pipe.
   8. Backfill and compact by hand in a single 6-inch layer to a point 6-inches above the top of pipe. At Contractor's option, embedment material may be substituted for backfill to a point 6-inches above the top of pipe. Backfill and compaction shall conform to Division 31 requirements.
   9. Place remainder of backfill and compact as specified in Division 31.
   10. During compaction, take care to prevent direct contact with the pipe by tools or mechanical equipment and avoid impacting or deflecting the pipe by placement of compaction equipment directly over the pipe.
   11. Perform all Work under and adjacent to buildings as specified in Division 01.
   12. Take special care when performing Work immediately adjacent to existing structures and facilities. Structures and facilities damaged by Contractor's operations shall be repaired or replaced by Contractor at no cost to Owner.
   13. Provide marking protection for all underground piping.

3.03 JOINTING:

A. General Requirements:
   1. Locate joint to provide for differential movement at changes in type of pipe embedment, impervious trench checks, and structures.
      a. Not more than 8 inches from structure wall, or
      b. Support pipe from wall to first joint with concrete cradle structurally continuous with base slab or footing.
   2. Perform conforming to manufacturer's recommendations.
   3. Clean and lubricate all joint and gasket surfaces with lubricant recommended.
   4. Use methods and equipment capable of fully seating or making up joints without damage.
   5. Check joint opening and deflection for specification limits.

B. Special Provisions for Jointing Ductile-Iron Pipe:
   1. Conform to AWWA C600.
      a. Check for cracks invisible to the eye prior to installation.

C. Special Provisions for Jointing Steel Pressure Pipe:
   1. Conform to AWWA M11.

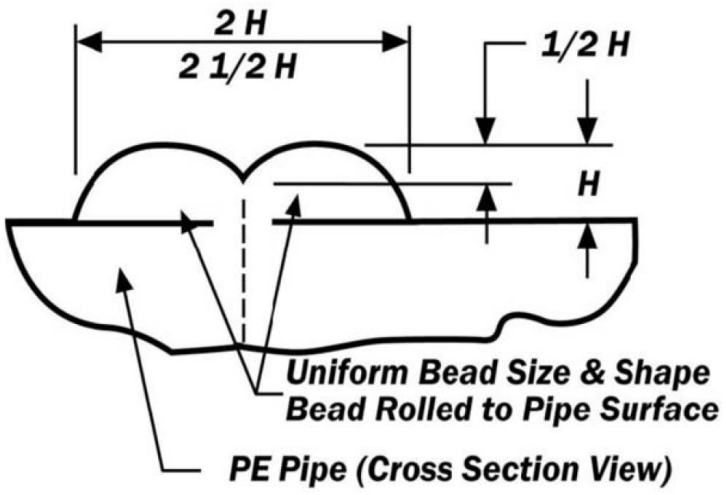
2. Check for holidays in coating and make repairs as required.
3. Weld pipe and fittings to conform to AWWA C206.
4. Grout inside joints of welded pipe and fittings mortar lined conforming to AWWA C205 and AWWA C602
5. Apply epoxy coating to inside of welded joints in pipe 24 inches and larger.
6. Repair polyurethane coatings where held back or damaged during welding. Install per AWWA C222.

D. Special Provisions for Jointing PVC Pipe:
1. Pressure pipe installation shall conform to AWWA C605 and AWWA M23.
2. Excavate bell holes at each joint or coupling to provide full length barrel support of the pipe and to prevent point loading at the bells or couplings.
3. Connect pipe to new or existing rigid structures with solid sleeve couplings.

E. Special Provisions for Jointing HDPE Pipe:
1. Fused pipe shall be handled in a safe and non-destructive manner before, during, and after the fusion process and in accordance with this specification and pipe manufacturer's guidelines.
2. Pipe welds shall not be cooled using air cooled or air assisted equipment.
   a. Fastfusion® is strictly prohibited.
   b. Fused pipe shall be allowed to cool using only ambient air temperatures.
3. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine.
4. Only appropriately sized and outfitted butt fusion machines that have been approved by the pipe manufacturer shall be used for the fusion process. Fusion machines must incorporate the following elements:
   a. Heat Plate – Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines. The heat plate shall be capable of maintaining a surface temperature between 400 to 450 degrees F.
   b. Power – Must be self-generated or generator supplied for electrical requirements.
   c. Clamping – Shall be able to clamp the pipe axially to allow for subsequent operations to take place.
   d. Carriage – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
   e. Facer – the unit shall have a facer to establish clean, parallel mating surfaces, perpendicular to the centerline of each pipe. Facing blades specifically designed for cutting fused HDPE pipe shall be used.
   f. General Machine – Overview of machine body shall yield no obvious defects, missing parts, leaks of hydraulic system, or potential safety issues during fusion.
   g. Data Logging Device – An HDPE pipe supplier and Contractor approved datalogging device with the current version of the pipe manufacturer's recommended and compatible software shall be used. Datalogging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
5. Other equipment specifically required for the fusion process shall include the following:

a. Pipe rollers shall be used for support of pipe to either side of the machine
b. Pipe cleaning solvent shall be accessible and used by the fusion crews at every joint. No oil or grease residue shall be present at the time of fusing.
c. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe manufacturer's recommendations.
d. Pipe rollers do need to be used for transporting the pipe unless there is risk of excessive/serious damage to the pipe.
e. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
f. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

6. On both sides of the joint, a double bead should be rolled over to the surface, and be uniformly rounded and consistent in size all around the joint. The double bead width should be 2 to 2-1/2 times its height above the surface, and the v-groove depth between the beads should not be more than half the bead height. Figure below illustrates the requirements.



7. Un-acceptable joints shall be completely removed and replaced.
   a. Un-acceptable joints include any of the following:
      (1) Visually un-acceptable joints as determined by Contractor and/or pipe manufacturer.
      (2) Joints determined to be out of manufacturer's specifications as measured in the field or collected by the fusion data logger.
      (3) Joints not recorded by the data logger.
      (4) Joints not visually inspected by the Contractor.

3.04 CUTTING:

A. Cut in neat manner without damage to pipe.
B. Observe Specifications regarding joint locations.
C. Cut cast-iron, ductile-iron, and steel pipe with carborundum saw or other acceptable method per manufacturer's instructions.
   1. Smooth cut by power grinding to remove burrs and sharp edges.
   2. Repair lining as required and approved.

3.05 CLOSURE PIECES:

A. Connect two segments of pipeline or a pipeline segment and existing structure with short sections of pipe fabricated for the purpose.
B. Observe Specifications regarding location of joints, type of joints, and pipe materials and strength classifications.
C. Field-fabricated closures, where required, shall be concrete encased between adjacent flexible joints.
D. May be accomplished with sleeve coupling:
    1. Of length such that gaskets are not less than 3 inches from pipe ends.

3.06 TEMPORARY PLUGS:

A. Plugs:
    1. Test plugs as manufactured by pipe supplier.
    2. Fabricated by Contractor of substantial construction.
    3. Watertight against heads up to 20 feet of water.
    4. Secured in place in a manner to facilitate removal when required to connect pipe.

3.07 COATING AND LINING REPAIR FOR INTERIOR STEEL OR DUCTILE IRON PIPE:

A. Repair coated steel or ductile iron pipe as indicated:
    1. At the coating plant (epoxy).
        a. Conform to AWWA C222.
        b. Test repaired area with a holiday tester. All holidays shall be repaired.
        c. Interior or pipe shall be electrically inspected for continuity at 2100 volts prior to exterior coating. If the number of holidays exceeds one per 3 linear feet of pipe 20 inches O.D. or smaller, or one per 2 linear feet of pipe over 20 inches O.D., the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in shop according to Subsection 3.4 – Coating Repair of the ANSI/AWWA 213 specifications.
        d. Exterior of pipe shall be electrically inspected for continuity at 1965 volts. If the number of holidays exceeds one per 3 linear feet of pipe length for pipe smaller than 14 inches O.D., or one per 25 square feet of surface area for pipe 14 inches in O.D. and larger, the pipe shall be reprocessed. If not reprocessed, all defects disclosed by the holiday detector shall be repaired in shop according to Subsection 3.4 – Coating Repair of the ANSI/AWWA 213 specifications.
        e. In addition to the above requirements, check for coating defects on the weld seam centerlines. There shall be no porous blisters, craters, or pimples lying along the peak of the weld crown.
    2. In the field (liquid epoxy).
        a. Conform to AWWA C222.
        b. Test repaired area with a holiday tester. All holidays shall be repaired.
        c. Holidays, scratches and damages areas incurred while polyurethane field coatings shall be patched per the coating manufacturer's recommendations. Lightly abrade or sandblast the lining or coating on the sides of the damaged area before applying the coating. Patched areas shall overlap the parent or base coating a minimum of at least one inch in all directions. If a damaged area exceeds 20 square inches, the entire lining and coating shall be removed and the entire piece of pipe shall be recoated and retested.
        d. All exterior surface coatings shall be inspected electrically, following the same requirements for factory inspection procedure and voltage indicated above.

3.08 POLYETHYLENE ENCASEMENT:

A. Installation:
   1. Perform to conform to AWWA C105.
   2. Use adhesive tape to fasten polyethylene film in place.
   3. Minimize exposure of polyethylene film to sunlight.
   4. Wrap pipe, valves, fittings, and couplings per AWWA C105 installation standards.

3.09 CONNECTION TO EXISTING SYSTEM:

A. At locations where connections to existing waterlines are to be installed, the Contractor shall locate the existing lines both vertically and horizontally and verify their exact size and material in advance of the time scheduled for making the connections.

B. Prior to connecting to existing water mains, the Contractor shall measure the existing pipe for 'roundness'. If the pipe is determined to be 'out of round', Contractor to coordinate construction with Engineer before connecting.

C. Prior to connecting to existing water mains, the Contractor shall have all personnel, materials, and equipment ready to connect the fitting to the existing main, so as to keep the shutoff time to a minimum. As soon as possible after making the connections, the Contractor shall flush the connection so as to prevent contamination of the existing facilities. The Contractor shall take every precaution necessary to prevent dirt or debris from entering the main.

D. Connections to the existing water system shall be completed in a neat and workmanlike manner. The Owner and Engineer shall be notified at least forty-eight (48) hours in advance and be present at all times during the Construction of the connection. The connection is subject to approval by the Owner or Engineer. Under NO circumstances shall a non-disinfected main, which cannot be isolated, be connected to an existing disinfected main.

E. The City does not guarantee the water tightness of its valves on existing facilities. If existing valves leak, the Contractor must use methods at his own disposal, to dewater the trench and complete any required testing or disinfection of the waterline.

F. All connections shall be valved to separate new construction from the existing system. Valves shall be kept closed until acceptance of the new system

3.10 FIELD TESTING:

A. Testing shall be performed on all pipelines in SECTION 33 11 00 and in SECTION 33 11 50.
   1. Acceptance Tests for Potable Pressure Pipelines:
      a. Perform disinfection process and high chlorine testing (as required)
      b. Perform hydrostatic pressure and leakage testing
      c. Perform flushing and pass bacteriological and turbidity "clear water" testing (as required).
   2. Acceptance Tests for Gravity Pipelines:
      a. Perform Low Pressure Leakage Test.

B. Disinfection and High Chlorine Testing for Waterlines:
   1. All forward-flow process piping and waterlines shall be disinfected and tested.
   2. Contractor shall provide all equipment and materials and perform conforming to AWWA C651.
      a. As modified herein.
      b. At no additional cost to Owner.
      c. Include preliminary flushing, chlorination, and final flushing.
   3. Obtain approval of materials and acceptance of methods proposed for use.
   4. May be conducted in conjunction with acceptance tests.
   5. Owner will coordinate sampling and laboratory testing.

6. At minimum initial dosage of 50 mg/L (ppm) in all portions of the line.
    a. Allow to stand for a minimum of 24 hours.
    b. Minimum residual after required contact time shall be at least 50 mg/L (ppm) at all tested locations.
    c. Flush pipeline before use for potable water supply purposes. Dispose of final flushing water without damage to public or private property.
7. Repeat disinfection procedure should initial treatment fail to yield satisfactory results.
    a. At no additional cost to Owner.
8. Minimum preliminary flushing rates to produce 2.5 fps velocity in main.
    a. Valve hydrant outlet to control flow. With 40 psi pressure in the main with the hydrant flowing to atmosphere, a 2-1/2-inch hydrant outlet will discharge approximately 1,000 gpm and a 4-1/2-inch hydrant outlet will discharge approximately 2,500 gpm.
    b. Dispose of preliminary flushing water without damage to public or private property.
        (1) The discharge of flushed water shall be accomplished such that no erosion will occur and with no harm to fish, animals, or plants. Procedures for discharge will be subject to review by the Owner and Engineer.

C. Hydrostatic Pressure Test for Pressure Pipelines:
1. Contractor shall provide all equipment and materials and perform conforming to AWWA C600 procedures.
    a. As modified herein.
    b. At no additional cost to Owner.
2. Test pressure shall not be less than 1.50 times the working pressure at the highest point along the test section and,
3. Be at least 2-hour duration. Maintain pressure throughout test $\pm$5 psi of test pressure.
4. Leakage test shall be conducted concurrently with the pressure test.
    a. Acceptable when leakage does not exceed that determined by the following formula:

$$L = \frac{S*D*\sqrt{P}}{148{,}000}$$

L = Allowable Leakage in gallons per hour
S = Length of pipe tested, in feet
D = Nominal diameter of pipe, in inches
P = Average test pressure during the hydrostatic test, in PSI:

    b. When testing against existing closed valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed.
5. When hydrants are in the test section, the test shall be made against the main valve in the hydrant.
6. Repeat test as necessary.
    a. After location of leaks and repair or replacement of defective joints, pipe, fittings, valves or hydrants. All visible leaks are to be repaired regardless of the amount of leakage.
    b. Until satisfactory performance of test.
7. Resident Field Representative will witness pressure and leakage test.

D. Bacteriological and Turbidity Testing:

1. Before placing into service, water from all new mains must successfully pass a bacteriological and turbidity test in accordance with the requirements of the Owner before the main is placed in service.
    a. Owner will coordinate sampling and laboratory testing.
        (1) A minimum 24 hours is required to receive bacteriological test results and may take as long as 72 hours.
    b. When unsatisfactory results are obtained from bacteriological tests, the Owner may direct the contractor to rechlorinate the main.
        (1) When rechlorination is deemed necessary, it will be done by the contractor, at his expense.
        (2) After rechlorination, the bacteriological test shall be performed again and the procedure repeated until the test passes.
    c. Repeat pipeline acceptance testing as necessary.
        (1) Until satisfactory performance of test.

E. Flushing:
1. See Section 433.13 of the City and County of Broomfield's Standards and Specifications.
2. The entire line shall be flushed after the specified disinfection contact time, and after passing the disinfection test.
    a. The entire line, including hydrant leads, branch lines, and dead-end mains shall be flushed.
3. Such flushing shall continue until the water is clear and meets the chlorine content of the existing line.
4. Flushing rates to produce a min. of 2.5 fps in main shall be achieved as recommended by AWWA C651. Flushing rates shall be maintained to a maximum velocity that will not damage interior lining systems and at no time shall exceed 10 fps.
    a. Valve hydrant outlet to control flow. With a 40 psi pressure in the main with the hydrant flowing to atmosphere, a 2-1/2-inch hydrant outlet will discharge approximately 1,000 gpm and a 4-1/2-inch hydrant outlet will discharge approximately 2,500 gpm.
    b. Contractor shall provide a means for measuring flushing rates and flushing volumes that is subject to review and acceptance of the Engineer and City Project Manager.
5. Dispose of preliminary flushing water without damage to public or private property.
    a. Contractor shall be responsible for all necessary temporary piping, valving, metering, holding tanks, etc. that may be required to facilitate flushing activities.
    b. The discharge of flushed water shall be accomplished such that no erosion will occur and with no harm to fish, animals, or plants. Procedures for discharge will be subject to the review by the Owner and Engineer.

3.11 FIELD PAINTING:

A. Specified in SECTION 09 90 00.

3.12 TRACER WIRE:

A. See Section 432.00 of the City and County of Broomfield's Standards and Specifications.
B. A six (6) inch wide detectable warning tape shall be installed above all pipe for the purpose of warning of location of buried pipeline.
C. A No. 6 AWG solid, uninsulated copper wire shall be attached to all pipes, including at least one carrier pipe inside a casing pipe, for the purpose of future location. If tracer wire is not attached to a carrier pipe, it may be cad-welded to both ends of a casing pipe and terminated in

test stations within ten (10) horizontal feet from the ends of the casing pipe. Brundy KS17 copper split connectors, or equal, shall be used.

D. For domestic water lines, tracer wire shall be run along each fire hydrant assembly and brought to the surface in a test station located behind the fire hydrant. No tracer wire shall be allowed in valve boxes.

E. Test stations shall be CP Test Services, Glenn Series Glenn-4 with locking lid, 3 1⁄2" x 4", or approved equal. For non-potable water lines, the tracer wire shall run along the outside of the in-line valve box, and through a hole drilled into the side of the triangle valve box with the wire then extended up to the surface. In all air-vac manholes, tracer wire shall run up the stairs to the surface.

END OF SECTION 33 31 50

SECTION 33 41 00 – STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes storm drainage culvert pipe material and installation.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. Section 31 20 00 – Site Preparation and Earthwork
B. Section 31 23 33 – Trenching and Backfill for Utilities

1.03 REFERENCES:

A. Applicable Standards:
   1. American Society for Testing and Materials (ASTM):
      a. C14 - Concrete Sewer, Storm Drain, and Culvert Pipe.
      b. C270 - Mortar for Unit Masonry.
      c. C478 - Precast Reinforced Concrete Manhole Sections.
      d. C506 - Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe.
      e. D2321 - Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
      f. D2729 - Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
      g. D3034 - Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. M36 - Zinc Coated (Galvanized) Corrugated Iron or Steel Culverts and Underdrains.
      b. M190 - Bituminous Coated Corrugated Metal Culvert Pipe and Arches.
      c. M252 - Plastic and Polyethylene Corrugated Drainage Pipe or Tubing.
   3. State of Colorado Department of Transportation (CDOT)
      a. Standard Specifications for Road and Bridge Construction

1.04 SUBMITTALS:

A. Tests to determine conformance with all requirements of this Specification for quality and properties of all Contractor-secured materials, shall be performed by an independent commercial laboratory retained and compensated by CONTRACTOR, and approved by ENGINEER.
B. When incorporating materials into the Work, quality control testing will be performed during construction by a testing laboratory retained and compensated by OWNER.
C. Copies of reports and certificates regarding tests and inspection of equipment, materials, and completed Work shall be distributed as specified in Division 01. Furnish specific schedule for sampling to provide ENGINEER with the opportunity to observe sampling.

PART 2 - PRODUCTS

2.01 REINFORCED CONCRETE PIPE (RCP) AND END SECTIONS:

A. RCP and end sections for use as storm drain culverts shall meet the requirements of Section 706.02 of the CDOT Standard Specifications for Road and Bridge Construction.
   1. Pipe shall be of nominal size as indicated on the drawings.
   2. Pipe shall be a minimum B wall, Class III.
   3. Joints shall be rubber gasket type conforming to ASTM C443.

2.02 UNDERDRAIN PIPES AND FITTINGS:

A. Perforated, PVC Sewer Pipe and Fittings: ASTM D2729, bell-and-spigot ends, for loose joints.

2.03 CLEANOUTS:

A. PVC Pipe: ASTM D3034, PVC cleanout threaded plug and threaded pipe hub.

2.04 GEOTEXTILE FILTER FABRICS:

A. Woven or nonwoven geotextile filter fabric, Mirafi 140N or the equivalent.

2.05 FILTER MATERIAL:

A. Filter material for placement under void forms shall meet the requirements of Class B Gradation in Section 703.09 of the CDOT Standard Specifications for Road and Bridge Construction.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform general earthwork to achieve lines and grades shown on contract drawings in accordance with Section 31 20 00 – Site Preparation and Earthwork.

B. Perform trench excavation for culvert and underdrain in accordance with Section 31 23 33 Trenching and Backfilling for Utilities:

3.02 UNDERDRAIN INSTALLATION:

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
   1. Foundation Subdrainage: Install piping pitched down in direction of flow, at the slope indicated on the contract drawings.
   2. Lay perforated pipe with perforations down.
   3. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PVC piping according to ASTM D2321.

3.03 UNDERDRAIN CLEANOUT INSTALLATION:

A. Install cleanouts from subdrainage piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.

B. In nonvehicular-traffic areas, use NPS 4 (DN 100) PVC pipe and fittings for subdrainage piping branch fittings and riser extensions to cleanout plug. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches (300 by 300 by 100 mm) in depth. Set top of cleanout plug 1 inch (25 mm) above grade.

3.04 UNDERDRAIN CONNECTIONS:

A. Connect subdrainage system to building downspouts. Drawings indicate general arrangement of piping and connections.

3.05 RCP CULVERT INSTALLATION:

A. Perform pipe placing and jointing to conform to pipe manufacturer's recommendations.

B. Install culvert and end section in accordance with Section 603 of CDOT Standard Specifications for Road and Bridge Construction.

END OF SECTION 33 41 00

DIVISION 40 – PROCESS INTEGRATION

SECTION 40 60 00 – PROCESS CONTROL AND INSTRUMENTATION – GENERAL REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

A. This Division includes instruments, control devices, control panels, computer hardware and system programming as specified in SECTIONS 40 60 00 – 40 70 00.

1.03 RELATED REQUIREMENTS:

A. SECTION 01 33 00 – Submittals.
B. SECTION 01 40 00 – Contractor QA/QC.
C. SECTION 01 42 00 – Definitions and Standards.
D. DIVISION 26 – Electrical.
E. DIVISION 33 – Utilities.
F. SECTION 41 22 00 – Cranes and Hoists
G. DIVISION 46 – Water and Wastewater Equipment.

1.04 REFERENCE STANDARDS:

A. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC).
B. Other standards as specified in applicable Sections.

1.05 DEFINITIONS

A. HMI – Human Machine Interface
B. OIT – Operator Interface Terminal
C. PLC – Programmable Logic Controller
D. PSC – Process Control System

1.06 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.
B. Product Data: Submit for each type of product specified and include the following as minimum:
   1. Device list and bills of material.
   2. Data sheets for all hardware and software.
   3. Description of operation for control Equipment.
C. As-Built Drawings:
   1. Upon completion of the project, submit final revised interconnect wiring diagrams in PDF format. Additionally, provide interconnect wiring diagrams in AutoCAD format on DVD-ROM.
D. Qualifications Submittal:
   1. Submit SI qualifications package with experience, resumes, and certifications for each member of the SI team responsible for the project.
E. Additional submittals as specified in each applicable Section, this Division.

1.07 QUALITY ASSURANCE:

A. General:

1. The Contractor shall provide the services of a single pre-approved System Integrator (SI), to provide the material, equipment, labor, and services specified in Sections 40 60 00 – 40 70 00. The SI shall be subcontracted and under the direct supervision of the Contractor.
   a. Pre-Approved System Integrator: Browns Hill

1.08 SEQUENCING AND SCHEDULING:

A. Coordinate the installation of Equipment and Materials specified in this Division with construction schedule.

1.09 PROJECT SITE CONDITIONS:

A. Altitude = 5500 feet above mean sea level.
B. Minimum and maximum outdoor ambient temperature range = -20 ºF - 105ºF.
C. Minimum and maximum indoor non-conditioned temperature range = 50ºF - 110ºF.
D. Minimum and maximum indoor conditioned temperature range = 50ºF - 85ºF.
E. Maximum Outdoor Relative Humidity = 100%.
F. Seismic Factors: Refer to Structural.

1.10 WARRANTY:

A. Provide a minimum one-year warranty on all equipment and systems provided. Warranty period shall begin after Final Acceptance unless specified otherwise. Provide written notification prior to this warranty start date.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Products as specified in Sections 40 60 00 – 40 70 00.

2.02 INTERCONNECT WIRING DIAGRAMS

A. SI is responsible for providing interconnect wiring diagrams for all process systems included on the project, including vendor provided equipment packages so there is a single set of documents produced with consistency.

1. Interconnect wiring diagrams are to include power, controls (analog and discrete), digital and network connections (Ethernet, RS-485, etc.) differentiating clearly between manufacturer-installed and field-installed wiring.
2. All equipment is to be labeled using equipment tagging/IDs identified on the Contract Drawings.
3. All wires are to indicate wire ID numbers indicated for field labeling. Refer to SECTION 26 05 53 - Identification for Electrical Systems.
4. Wire colors are to be consistently identified on or near the wiring terminals on one end of the wire.
5. Clearly identify shielded wires and proper ground locations.
6. Clearly identify wires that are part of cable assemblies.

2.03 MOBILE WORKSTATIONS (LAPTOPS):

A. The specifications below are intended for the Treatment Plant Construction Contract System Integrator.

B. The processor shall be an 12th generation Intel Core i7 processor (8-efficient cores 3.6GHz, and 6-Performance cores 4.8GHz) or AMD equivalent mobile processor, minimum specs. Processor shall have a minimum of 24.0 MB (megabytes) total cache. Processor power shall have a max TDP (total dissipated power) of 64W.

C. Provide 32.0 GB (gigabytes), minimum, of LPDDR5 RAM (5200MHz).

D. Provide with integral keyboard and touchpad.

E. Provide with an internal 10/100/1000 Base-T network interface card.

F. Provide with a dual band wireless network card. Shall support the 802.11a/b/g/n standards.

G. Shall contain an integrated graphics processor with a minimum of 1.0 GB (gigabytes) of dedicated video memory. It shall provide high resolution graphics with a minimum resolution of 1920 by 1200 at 16.7 million colors.

H. The display shall have a minimum of 14-inch widescreen (16:9) viewable area and support a minimum resolution of 1920 by 1200 at 60 hertz. Touch LCD screen shall be LED back-lit.

I. Provide a 1 TB SSD M.2 2280 PCIe internal drive.

J. Provide an external USB DVD+/-RW optical drive to meet the following requirements:
   1. A minimum read speed of 48x/16x (CD/DVD).
   2. A minimum write speed of 48/24x (CD/DVD).
   3. A minimum rewrite speed of 32x/6x (CD/DVD).
   4. Cache size of 2 Mbyte minimum.
   5. Support both single- and double-layer disks.
   6. Software required for proper operation.

K. External ports shall include the following as minimum:
   1. Two (2) USB 3.0 ports and two (2) USB 2.0 ports.
   2. HDMI and/or DisplayPort for external monitor connection.
   3. Headphones/Speaker/Microphone/Line-in.
   4. RJ-45 Ethernet
   5. SD card reader suitable for flash memory cards (i.e. SD, MMC, xD, etc.).

L. Accessories:
   1. Provide a carrying case designed to fit the laptop unit and accessories provided.
   2. Provide a Bluetooth 5.0LE wireless mouse with USB “nano” transceiver. Mouse shall be three button, minimum, with scroll wheel.

M. Software:
   1. Provide a new copy of Microsoft Windows 11 Professional Edition for each laptop and workstation.
      a. The Operating System shall have the latest service packs and patches required for proper operation of the workstation and control software. Provide the OS installation media (DVD, etc) with associated license documentation as part of the workstation package.
      b. Configure the Operating System to allow all control software full access to communication ports as required.
      c. The PC shall have a clean install of the operating system and essential hardware drivers and software only. Non-essential applications, such as manufacturer provided trial software and utilities, shall not be loaded on the system.
   2. Provide a copy of the latest version of Microsoft Office Professional (including Microsoft Word, Excel, and Access) for each PC workstation.

3. Provide and install the latest edition of Adobe Acrobat Professional.
4. Provide integrated firewall, virus, spyware, and malicious software protection in accordance with NIST Special Publication 800-83 and based on the NIST report "Guidance and Performance Impact Testing to Support the use of Antivirus Software on SCADA and Industrial Control Systems."
    a. Coordinate with control system manufacturer for tested and recommended anti-virus software and setup.
5. All software shall be licensed to the City.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment and systems specified in this Division.

3.02 RADIO PATH SURVEY

A. Contractor to work with City of Broomfield to determine exact location of receiving equipment and perform radio path analysis to determine direction and height of radio antenna equipment.

3.03 INSTALLATION:

A. System Integrator shall be responsible for all cabling terminations at instruments, control panels and devices supplied by the System Integrator.
B. Refer to Section 26 05 19 – Low Voltage Cable for additional cable termination requirements.

3.04 FIELD QUALITY CONTROL:

A. Manufacturer's field services:
    1. As specified in each applicable Section, this Division.
B. Field Testing:
    1. General Requirements:
        a. Conform to requirements as specified in Division 01.
        b. Conduct all tests in the presence of Engineer under the supervision of Equipment manufacturer's field engineer.
        c. Notify Engineer two weeks prior to the commencement of all tests.
        d. Include all tests recommended by the Equipment manufacturer unless specifically waived by Engineer.
        e. Include all additional tests recommended by Engineer that he deems necessary because of field conditions, to determine that Equipment and Materials and systems meet requirements of Contract Documents.
        f. Be responsible for all damage to Equipment and Materials due to improper test procedures or test apparatus handling.
    2. Test Reports:
        a. Submit test reports as specified in Division 01.
        b. Maintain a written record of all tests showing date, personnel making tests, equipment or material tested, tests performed, and results.

3.05 TRAINING:

A. The System Integrator shall provide formal training for operators, maintenance and service personnel.

B. A training schedule and log shall be developed. The training schedule shall identify scheduled dates and times for all training sessions specified in this Division. The training log shall identify dates for training and record training session attendees.
C. Training sessions shall be scheduled with the Owner a minimum of two weeks prior to occurrence and a training schedule shall be maintained and communicated to the Owner on a routine basis.
D. Contractor shall make digital video recordings of all on-Site training for training purposes. Any charges for this video recording shall be included.
E. Provide training as specified in each applicable Section, this Division.

END OF SECTION 40 60 00

SECTION 40 61 96 – PROCESS CONTROL SYSTEM PROGRAMMING AND REPORTS

PART 1 - GENERAL

1.01 SUMMARY:

A. This section includes PCS (process control system) programing requirements. This section includes but is not limited to the following:
   1. PLC Programing Software.
   2. OIT Programing Software.
   3. License requirements.
   4. Graphics requirements.

B. This Section includes control descriptions and requirements for the PLC and control system software programming.

C. Make the PCS work together as a whole complete system. Including PLC logic, HMI graphics, OIT programming, motor controllers, networking and control system programming.

D. Programing shall be performed based on the control system manufacturer enterprise software with common libraries programing blocks symbols and alarm interface.

E. Related Work Specified Elsewhere:
   1. Section 40 60 00 - Process Control and Instrumentation General Requirements
   2. Section 40 66 00 - Process Control Networks
   3. Section 40 67 00 - Process Control Panels and Hardware
   4. Section 40 68 00 - Process Control Software
   5. Section 40 70 00 - Instrumentation for Process Systems

1.02 RELATED REQUIREMENTS:

A. Section 40 60 00 – Process Control and instrumentation General Requirements
B. Section 40 66 00 – Network and Communications Equipment.
C. Section 40 67 00 – Process Control Panels and Hardware.
D. Section 40 70 00 – Instrumentation for Process Systems.

1.03 REFERENCE STANDARDS:

A. International Society of Automation (ISA).
   1. 101.01 – Human Machine Interfaces for Process Automation Systems.

1.04 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.

B. Product Data: Submit for each type of product specified and included the following as minimum:
   1. A complete listing of all proposed HMI/OIT graphics and the corresponding points and parameters displayed.
   2. Proposed standard HMI and PLC objects for the project (i.e. pump control, etc.). Inputs and outputs developed for each object shall be identified.
   3. Submit a minimum of two electronic sample graphic screens developed for similar projects.

C. Shop drawings:
   1. A functional description of how the equipment should be controlled and operated. Include a list of parameters with setpoints to be monitored, controlled and alarmed.
   2. Power Failure and Restoration programing:
      a. Provide a complete description of the power failure and restoration mode programming.

3. Complete list of IP Addresses for all network connected devices.
4. Submit as delivered onsite (post Factory acceptance test) for the entire system including:
    a. PLC Logic and database programing.
    b. HMI/OIT Graphics.
    c. HMI/OIT programing.
5. Submit as constructed (post Site Acceptance) for the entire system including:
    a. PLC Logic and database programing.
    b. HMI/OIT Graphics.
    c. HMI/OIT programing.

D. Maintenance Material Submittals:
1. Software:
    a. Assemble and submit all software and program copies in native format.

E. Closeout:
1. Provide final copy of all programs to Owner upon completion.

PART 2 - PRODUCTS

2.01 GENERAL:

A. Programing as indicated on the P&IDs and as specified in the Contractor-furnished equipment procurement packages.

PART 3 - EXECUTION

3.01 GENERAL:

A. The intent of the control system specified and indicated is to provide complete control and monitoring capabilities for the facility.
B. The PLCs shall be programmed to communicate the required data to the associated I/O servers via the communication network as required by the control system manufacturer.
C. HMI/OIT graphics and programing logic shall be developed for control interface and monitoring of the systems described.
D. All set points and time delays are initial values and shall be adjustable by the System Administrator through the Engineering interface not through the HMI/OIT graphics.
E. Coordinate with Suppliers for communication of specified points between the network servers and the manufacturer supplied PLC’s.
F. HMI/OIT graphics shall be developed to display status and provide control interfaces for the manufacturer supplied equipment.
G. Coordination with System Supplier’s:
1. Coordinate graphic layout, including screen titles, alarm symbols and locations, navigation buttons.
2. Coordinate standard equipment control logic for each type of equipment in order for the whole control system to share the same typical graphics, faceplates, symbols, and function blocks, including status and indication for:
    a. Manual and auto modes.
    b. Hand-Off-Auto Status.
    c. Manual start and stop commands.
    d. Auto starts and stop commands.
    e. Running, stopped and alarm states.
    f. Fail to start, fail to stop, permit to start and override stop states.

3. Coordinate standard valve control logic for each type of valve in order for the whole control system to share the same typical graphics, faceplates, symbols, and function blocks, including status and indication for:
    a. Manual and auto modes.
    b. Remote-Local Status.
    c. Manual open or close commands.
    d. Auto open and close commands.
    e. Opened, closed and alarm states.
    f. Fail to open, fail to close, permit to open/close and override open/close states.
4. Coordinate alarm management, priority and alarm protocol. Including:
    a. This shall include standard alarm level
5. Coordinate to ensure required control and monitoring signals are communicated correctly across the PCS network.
6. Motor controllers shall be connected to the PCS network as shown on the network diagram.
7. As a minimum the SI shall coordinate and lead two web conferences with system suppliers and the Contractor to determine programming standards, verify proper application of the standards and coordinate communicated signals.
    a. The first web conference shall occur one month after notice to proceed and before the system suppliers have started programming efforts, to layout the standard graphic layout requirements, equipment and valve control logic used in the PCS.
    b. The second web conference shall occur after initial screen and logic development and shall serve as a review meeting to verify that proper standards have been followed and proper points are being communicated.
    c. Follow-up conferences shall occur as required during development and after initial development is completed to ensure the agreed to standards are being followed, discuss progress, verify communicated points and address any outstanding communication questions.

3.02 HMI/OIT STANDARDS AND GRAPHIC DEVELOPMENT:

A. General:
1. Graphics shall be developed for control interface and monitoring of systems and facilities and related equipment.
2. Where possible, standard objects shall be developed and utilized throughout the project. Objects shall be developed for flexibility with nested blocks within blocks where necessary and with the worst-case scenario in mind to allow blocks to be adaptable throughout the project. Proposed blocks shall be submitted as specified.
3. All graphics shall be developed using graphics and icons from the manufacturer's enterprise software library when possible. The graphic displays shall be developed using design elements and concepts intended to enhance the operator's "Situational Awareness". The development, design, and implementation of the system displays shall comply with ISA 101.01 – Human Machine Interfaces for Process Automation Systems.
4. Graphics shall be developed based upon a 1920x1080 (16:9) ratio and shall allow for multi monitor display.
5. All graphics shall be developed with input from the Owner and Contractor and all graphics shall be approved by the Owner prior to startup of the system.
    a. The SI shall schedule necessary meetings with the Owner and Contractor to properly coordinate graphic development, layout, and other required Work to

ensure the developed graphics and systems best meet the needs and desires of the Owner for operating the facility.

6. All analog values shall be trended and recorded in the historical database.
7. Low, low-low, high and high-high and loss of signal alarm points shall be programmed and available to set for all analog points. The operators shall be able to set values for or disable the alarm points from the graphics. If alarm range settings are not provided the alarm settings shall be adjustable over the entire range of the associated the analog value.
8. A minimum of one decimal point of accuracy shall be provided for all analog points displayed on the HMI/OIT. Additional decimal places shall be provided where applicable.
9. All automatic control such as start/stop, speed control, flow control, and similar shall be programmed into the nearest local PLC processor. All manual controls such as start/stop, open/close, speed control, etc. shall be incorporated into the PLC programming and graphics as described this section.
10. For monitoring and alarming purposes, all manual controls such as start/stop, open/close, speed control, etc. shall be incorporated into the PLC programming and graphics as described this section.
11. Provide run time totalization for all equipment in the nearest local PLC processor and display the current value on the relevant graphic(s).

B. Security Access Levels:
   1. Provide at a minimum four levels of access to the control system:
      a. Guest Level: allows viewing of plant status but no control.
      b. Operator:
         (1) Password Protected.
         (2) In general, allows the operator control the process equipment within the designed and programmed ranges.
         (3) Allows for selection of operational modes.
         (4) Allows for starting and stopping of equipment
         (5) Adjustment of manual and automatic setpoints.
         (6) Allows printing of graphics.
      c. Supervisor:
         (1) Password Protected.
         (2) In general, allows programing updates to the graphics, and tunable logic settings to increase or decreases ranges, timers and default setpoints.
         (3) All functions of Operator Level.
         (4) Allows changes to be made to alarm setpoints, time delays and the ability to inhibit alarms.
         (5) Allows printing of control system programing.
      d. Administrator:
         (1) Password Protected.
         (2) In general allows full access for reprograming of the entire control system, including graphics, logics, I/O & alarm databases, historian management.
         (3) All functions of Supervisor Level.
         (4) Allows for adjustments to code and programing.

C. Hierarchy:
   1. Graphics shall be organized in a hierarchical manner and designed to allow efficient movement between each of the levels within the hierarchy. Each graphic shall also implement relational links between nodes of a specific process when applicable, e.g.

through process piping or flow interconnections. The relational links should allow the user to navigate the various graphics by following the process flow stream:

Level	Type	Description
1	Facility Overview	Provides an overview for the entire facility geographically and/or in process flow diagram format. Identifies major equipment, valves, abnormal status, and key process parameters for the facility.
	Alarm Summary	Identifies all top priority alarms, alarm history, and acknowledged status. Allows an administrator to inhibit or activate alarms
	Historical Trends	Displays of embedded or full-graphic trends.
2	Process Displays	Designed to be the primary operating display for normal operation and monitoring of a specific process. Includes equipment, associated status, alarm, and instrumentation.
3	System or Subsystem Detail Displays	Displays interfaces necessary for equipment control, indicators, switching, and setpoint adjustment (when applicable). Includes all associated status and alarm conditions for the equipment providing sufficient information for process diagnostics.
4	Diagnostic and Informational Displays	Provides operational procedures and/or help information such as interlocks and permissive information. Not intended for process or system control. Generally displayed in the form of faceplates or popups.

D. Presentation and Content:
   1. Coordinate the graphic layout and symbols philosophy of each graphic and review with the Suppliers, Owner and Contractor during the preliminary development phase.
   2. The presentation for each graphic shall be designed to maximize the user's ability to navigate, enter data, and monitor the associated information.
   3. All graphics shall include:
      a. A global navigation menu at the bottom of the graphic.
      b. Alarm indication in the upper right corner of the graphic with button or link to an alarm list.
      c. Graphic Title at the top of the graphic.
      d. Pull down menus, pop-up windows, buttons, following a standard template for the project.
   4. The graphics shall generally follow the process flow from left to right. If specific types of graphics benefit from a geographical layout (e.g. overview), exceptions shall be reviewed and approved by the Owner and Contractor.
   5. The graphics shall use standard library symbols to represent all major pieces of equipment at the facility (i.e. wet wells, storage basins, metering vaults, and lift station) as indicated on the P&IDs. The symbols shall be representative of the types of equipment and tanks, e.g. centrifugal pumps, vertical turbine pumps, progressive cavity, open basin vs covered etc.

6. Equipment not controlled through the control system, such as manual gates and valves, should be minimally shown and indicated as such.
7. Equipment shall indicate the equipment tag below each piece of equipment on the graphics, and the equipment description on each or the equipment's pop-up faceplate.
8. Vessels and similar tankage should be depicted in similar shape to their actual physical shape. Shapes should typically be two-dimensional, keeping details to a minimum. Size should reflect importance and/or be representative of the vessel physical size in relationship to other vessels shown within the display. Dynamic elements should be located within the vessel shapes such as embedded trends when process variables such as level, flow, or similar is being monitored for the associated vessel or pipe.
9. Protocol shall be established which animates alarms prior to being acknowledged and maintains alarm display until the alarm condition is removed or the alarm is inhibited. Alarms, alarm acknowledgement, and inhibits shall be recorded to an event log.
    a. An audit graphic shall be developed to allow a Supervisor or Administrator to view inhibited alarms and to inhibit nuisance alarms.

E. Display Elements and Color Conventions:
1. Colors shall be used to enhance the user's ability to recognize the importance of key information such as alarms and other abnormal conditions.
2. Color selection shall be used to distinguish the type of information being displayed with higher priority information being emphasized using the most noticeable colors.
3. Color shall be used conservatively and consistently throughout the displays.
4. Colors used for alarms shall not be used for any other purpose to ensure their meaning is strengthened.
5. Recommended colors have been identified in the table below for commonality between equipment manufacturer developers and SI. Red, Green and Blue (RGB) levels are provided in addition to the equivalent Hue, Saturation, and Luminance (HSL) values. These colors shall be used as a guide for developing all displays. Note that some colors may be listed but not utilized for the project. Additional colors may be used when in conformance with the design philosophy specified herein and approved by the Owner and Contractor.

Color	Red	Green	Blue	Hue (°)	Sat (%)	Lum (%)
Black	0	0	0	0	0	0
White	255	255	255	0	0	100
Light Gray	204	204	204	0	0	80
Gray	140	140	140	0	0	55
Dark Gray	76	76	76	0	0	30
Cyan	163	245	245	180	80	80
Dark Cyan	23	206	206	180	80	45
Green	132	191	64	88	50	50
Light Green	181	217	140	88	50	70
Dark Green	79	115	38	88	50	30
Brown	115	84	38	36	50	30
Light Brown	204	163	102	36	50	60
Magenta	255	0	255	300	100	50

Color	Red	Green	Blue	Hue (°)	Sat (%)	Lum (%)
Light Magenta	255	179	255	300	100	85
Dark Magenta	128	0	128	300	100	25
Red	223	32	32	360	75	50
Light Red	242	166	166	360	75	80
Yellow	242	242	13	60	90	50
Light Yellow	251	251	182	60	90	85
Orange	242	128	13	30	90	50
Light Orange	247	179	110	30	90	70

6. Static Display Elements:
   a. Static display elements and process flow streams shall conform to the table below.

Static Elements	Color
Graphic Display Background	Light Gray
Static Text: Display Titles Equipment Identifiers Equipment Symbol Outlines	Black
Static Equipment Symbols: Isolation Valves Flow Meters Similar Devices Process Symbol Outlines	Black
Static Process Symbols: Basins Filters Vessels	Gray
Primary/Major Process Flow Streams:	Dark Gray
Secondary/Minor Process Flow Streams:	Dark Gray
Chemical Feed Systems:	Gray
Compressed Air, Instrument Air	Gray

7. Lines and Arrows:
   a. Lines and arrows used for the primary process flow shall be easily distinguished from secondary flows and instrumentation.
   b. Process lines shall be shown as solid with instrument lines shown as dashed.
   c. Line crossings shall give precedent to the primary process flow with the secondary lines being split.
   d. Each process flow line shall be labeled at the entrance and exit of each display and identify flow direction.

e. When the flow line continues to another display, the entrance and exit of each flow line shall include a link to the next display associated with the flow.
f. Arrows used for links shall be distinguished in appears from non-linked arrows.
g. Line weights and patterns shall be as follows:
   (1) Primary Process Flow: 4 point line weight with solid pattern.
   (2) Secondary Process Flow: 3 point line weight with solid pattern.
   (3) Chemical Feed and other Minor Flows: 2 point line weight with solid pattern.
   (4) Instrumentation Lines: 1 point line weight with dashed pattern.

8. Dynamic Display Elements:
   a. Dynamic symbol and text elements, both discrete and analog, shall conform to the requirement as specified below.
   b. Color for dynamic elements shall be used for process variables, warning, and alarm conditions. Colors shall be used to represent the priority of the associated condition, e.g. low, high, critical, etc.
   c. The dynamic elements used shall place emphasis and promote situational awareness for the operator.
   d. Equipment modes shall indicate whether the equipment is in local, off, or remote.
   e. Equipment status shall indicate running and stopped, open and closed, etc.
   f. The quality of the signal shall be represented to indicate out-of-service, inhibited alarm, bad data or communication failure.
   g. Symbols shall be emphasized using a separate colorized flashing box around the object to indicate unacknowledged alarms, signals out of range, and those not having proper communication. If the specific project implementation requires more than two priorities (warning and alarm), the flashing box shall also include a priority identification symbol attached to the box.
   h. Refer to the following table for each dynamic element's associated color and usage.

Element	Color	Usage
Pumps, Fans, Blowers, and other two-state devices	Dark Gray	Running, On or Open
	White	Stopped, Off, or Closed
Throttling Valves and other Modulating Devices.	Dark Gray	Fully Open
	White	Fully Closed
	Half Dark Gray/Half White	In Transition
Alarm Conditions	Yellow Flashing Box	Warning
	Red Flashing Box	Alarm, Unacknowledged
	Gray/Dark Gray Hatching	Out-of-Service
	Magenta Box	Comm. Error / (Old Data)

9. Control Function Interfaces:
   a. Control functions requiring operator interaction or input such as hand-off-auto selection, mode selection, setpoint input, and similar shall be presented in a control panel pane integrated into the associated display windows when possible. A pop-up window shall be used if space is limited on the equipment display. The appearance of the operator interfaces shall be consistent in either presentation.
   b. PID setpoint, process variable, output and other tuning parameters shall be made available through this control panel interface when applicable. If the security

access level is not sufficient, the parameters shall be hidden or made unavailable for user interaction.

c. Buttons and setpoint entry fields used for process control shall be designed with a raised appearance or perceived depth to allow immediate recognition of its function by the Operator.

d. Setpoint entry fields shall be clearly labeled with the appropriate units displayed and also be raised in appearance.

e. Navigational buttons should be distinct from buttons used for process control.

f. Button colors and setpoint fields shall be as identified in the table below.

Element	Color	Usage
Button (Active/Enabled)	Dark Gray	Button Fill
	Dark Green	Button Text
	White / Gray	Border and Shading
Button (Inactive/Disabled)	White	Button Fill
	Dark Blue	Button Text
	Dark Gray / Gray	Border and Shading
Setpoint Input Field	White	Background Fill
	Dark Gray / Gray	Border and Shading
	Dark Green	Setpoint Text

10. Dynamic Text and Bar Graphs:

a. Dynamic text shall be used to represent a discrete or analog signal on the operator HMI.

(1) Dynamic text elements shall be colorized to distinguish them from static text, in addition to flashing boxes used for identifying warning and alarm conditions.

b. Bar graphs may be utilized in addition to dynamic text elements to represent process variables.

(1) Bar graphs may be used for process variables such as level, speed, and other analog instrumentation.

(2) The bar graph shall be segmented to identify the variable setpoint, warning and alarm ranges in addition to the current value.

(3) Bar graphs shall not change color or flash to represent a warning or alarm condition. Similar to other dynamic elements, a colored box around the associated bar shall be used for this purpose.

c. Color conventions for dynamic text and bar graph elements shall be as identified in the table below.

Element	Color	Usage
Bar Graphs and Other Bar Style Elements.	Dark Blue	Process Variable
	Cyan	Normal Range
	White	Warning Range
	Dark Gray	Alarm Range
	Dark Green	Setpoint

Element	Color	Usage
Dynamic Text	Dark Blue	Process Variable
	Dark Blue w/Flashing Yellow Box	Warning, Unacknowledged
	Dark Blue w/Yellow Box	Warning, Acknowledged
	Dark Blue w/Flashing Red Box	Alarm, Unacknowledged
	Dark Blue w/Red Box	Alarm, Unacknowledged
	Magenta w/Magenta Box	Communication Error/Old Data

11. Display Text:
    a. Both dynamic and static text elements shall be consistent for all displays.
    b. Arial 16-point bold font shall be used for headings and titles.
    c. Arial 12-point bold font shall be used for all other text.
    d. Text color shall be as previously defined.
    e. Labels and other static text element colors not previously defined shall utilize shades of dark gray and black to sufficiently contrast against the light gray background.
12. Alarm Text:
    a. In addition to the warning and alarm condition box animations defined in previous sections, alarms shall be displayed in text form in the alarm window. The alarm display text colors conventions shall be as defined in the table below.

Element	Text Color	Text Background Fill	Usage (Priority Level)
Alarm Display Window Text (Active)	Black	Red, Flashing	Alarm Unacknowledged (1)
	Black	Red	Alarm, Acknowledged (1)
	Black	Light Red	Alarm, Return (1)
	Black	Yellow, Flashing	Warning, Unacknowledged (4)
	Black	Yellow	Warning, Acknowledged (4)
	Black	Light Yellow	Warning, Return (4)
	Black	Orange / Light Orange	Priority 2 (If required), Flashing
	Black	Magenta / Light Magenta	Priority 3 (If required), Flashing
Alarm Display Window Text (Suppressed)	Black	White	Alarm
Alarm Display Window Text (Inhibited)	Black	Gray	Alarm
Alarm Display Window Text (Shelved)	Black	Light Brown	Alarm

F. Screen Development: As a minimum the following screens shall be developed for the project:
    1. System Overview Screen:

a. Diagrammatically indicates the complete facility based on the Site Layout including all major structures, equipment, valves, tanks, storage basins, and interconnecting piping.
b. Displays for this screen shall at a minimum include the status of each facility, influent and effluent flow rates, and daily totals for the plant.
c. Displays all monitored parameters including electrical and mechanical system analog points and alarms. Allow for the adjustment of alarm points associated with the building or structure.
d. Displays the combustible gas detectors and alarm status for hazards area locations.
e. Displays the alarm status for HVAC equipment required for zone declassification.
f. Allow the operator to point and click to open a detailed process screen for each location or structure.
g. Additional screens shall be developed as necessary to clearly indicate the associated control and status points. The overview screen shall provide links to the associated detailed screens.

2. Detailed System Screens:
   a. A detailed process screen based on the P&IDs shall be developed for each process system.
   b. The detailed screens shall display all monitored parameters and allow for the adjustment of the control and alarm associated with the system.
   c. If a particular system requires additional screens to clearly identify and display all control and status points for the system equipment the Detailed Screen and Overview Screen shall include links to the additional subsystem screens.
   d. Links shall be established between related screens and for process piping continuations between screens.
   e. Potable and Reuse Water Systems are not interconnected at the pump station level. Detailed graphics shall be developed for each system. Some graphics may be combined as indicated on the P&IDs including, but not limited to, the following:
      (1) Pump Station & Tank Overview
      (2) Pumps
      (3) Tanks Overview
      (4) Individual Tanks
3. Electrical System Screen:
   a. Shall include a graphical depiction of the electrical one-line diagram for the plant.
   b. Shall provide display panels for monitored equipment status, bus Voltage, Amps, Watts, and Vars as applicable for each monitored circuit.
   c. Shall include the automatic transfer switch, MCC/VFD, and the emergency power generator.
4. Communications Status Screen:
   a. Shall graphically depict the entire Ethernet network showing all PLC, MCC, network switches, graphic terminals, servers, motor controllers, and PC workstations in the system.
   b. Shall indicate communication system status for all switches, PLC’s, radio links, and other networked equipment.
   c. Shall indicate UPS and power supply status points.
   d. Shall include heartbeat monitoring between device to notify the operators in case of loss of communication.
   e. Shall provide links to embedded web pages associated with each intelligent device on the network including but not limited to PLCs, power monitors, VFDs,

intelligent overload relays, network switches, and UPSs. Required web browser program shall be launched when links are activated.

5. Alarm and Event Management Screens:
   a. Shall display alarms and events.
   b. Shall list the discrete alarm points and allow the operator to inhibit the alarm and select whether the alarm point causes the audible alarm to sound.
   c. Shall allow the operator to set the parameters associated with the audible alarms.
   d. Shall allow the operator to place the associated equipment alarms into "Out Of Service" mode to prevent out of service equipment from triggering alarms.
   e. Color schemes and display properties shall be as defined this Section.
6. Event Notification:
   a. The following methods shall be used for notification of alarms:
      (1) Alarm screens and alarm box animations for each process variable displayed.
      (2) Audible alarms via PC workstation speakers.
      (3) Remote alarms via radio network.
7. Maintenance Screens:
   a. Maintenance screens shall be developed for each system and associated equipment.
   b. The maintenance screens shall provide links to electronic O&M materials, As-Built drawings stored in PDF format, maintenance and calibration records in excel format.
   c. The PDF's shall be supplied as part of the manufacturers O&M material and final documentation. The systems integrator shall assemble all of the electronic documents in a common area on the control system server.
   d. Specific portions of the electronic documents to be accessed more frequently should be pulled from the full O&M documents and stored as separate PDF files for quicker access. The specific portions to be separately stored shall include, but not be limited to, to following items:
      (1) Wiring diagrams.
      (2) Pump Curves.
      (3) Manufacturer's recommended maintenance schedules.
      (4) Other items as requested by the Owner.
   e. As-Built drawing PDF's shall be supplied by the Subcontractor after the plant construction is completed. The SI shall utilize the "For Construction" drawing PDF's for the initial development. After the As-Built PDF's are supplied the SI shall replace the contract drawing PDF files with the final As-Built files.

3.03 NETWORK CONFIGURATION:

A. The plant control system Ethernet network shall be configured as specified in Section 40 66 00 – Network and Communications Equipment and as indicated on the contract drawings.

B. The SI shall be responsible for programming and verifying the IP Addresses, Subnet, and Default Gateways, when applicable, for all devices on the network. Coordinate with Owner, or assigns, for valid IP addresses.

C. When shown, the network IP addresses shall be defined based on the Ethernet Network TCP/IP Addresses indicated on the network architecture diagram. Addresses for devices not listed in the table shall be assigned by the SI after coordination with the Owner.

3.04 PROGRAMMABLE LOGIC CONTROLLER (PLC) PROGRAMMING:

A. The PLCs shall be programmed utilizing the latest version of the control system manufacturers latest enterprise software.

B. The PLC program shall be thoroughly documented with comments explaining the code for each operation performed.

C. Where possible the PLCs shall be programmed utilizing object oriented programming (OOP) blocks and user defined data types (UDT) to maintain consistency throughout the PLC program. Programming blocks shall be developed with the worst case scenario in mind to allow blocks to be adaptable throughout the project. Proposed blocks shall be submitted as specified.

D. The PLC shall be programmed to perform the required logic for proper operation of the associated equipment.

E. The PLC shall monitor communications status through a heartbeat monitor to each PLC on the network and alarm if communication failures occur.

F. The PLC shall monitor power status of the building or structure power supply. Logic shall be implemented that shall clear run contacts or shut down equipment when power to the facility is lost and perform routine startup of equipment after power restoration. Operator adjustable time delays shall be established between the restarting of motor driven equipment.

G. Each alarm point shall have a programmed 2 second time delay to prevent “nuisance” or “false” alarms.

H. Momentary start contacts shall be programmed to close for 2 seconds and then open. Momentary stop contacts shall be programmed to open and stay open until shutdown of the motor is detected.

I. All required field programming and tuning of the control loops shall be included.

3.05 INTERFACE TO SCADA SYSTEM:

A. A Ethernet Radio interface shall be provided to communicate with the City of Broomfield’s control system as shown on the network architecture diagram included in the Contract Drawings.

B. All modifications and additions to the City’s existing control system screens to add pump station and tank specific screens shall be coordinated with the Owner.

3.06 PROCESS DESCRIPTIONS:

A. Refer to P&IDs and the below control narratives for each systems process programing requirements.

1. T-100
    a. General – T-100 is a large potable water storage tank.
    b. Level Transmitter, LIT-105, is a radar level transmitter and will send a 4-20mA analog level signal (LI-105) to PLC-100. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-100 control panel.
    c. Level Switch, LS-105-H, is a float type level switch and will send a discrete signal (LA-105-H) to PLC-100.
2. MXR-105
    a. General - Mixer MXR-105 is located in Tank T-100. An integral float serves to protect the mixer when water levels are too low to safely operate the mixer.
        (1) RUN – When called in run in AUTO Mode, PLC-100 will send a RUN command (JY-101-RUN) to the VFD.

(2) RUNNING - When running, VFD-MXR105 will send run confirmation signal (YS-105-RC) to PLC-100.
(3) FAULT - When in a fault condition, VFD-MXR105 will send a fault signal (YA-105-FLT) to PLC-100.
(4) SPEED COMMAND – When called to run in AUTO Mode, PLC-100 will send a speed command (SC-105) to the VFD.
(5) AUTO – When HS-105 is placed in the AUTO position, VFD-MXR105 will output an auto signal (HS-105-A) to PLC-100.

b. AUTO Mode – In AUTO Mode, the mixer is to run based on commands from PLC-100. PLC-100 will issue a call to run (JY-105-RUN), and a speed command (SC-105). Speed commanded and sent by PLC-100 will be determined by operator setpoint. If the water level is too low the mixer will be stopped from running.
c. HAND Mode – In HAND Mode, the mixer is to run when placed in HAND at the VFD. When placed in HAND, the mixer will run at a default speed programmed into the VFD. Speed will then be controlled locally. If the water level is too low the mixer will be stopped from running.
d. OFF Mode – In OFF mode, the mixer will not run.

3. T-101
   a. General – T-101 is a large potable water storage tank.
   b. Level Transmitter, LIT-106, is a radar level transmitter and will send a 4-20mA analog level signal (LI-106) to PLC-100. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-100 control panel.
   c. Level Switch, LS-106-H, is a float type level switch and will send a discrete signal (LA-106-H) to PLC-100.
4. MXR-106
   a. Operation is similar to MXR-105. Change tags accordingly.
5. BV-135
   a. General – BV-135 is provided as a remotely operable isolation valve intended as backup to the altitude valve (FV-100). The valve is capable of being controlled locally and remotely by PLC-100.
      (1) OPEN - When in AUTO Mode, PLC-100 shall be capable of sending an OPEN signal (JY-135-OPEN) to the valve actuator.
      (2) CLOSE - When in AUTO Mode, PLC-100 shall be capable of sending a CLOSE signal (JY-135-CLOSE) to the valve actuator.
      (3) OPEN - When the valve is fully in the open position, BV-135 will send an open signal (ZS-135-OPEN) to PLC-100.
      (4) CLOSED - When the valve is fully in the closed position, BV-135 will send a closed signal (ZS-135-CLOSE) to PLC-100.
      (5) REMOTE - When the valve LOR hand switch is in the remote position, BV-135 will send a remote signal (HS-135-REM) to PLC-100.
      (6) FAULT - When the valve experiences a fault condition, BV-135 will send a fault signal (YA-135-FLT) to PLC-100.
   b. REMOTE Mode – In REMOTE Mode, the valve is to operate based on commands from PLC-100.
      (1) The PLC will open and close the valve based on pump operation. Refer to paragraph Pump Operation – PMP-101, PMP-102, PMP-103 included below.
      (2) OPEN - When the valve is in REMOTE mode and placed in the open position, the valve will begin to open. As long as the signal is maintained, the

valve will continue opening. If the valve reaches end of travel and the valve becomes fully opened, then valve operation shall automatically stop.

(3) CLOSE - When the valve is in REMOTE mode and placed in the close position, the valve will begin to close. As long as the signal is maintained, the valve will continue closing. If the valve reaches end of travel and the valve becomes fully closed, then valve operation shall automatically stop.

c. OFF – In OFF mode, the valve will not operate.

d. LOCAL Mode - In LOCAL Mode, the valve will operate based on operator input from the OPEN/STOP/CLOSE hand switch.

(1) OPEN - When the valve is in LOCAL mode and placed in the open position, the valve will begin to open. If the operator allows or engages the stop button the valve will stop at its current position until further command is given, or the valve is placed in another operating mode. If the valve reaches end of travel and the valve becomes fully opened, then valve operation shall automatically stop.

(2) STOP – This is the normal expected position. To operate the valve, an operator must toggle the OPEN/STOP/CLOSE hand switch into either the open or close position.

(3) CLOSE - When the valve is in LOCAL mode and placed in the close position, the valve will begin to close. If the operator allows or engages the stop button the valve will stop at its current position until further command is given, or the valve is placed in another operating mode. If the valve reaches end of travel and the valve becomes fully closed, then valve operation shall automatically stop.

6. FCV-100

a. FCV-100 is a self-contained altitude valve requiring no process control system commands. Listed below are outputs from the valve for input to PLC-100 for remote monitoring.

(1) OPEN - When the valve is fully in the open position, BV-135 will send an open signal (ZS-135-OPEN) to PLC-100.

(2) CLOSED - When the valve is fully in the closed position, BV-135 will send a closed signal (ZS-135-CLOSE) to PLC-100.

7. PIT-110

a. PIT-110 is a pressure transmitter intended to supply a pressure signal to PLC-100 to indicate the suction side pressure of the pump station. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-100 control panel.

8. Pump Operation – PMP-101, PMP-102, PMP-103

a. General - The potable water pump station is currently configured with 3 operable pumps. The current programming requirements will utilize pumps in a 2 duty, 1 spare arrangement. The process setpoint will be discharge pressure; refer to paragraph PIT-120. Tags used in the narrative in the following paragraphs are based on PMP-101; change tags as required for other equipment.

(1) Contractor shall determine minimum effective pumping speed (MEPS) for conditions running 1 pump, 2 pumps, and 3 pumps at a time; these shall be programmed as setpoints within the PLC. Contractor shall determine appropriate tagnames for use below.

(2) Contractor shall coordinate with the Owner to determine appropriate length of time to use as delay setpoints for how long to run pumps at the MEPS before shutting down pump(s) , or if indefinite time shall be allowed. Contractor shall determine appropriate tagnames for use below.
(3) TE-101 – The VFD will determine an alarm condition to protect the motor, and a pump motor winding temperature alarm high (TA-101-H) will be sent to PLC-100.
(4) PS-101-H – The pump discharge pressure switch high is an input to the VFD. A high pressure alarm condition will be used to shut down the pump. The VFD will forward a high pressure alarm (PA-101-H) to PLC-100.
(5) Pump motors will have local disconnects. Local disconnects will have a set of early-break auxiliary contacts. These contacts will be wired into the VFD as an interlock disabling pump run if the disconnect is open, and by their nature of being early-break, these contacts will render the disconnect safe even during motor running conditions. A tagname is not generated for this VFD input.
(6) RUN – When called in run in AUTO Mode, PLC-100 will send a RUN command (JY-101-RUN) to the VFD.
(7) RUNNING - When running, VFD- PMP101 will send run confirmation signal (YS-101-RC) to PLC-100.
(8) FAULT - When in a fault condition, VFD- PMP101 will send a fault signal (YA-101-FLT) to PLC-100.
(9) SPEED COMMAND – When called to run in AUTO Mode, PLC-100 will send a speed command (SC-101) to the VFD.
(10) SPEED INDICATION – VFD- PMP101 will output the running speed (SI-101) to PLC-100.
(11) AUTO – When HS-101 is placed in the AUTO position, VFD-PMP101 will output an auto signal (HS-101-A) to PLC-100.

b. AUTO Mode – In AUTO Mode, pumps are to operated as described below in order to maintain system discharge pressure. Pumps will use interlocks described above to determine if a pump is allowed to run. Pumps must be in the AUTO position to be included in the run sequence described below.
(1) Pumps will be called to run based on a first-on, first-off alternation scheme.
(2) Inadequate suction pressure:
(a) Prior to starting pumps the suction side pressure transmitter shall exceed the pressure set point necessary to allow pump operation.
(3) Inadequate discharge pressure:
(a) Prior to starting pumps, valve BV-135 shall be commanded to the closed position (JY-135-CLOSE). Once the valve has issued a closed command (ZS-135-CLOSED), pumps may be started. Refer to paragraph BV-135 above.
(b) During pump station startup, or conditions where system discharge pressure is below the setpoint requirement the Lead pump shall be called to run, ramping up to it's MEPS. The PLC will then use the system discharge pressure to modulate the pump speed. If the pump speed is increased to 100% and system pressure does not meet the setpoint value, move to step (b). However, if the pump speed is reduced to the MEPS for a period of 5 minutes (operator set point) and system discharge pressure is maintained, the pump may be shut down.

(c) During conditions where a single pump is running and the system discharge pressure does not meet the setpoint value a Lag pump shall be brought online starting ramped up to the MEPS. From here, the two running pumps shall be modulated in speed as required to reach the setpoint value; the Lead pump will likely be reduced in speed, and the Lag pump will likely be increased in speed. If the pump speed is increased to 100% and system pressure does not meet the setpoint value, then an insufficient pumping alarm shall be generated and made available for remote monitoring.

(4) Excess discharge pressure:

(a) During conditions where the running pumps are creating excess system discharge pressure, then pump speeds shall be reduced to meet setpoint. If two pumps are running and pump speed is reduced down to the respective MEPS the setpoint time delay shall begin counting down. If the setpoint time delay expires, then the original Lead pump shall be shut down and the remaining pump modulated as required to maintain system pressure.

(b) If the new Lead pump still creates excess system pressure and the pump is reduced to the MEPS the setpoint time delay shall begin counting down, then the pump shall be shut down. If the setpoint time delay expires, then the new Lead pump shall be shut down.

(c) Future pump starts will alternate to the next pump in line.

c. HAND Mode – In HAND Mode, the pump is to run when placed in HAND at the VFD. When placed in HAND, the pump will run at a default speed programmed into the VFD. Speed will then be controlled local to the VFD.

(1) Inadequate suction pressure:

(a) In HAND mode the suction side pressure is not interlocked.

(2) Excessive discharge pressure:

(a) In HAND mode the discharge side pressure is shall be interlocked in pump operation.

d. OFF Mode – In OFF mode, the pump will not run. Additionally, the pump will not be considered in the overall pump alternation philosophy.

9. PIT-120

a. PIT-120 is a pressure transmitter intended to supply a pressure signal to PLC-100 to indicate the discharge side pressure of the pump station. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-100 control panel.

10. FIT-121

a. FIT-121 is a magnetic flowmeter intended to supply a combined flow signal to PLC-100 to indicate the combined flow through the pump station measured on the pump discharge header. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-100 control panel.

11. LS-122-H

a. LS-122-H is a donut type magnetic reed float switch intended to supply a discrete level signal to PLC-100 to indicate the presence of a high water level within the pump station trench.

12. AIT-130A-COND

a. AIT-230A-COND is a conductivity analyzer and will send an analog conductivity signal to PLC-100.

13. AIT-130B-CL2
    a. AIT-230A-CL2 is a chlorine analyzer and will send an analog chlorine level signal to PLC-100. The instrument will be capable of sending a total chlorine level or free chlorine level depending on the reagent used.
14. AIT-130C-TEMP
    a. AIT-230A-TEMP is a temperature analyzer used in conjunction with the pH analyzer and will send an analog temperature signal to PLC-100.
15. AIT-130C-PH
    a. AIT-230A-PH is a pH analyzer and will send an analog pH signal to PLC-100.
16. ZS-194*-O (* = A through D)
    a. ZS-194*-O are door contacts used to signal the PLC of a door open condition at the pump station building on the Potable Water Side. Refer to the Intrusion Detection description found above in 3.04
17. ZS-195*-O (* = A & B)
    a. ZS-195*-O are gate contacts used to signal the PLC of a gate open condition. A warning signal shall be sent to the City's SCADA system to notify of the condition if an acceptable Key Card is presented or correct disarming code is not entered.
18. ZS-196*-O (* = A & B)
    a. ZS-195*-O are gate contacts used to signal the PLC of a gate open condition. A warning signal shall be sent to the City's SCADA system to notify of the condition if an acceptable Key Card is presented or correct disarming code is not entered.
19. JY-196-ON
    a. JY-196-ON output sends an ON signal to the lighting control panel to control the tank parking area lights when a gate (ZS-196A-O or ZS-196B) is opened.
        (1) ZS-196A-O – Open signal received from door contact switches on swing gate at the tanks.
        (2) ZS-196B-O – Open signal received from door contact switches on man gate at the tanks.
20. YS-197-OK
    a. YS-197-OK is a relay contact output from the card access system to be used in conjunction with the Instruction Detection found above in 3.04.
21. T-200
    a. General – T-200 is a large potable water storage tank.
    b. Level Transmitter, LIT-106, is a radar level transmitter and will send a 4-20mA analog level signal (LI-106) to PLC-200. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-200 control panel.
    c. Level Switch, LS-106-H, is a float type level switch and will send a discrete signal (LA-106-H) to PLC-200.
22. MXR-205
    a. General - Mixer MXR-205 is located in Tank T-200. An integral float serves to protect the mixer when water levels are too low to safely operate the mixer.
        (1) RUN – When called in run in AUTO Mode, PLC-200 will send a RUN command (JY-205-RUN) to the VFD.
        (2) RUNNING - When running, VFD-MXR105 will send run confirmation signal (YS-205-RC) to PLC-200.

(3) FAULT - When in a fault condition, VFD-MXR205 will send a fault signal (YA-205-FLT) to PLC-200.
(4) SPEED COMMAND – When called to run in AUTO Mode, PLC-200 will send a speed command (SC-205) to the VFD.
(5) AUTO – When HS-205 is placed in the AUTO position, VFD-MXR205 will output an auto signal (HS-205-A) to PLC-200.

b. AUTO Mode – In AUTO Mode, the mixer is to run based on commands from PLC-200. PLC-200 will issue a call to run (JY-205-RUN), and a speed command (SC-205). Speed commanded and sent by PLC-200 will be determined by operator setpoint. If the water level is too low the mixer will be stopped from running.
c. HAND Mode – In HAND Mode, the mixer is to run when placed in HAND at the VFD. When placed in HAND, the mixer will run at a default speed programmed into the VFD. Speed will then be controlled locally. If the water level is too low the mixer will be stopped from running.
d. OFF Mode – In OFF mode, the mixer will not run.

23. BV-235
a. General – BV-235 is provided as a remotely operable isolation valve intended as backup to the altitude valve (FV-200). The valve is capable of being controlled locally and remotely by PLC-200.
(1) OPEN - When in AUTO Mode, PLC-200 shall be capable of sending an OPEN signal (JY-235-OPEN) to the valve actuator.
(2) CLOSE - When in AUTO Mode, PLC-200 shall be capable of sending a CLOSE signal (JY-235-CLOSE) to the valve actuator.
(3) OPEN - When the valve is fully in the open position, BV-235 will send an open signal (ZS-235-OPEN) to PLC-200.
(4) CLOSED - When the valve is fully in the closed position, BV-235 will send a closed signal (ZS-235-CLOSE) to PLC-200.
(5) REMOTE - When the valve LOR hand switch is in the remote position, BV-235 will send a remote signal (HS-235-REM) to PLC-200.
(6) FAULT - When the valve experiences a fault condition, BV-235 will send a fault signal (YA-235-FLT) to PLC-200.

b. REMOTE Mode – In REMOTE Mode, the valve is to operate based on commands from PLC-200.
(1) The PLC will open and close the valve based on pump operation. Refer to paragraph Pump Operation – PMP-201, PMP-202, PMP-203 included below.
(2) OPEN - When the valve is in REMOTE mode and placed in the open position, the valve will begin to open. As long as the signal is maintained, the valve will continue opening. If the valve reaches end of travel and the valve becomes fully opened, then valve operation shall automatically stop.
(3) CLOSE - When the valve is in REMOTE mode and placed in the close position, the valve will begin to close. As long as the signal is maintained, the valve will continue closing. If the valve reaches end of travel and the valve becomes fully closed, then valve operation shall automatically stop.

c. OFF – In OFF mode, the valve will not operate.
d. LOCAL Mode - In LOCAL Mode, the valve will operate based on operator input from the OPEN/STOP/CLOSE hand switch.
(1) OPEN - When the valve is in LOCAL mode and placed in the open position, the valve will begin to open. If the operator allows or engages the stop button the valve will stop at its current position until further command is given, or

the valve is placed in another operating mode. If the valve reaches end of travel and the valve becomes fully opened, then valve operation shall automatically stop.

(2) STOP – This is the normal expected position. To operate the valve, an operator must toggle the OPEN/STOP/CLOSE hand switch into either the open or close position.

(3) CLOSE - When the valve is in LOCAL mode and placed in the close position, the valve will begin to close. If the operator allows or engages the stop button the valve will stop at its current position until further command is given, or the valve is placed in another operating mode. If the valve reaches end of travel and the valve becomes fully closed, then valve operation shall automatically stop.

24. FCV-200
    a. FCV-200 is a self-contained altitude valve requiring no process control system commands. Listed below are outputs from the valve for input to PLC-200 for remote monitoring.
        (1) OPEN - When the valve is fully in the open position, BV-235 will send an open signal (ZS-235-OPEN) to PLC-200.
        (2) CLOSED - When the valve is fully in the closed position, BV-235 will send a closed signal (ZS-235-CLOSE) to PLC-200.
25. PIT-210
    a. PIT-210 is a pressure transmitter intended to supply a pressure signal to PLC-200 to indicate the suction side pressure of the pump station. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-200 control panel.
26. Pump Operation – PMP-201, PMP-202, PMP-203
    a. General - The potable water pump station is currently configured with 3 operable pumps, and a space for a fourth future pump. The current programming requirements will utilize pumps in a 2 duty, 1 spare arrangement. The process setpoint will be discharge pressure; refer to paragraph PIT-220. Tags used in the narrative in the following paragraphs are based on PMP-201; change tags as required for other equipment.
        (1) Contractor shall determine minimum effective pumping speed (MEPS) for conditions running 1 pump, 2 pumps, and 3 pumps at a time; these shall be programmed as setpoints within the PLC. Contractor shall determine appropriate tagnames for use below.
        (2) Contractor shall coordinate with the Owner to determine appropriate length of time to use as delay setpoints for how long to run pumps at the MEPS before shutting down pump(s), or if indefinite time shall be allowed. Contractor shall determine appropriate tagnames for use below.
        (3) TE-201 – The VFD will determine an alarm condition to protect the motor, and a pump motor winding temperature alarm high (TA-201-H) will be sent to PLC-100.
        (4) PS-201-H – The pump discharge pressure switch high is an input to the VFD. A high pressure alarm condition will be used to shut down the pump. The VFD will forward a high pressure alarm (PA-201-H) to PLC-200.
        (5) Pump motors will have local disconnects. Local disconnects will have a set of early-break auxiliary contacts. These contacts will be wired into the VFD

as an interlock disabling pump run if the disconnect is open, and by their nature of being early-break, these contacts will render the disconnect safe even during motor running conditions. A tagname is not generated for this VFD input.

(6) RUN – When called in run in AUTO Mode, PLC-200 will send a RUN command (JY-201-RUN) to the VFD.

(7) RUNNING - When running, VFD-PMP201 will send run confirmation signal (YS-2051RC) to PLC-200.

(8) FAULT - When in a fault condition, VFD-PMP201 will send a fault signal (YA-201-FLT) to PLC-200.

(9) SPEED COMMAND – When called to run in AUTO Mode, PLC-100 will send a speed command (SC-201) to the VFD.

(10) SPEED INDICATION – VFD-PMP201 will output the running speed (SI-201) to PLC-200.

(11) AUTO – When HS-201 is placed in the AUTO position, VFD-PMP201 will output an auto signal (HS-201-A) to PLC-200.

b. AUTO Mode – In AUTO Mode, pumps are to operated as described below in order to maintain system discharge pressure. Pumps will use interlocks described above to determine if a pump is allowed to run. Pumps must be in the AUTO position to be included in the run sequence described below.

(1) Pumps will be called to run based on a first-on, first-off alternation scheme.

(2) Inadequate discharge pressure:

(a) Prior to starting pumps, valve BV-235 shall be commanded to the closed position (JY-235-CLOSE). Once the valve has issued a closed command (ZS-235-CLOSED), pumps may be started. Refer to paragraph BV-235 above.

(b) During pump station startup, or conditions where system discharge pressure is below the setpoint requirement the Lead pump shall be called to run, ramping up to it's MEPS. The PLC will then use the system discharge pressure to modulate the pump speed. If the pump speed is increased to 100% and system pressure does not meet the setpoint value, move to step (b). However, if the pump speed is reduced to the MEPS and system discharge pressure is maintained,

(c) During conditions where a single pump is running and the system discharge pressure does not meet the setpoint value a Lag pump shall be brought online starting ramped up to the MEPS. From here, the two running pumps shall be modulated in speed as required to reach the setpoint value; the Lead pump will likely be reduced in speed, and the Lag pump will likely be increased in speed. If the pump speed is increased to 100% and system pressure does not meet the setpoint value, then an insufficient pumping alarm shall be generated and made available for remote monitoring.

(3) Excess discharge pressure:

(a) During conditions where the running pumps are creating excess system discharge pressure, then pump speeds shall be reduced to meet setpoint. If two pumps are running and pump speed is reduced down to the respective MEPS the setpoint time delay shall begin counting down. If the setpoint time delay expires, then the original Lead pump shall be

shut down and the remaining pump modulated as required to maintain system pressure.

(b) If the new Lead pump still creates excess system pressure and the pump is reduced to the MEPS the setpoint time delay shall begin counting down, then the pump shall be shut down. If the setpoint time delay expires, then the new Lead pump shall be shut down.

(c) Future pump starts will alternate to the next pump in line.

c. HAND Mode – In HAND Mode, the pump is to run when placed in HAND at the VFD. When placed in HAND, the mixer will run at a default speed programmed into the VFD. Speed will then be controlled locally.

d. OFF Mode – In OFF mode, the pump will not run. Additionally, the pump will not be considered in the overall pump alternation philosophy.

27. PIT-220
    a. PIT-220 is a pressure transmitter intended to supply a pressure signal to PLC-200 to indicate the discharge side pressure of the pump station. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-200 control panel.
28. FIT-221
    a. FIT-221 is a magnetic flowmeter intended to supply a combined flow signal to PLC-200 to indicate the combined flow through the pump station measured on the pump discharge header. Being an analog signal, operator settable set points, LL, L, H, HH, will be programmed into the PLC as alarm points; set points will be available on the OIT screen on PLC-200 control panel.
29. LS-222-H
    a. LS-222-H is a donut type magnetic reed float switch intended to supply a discrete level signal to PLC-200 to indicate the presence of a high water level within the pump station trench.
30. AIT-230A-TURB
    a. AIT-230-TURB is a turbidity analyzer and will send an analog turbidity signal to PLC-200.
31. Generator Load Stepping
    a. Provide programming to allow the PLC to control equipment in such a way that the generator load stepping identified in Section 26 32 13, Paragraph “Performance Requirements” is achieved when operating the AUTO Modes.
32. Intrusion Detection:
    a. Each PLC shall be programmed to include intrusion detection alarming.
    b. Each PLC shall monitor door contact switches listed below and initiate a system timer upon detecting an open door. The operator adjustable timer shall be set for 60 seconds to allow operators to clear the pending alarm condition.
    c. Entry type:
        (1) No Key Card Presented – this mode of entry can be through physical door key entry or by forced entry. Upon detecting an open door the door timer shall immediately initiate counting down. If the timer expires and the correct passcode has not been entered on either OIT, then an alarm shall be sent to the City SCADA system.
        (2) Card Access Key Card Presented – Upon presentation of an approved key card, and the card access systems grants access and opens the door, then the

system will be immediately disarmed, requiring no intervention from the operator.

d. Each OIT shall incorporate a lock screen requiring passcode to enter. Entry of a correct operator password shall disarm the intrusion detection programming.
e. Each OIT shall incorporate a system re-arm button on the main screen.
f. The PLC shall be programmed to allow an arm/disarm schedule for normal work hours to allow free entry and exit from the doors without initiating the alarm countdown sequence. The schedule can be enabled or disabled.
g. Passcodes and arm/disarm schedule shall be operator setable under the administrator access level.
h. ZS-294*-O (* = A through D)
   (1) ZS-294*-O are door contacts used to signal the PLC of a door open condition at the pump station building on the Reuse Water Side. Refer to the Intrusion Detection description found above.
i. YS-297-OK
   (1) YS-297-OK is a relay contact output from the card access system to be used in conjunction with the Instruction Detection found above.

3.07 FIELD QUALITY CONTROL:

A. Field Testing:
   1. As specified in Section 40 60 00 – Process Control and instrumentation General Requirements and each applicable equipment Section.
   2. A testing plan shall be developed and submitted for approval prior to testing of the control system.
   3. Each mode of operation shall be tested along with fault conditions for proper system response.
   4. Prior to and during initial startup period Systems Integrator shall demonstrate all modes of operation and step through various operating and failure scenarios.
      a. Startup and operation mode testing shall be witnessed by the Contractor.
      b. Subcontractor shall notify the Contractor a minimum of 2 weeks prior to the specified startup testing.

B. Test Reports:
   1. Submit test reports as specified in Division 01.
   2. Maintain a written record of all tests showing date, personnel making tests, equipment or material tested, tests performed, and results.

3.08 TRAINING:

A. The SI shall provide formal training for operators, maintenance and service personnel.
B. The training session shall include classroom discussion on the theory of operation of the control system as well as maintenance and service methods for the system. Topics covered shall include functionality of the system, system navigation, data management and recommended backup procedures.
C. Operator Training Sessions:
   1. Prior to the startup of the new control system a training session shall be provided for all operators. The training session shall clearly explain how to utilize the new system. HMI graphics for the new system shall be presented and operators shall have the opportunity to utilize the new system in a demonstration mode and navigate all the screens. The training session shall also explain and demonstrate customized features such as report generation, alarm review and acknowledgment procedures.

2. Two complete training sessions for all specified training shall be provided for the operators, one session for each shift.
3. Two months after the completion of the project a 4-hour refresher training session shall be provided to review the operations of the entire plant control system and answer any questions operators have developed on the system.
4. Eleven months after the completion of the project a 4-hour refresher training session shall be provided to review the operations of the entire plant control system and answer any questions operators have developed on the system.

D. Maintenance and Service Personnel Training:
1. Prior to the startup of the new control system one day of hands on training shall be provided for all maintenance and service personnel. The training session shall include the following:
   a. Clearly explain the architecture of the new system and explain how the network is configured and managed. Personnel shall be trained on network switch programming troubleshooting and available diagnostic tools.
   b. Cover all system software operation and configuration.
   c. Introduce basic PLC programming and explain methods for troubleshooting and identifying system issues.
   d. Cover system hardware and functionality.
   e. Cover database management and trending.
   f. Cover report template creation and report generation.
   g. Cover I/O database management and modifications including how points are added to the control system and managed.
   h. Cover PLC programming layout and logic associated with the plant. Programming logic shall be reviewed with the Owner and explanations shall be provided on programming methodologies and how the programs are organized and notated.
   i. Programming comments and documentation shall be reviewed with the Owner to provide a clear understanding of how the system functions.
   j. Additional topics as required to provide Owner with the ability to manage, troubleshoot, modify and maintain the plant control system.
2. Eleven months after the completion of the project a one day refresher training session shall be provided to review all of the topics covered in the original training session and answer any questions personnel have developed.

E. Subcontractor shall record the training sessions and provide a final edited version to the Owner on a DVD-ROM and electronic video file format.

END OF SECTION 40 61 96

SECTION 40 66 00 – PROCESS CONTROL NETWORKS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes network infrastructure, and ancillaries for process control networks and Supervisory Control and Data Acquisition (SCADA) systems.
B. Process control network shall not be connected to the internet and shall remain separate and unconnected from any Local Area Network (LAN) provided by the Owner.
C. This Section includes, but not limited to the following:
    1. Network Cabling and Accessories.
    2. Ethernet Switches.
    3. Equipment Racks and Accessories.

1.02 RELATED REQUIREMENTS:

A. SECTION 40 60 00 - Process Control and Instrumentation General Requirements
B. SECTION 40 67 00 - Process Control Panels and Hardware
C. SECTION 40 68 00 - Process Control Software

1.03 REFERENCE STANDARDS:

A. Furnish equipment which conforms in all respects to applicable industry standards and sound engineer practice.
B. Design, fabricate, assemble, and test equipment so as to conform with the latest revision of all applicable codes and standards including, but not necessarily limited to, the following.
C. Electronic Components Industry Association (ECIA):
    1. EIA/ECA-310-E – Cabinets, Racks, Panels, and Associated Equipment.
D. Institute of Electrical and Electronic Engineers (IEEE):
    1. IEEE 802.1 – Local and Metropolitan Area Networks.
    2. IEEE 802.3 – Ethernet.
    3. IEEE 1613 – Environmental and Testing Requirements for Communications Networking Devices in Electric Power Substations.
E. National Electrical Manufacturer's Association (NEMA):
    1. NEMA 250 – Enclosures for Electrical Equipment (1000 Volts Maximum).
F. National Fire Protection Association (NFPA):
    1. NFPA 70 – National Electrical Code.
    2. NFPA 262 – Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
G. Underwriter's Laboratories, Inc. (UL):
    1. UL 44 – Thermoset-Insulated Wires and Cables.
    2. UL 50 – Electrical Cabinets and Boxes.
    3. UL 444 – Communications Cables.
    4. UL 467 – Grounding and Bonding Equipment.
    5. UL 514C – Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers.
    6. UL 969 – Marking and Labeling Systems.
    7. UL 1581 – Electrical Wires, Cables, and Flexible Cords.
    8. UL 1863 – Communication Circuit Accessories.
    9. UL 60950-1 – Information Technology Equipment - Safety - Part 1: General Requirements.

1.04 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.

B. Product Data:
   1. Data sheets for each cable type and equipment type specified.
   2. Cable manufacturer's approval of pulling compounds.
   3. Cable manufacturer's installation requirements such as maximum pulling tensions, sidewall pressures, minimum bending radii, reel dimensions, etc.
   4. Other ancillary equipment and materials to be used.
   5. Description of cable identification tags and attachment methods which will be used.

1.05 QUALITY ASSURANCE:

A. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to Bid opening. Each major component of the equipment shall have the manufacturer's name and type identified on the equipment. All products supplied shall be specifically designed and manufactured for use with plant communications systems. All items of the same class of equipment shall be the products of a single manufacturer unless indicated otherwise.

1.06 SITE CONDITIONS:

A. All Equipment provided as part of this system shall be rated for the temperature, seismic and elevations as specified in the Site Conditions in identified in Specification 26 00 00.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. UTP Cables, Patch Panels, Connectors and Accessories:
   1. Belden.
   2. Berk-Tek, Nexans.
   3. Leviton.
   4. Mohawk, Belden.
   5. Ortronics, Legrand.
   6. Panduit.
   7. Siemon.

B. Ethernet Switches:
   1. Manufacturer:
      a. Cisco
      b. Moxa
      c. N-Tron

C. Cable Accessories:
   1. Tape:
      a. Minnesota Mining and Manufacturing (3M).
   2. Cable Ties:
      a. AMP, TE Connectivity Ltd.
      b. IDEAL Industries, Inc.
      c. Minnesota Mining and Manufacturing (3M).
      d. Panduit.
      e. Thomas and Betts Corporation, ABB Group.
   3. Cable Supports:
      a. O-Z Gedney, Emerson Electric Co.
   4. Surge Protective Devices:

a. Refer to Section 26 43 13 Surge Protective Devices.

2.02 UTP JUMPER/PATCH CORD:

A. Patch cords shall consist of factory assembled, 4 pair, 100 ohm UTP, Category 6 cables and equivalent eight-position, RJ-45 wiring connectors at each end.
B. Cables shall be wired with straight through pinning and shall be label verified.
C. Cable jacket shall be factory marked indicating organization and performance level.
D. Cable assemblies shall be designed with strain relief at each connector.
E. Cables shall be terminated according to type T568B configuration as defined by TIA-568-C.1.
F. Minimum length of 2 feet. Provide longer jumpers as required.
G. Provide patch cords as indicated plus 25% spare.
H. Cable shall comply with the applicable requirements of UL 444, UL 1685, UL 1863, and ANSI/TIA-568-C.2.
I. UTP patch cable specifications shall be as provided by the specification sheets at the end of this Section.

2.03 COMMUNICATIONS JACK/CONNECTOR ASSEMBLIES:

A. Copper jack/connectors shall comply with FCC Part 68.5, and TIA-568-C.2.
B. Shall be UL 1863 and UL 44 listed, non-keyed, 4 pair, constructed of high impact rated thermoplastic housing and shall be third party verified and shall comply with TIA-568-C.2 Category 6 requirements.
C. Shall meet or exceed Category 6 requirements.
D. Shall be terminated using a 110 style PC board connector, color coded for both T568A and T568B wiring.
E. Shall be wired T568B.
F. Shall comply with TIA-455-21A for 500 mating cycles.
G. Cover plates shall comply with UL 514C, and TIA-568-C.2; flush design constructed of 302 stainless steel material.
H. Stenciled lettering for voice and data circuits shall be provided using thermal ink transfer process.
I. Cover plates shall accept 4 Category 6 data jacks, or 4 RJ-45 telephone jacks, or a combination thereof.
J. Provide blank filler plates as required.

2.04 ETHERNET SWITCHES:

A. Ethernet switches provided for the network shall be DIN rail mount hardened industrial Ethernet switches, capable of 10/100/1000 Mbps with autosensing and operate using the Store and Forward Method.
B. Switches must be managed type switches. Unmanaged will not be accepted.
C. Capable of tree spanning protocol or manufacturers equivalent required for ring level topology in self-healing network.
D. Unmanaged switches are not acceptable.
E. Operating temperature 0°C to 60°C minimum.
F. Provide with redundant fan module for switch chassis when required to meet industrial environment ratings.
G. Ethernet switch shall be modular in design and accept Small form-factor pluggable (SFP) media modules.
H. Provide with required 10/100/1000 Base-T RJ-45 ports.
I. Shall provide half and full duplex operation.

J. LED indicators for system status, each power supply status, fault.
K. LED indicators for each port indicating link, activity, full/half duplex mode and speed.
L. Provide with a basic set of I/O parameters available via the Ethernet/IP protocol for device management and remote monitoring.
M. Comply with IEEE 802.1Q, 802.1D, 802.3, 802.3U, 802.3X, 802.3Z, and 802.3ab.
N. Capable of operating in a mesh network with rapid spanning tree protocol.
O. Shall support the following protocols or functions as minimum: SNMPv3, IGMP, DHCP, RMON, RSTP, HTTP, HTTPS, Telnet, and VLAN.
P. Shall be UL listed and FCC approved. Unit shall be rated for continuous operation under the environmental temperature, humidity, and vibrating conditions encountered at the installed location.
Q. Provide all required management and monitoring software.
R. Provide with redundant 120Vac, 60-hertz power supplies and cord and plug connection.
S. Provide with a minimum of two gigabit LC ports for connection to the fiber backbone.

2.05 ACCESSORIES:

A. Cable Supports:
   1. Cable supports for cables in vertical conduit risers or vertical tray, with considerable weight of cables shall be O. Z. Gedney Type "R" wedging plug type or approved equal.
B. Cable Ties:
   1. Shall be hook-and-loop (Velcro type) to meet EIA/TIA standards.
C. Cable Identification Tags:
   1. Designed to provide a permanent wire and cable identification system.
   2. Show complete cable number including colors.
   3. Cable numbers shall be machine printed, legible, and permanent.
   4. Character size for cable numbers shall be a minimum of 1/8 inch.
   5. Material shall be nonmetallic and impervious to moisture.
   6. Be securely attached to cables and accessible for inspection.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment. The area for network equipment installation shall be fully enclosed, weather tight, and free of contaminants.
B. Final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to installation and shall be maintained for the remainder of the construction period.
C. Verify that all labels and nameplates meet UL 969 standards.
D. Any applicable equipment shall meet UL 60950-1.

3.02 INSTALLATION:

A. General:
   1. Cabling, connector assemblies, and associated hardware shall be installed in accordance with TIA 568 C.1, TIA 568 C.2, TIA-568-C.3, TIA 569 C, NFPA 70, and UL standards as applicable.
B. Cable:
   1. General Requirements:
      a. Metal raceway bases, covers, and dividers shall be bonded and grounded in accordance with TIA-607-B and UL 467.

b. Install cable in raceway as indicated.
c. Do not subject cable to pulling tensions or sidewall pressures in excess of manufacturer's recommendations.
d. Subcontractor shall use a load rated swivel, rated to assure compliance with cable pulling tension as published by the cable manufacturer.
e. Attach pulling grips around the cable diameter. Sufficient slack should be provided to cut off several meters of cable after it is in place.
f. Do not subject cable to bending radius less than those recommended by the cable manufacturer.
g. Support cables at connections or termination points such that any strain on cable will not be transmitted to the connection or termination.
h. Install cable supports in vertical runs of conduit, at boxes and at terminations in equipment, and as required to meet intermediate support requirements of National Electrical Code (NEC).
i. All pulling compounds shall be approved by cable manufacturer as being compatible with cable materials.
j. Follow the cable numbering scheme indicated and attach a cable identification tag to each cable at all termination or end points.

2. UTP Cable:
   a. Communications cabling and pathways with copper media shall be installed in accordance with the following criteria to avoid potential electromagnetic interference between power and communications equipment.
      (1) The interference ceiling shall not exceed 3.0 volts per meter measured over the usable bandwidth of the communications cabling.
      (2) Pathways shall be installed in accordance with the following minimum clearance distances of 4 feet from motors, generators, frequency converters, transformers, or uninterruptible power system, 12 inches from power conduits and cable systems, 5 inches from fluorescent or high frequency lighting system fixtures.
   b. Screw terminals shall not be used.
   c. Use an approved insulation displacement connection (IDC) tool kit for copper cable terminations.
   d. Do not untwist Category 6 UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
   e. Provide service loop on each end of the cable, 10 feet at the equipment rack and 12 inches at the jack.
   f. Do not exceed 25 pounds pull tension for four pair copper cables.
   g. Do not chafe or damage outer jacket materials.
   h. Do not over cinch cables, or crush cables with staples.
   i. UTP cable bend radii shall not be less than four times the cable diameter.
3. Cable Connections and Terminations:
   a. Subcontractor shall provide a qualified technician to make all connections and terminations cable as specified.
   b. All cable connections and terminations shall be made according to manufacturer's instructions.
   c. Make only in terminal boxes, equipment or other accepted enclosures and not in conduit or cable tray.
   d. Install all connectors with manufacturer's approved tooling.
   e. Cable identification markers shall be installed at each connection.

C. Surge Protection
   1. Provide surge protection at each end of cable on all copper communications cables where both terminations are not within the same building envelope.

D. Ethernet Switches:
   1. Install Ethernet switches in equipment rack or control panels and make connections as indicated.
   2. Arrange with proper clearances from other equipment and material to obtain accessibility for operation and maintenance.
   3. Program managed switches for proper operations.
      a. Rapid spanning tree operation shall be implemented for redundancy in system.
      b. Program switch fault contacts to alert operators of switch problems or errors.
   4. Manufacturer's management software shall be installed on the server, Workstation and laptop to allow the Owner to monitor and configure the Ethernet switches.

E. Radio System and Ancillaries:
   1. Confirm surge protection is provided with the antenna.
   2. Confirm installation is correct and equipment is operating properly.

3.03 FIELD QUALITY CONTROL:

A. System Tests:
   1. Perform communications cabling inspection, verification, and performance tests in accordance with TIA-568-C.0, TIA-568-C.1, TIA-568-B.2 and TIA-568-C.3.
   2. Inspect all cabling terminations to confirm color code for tip and ring pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.2.
   3. Perform optical fiber end to end attenuation tests using an optical light meter and manufacturer's recommended test procedures.
      a. Perform tests in accordance with TIA-526-14-B, Method B for horizontal, multimode optical fiber.
      b. Perform verification acceptance test on each fiber after installation of the cable.
      c. Any excessive losses due to installation, connectors, etc., shall be identified and corrected by the Subcontractor and tested with no additional charge.
   4. Category 6 Links: Perform UTP link tests in accordance with TIA-568-C.2.
      a. Tests shall include wire map, length, attenuation, NEXT, and propagation delay.
   5. After acceptance of communication cable system, all additional components (including Ethernet switches and jumpers) shall be installed and operation of the complete system tested.
   6. Copies of the test shall be submitted to the Contractor for acceptance of the communication system.

B. Radio System RF Performance:
   1. Each station checked for antenna VSWR, transmitter power output and receive signal strength.
      a. Antenna VSWR less than 1.2:1.
      b. Transmitter Power output at 1 watt.
      c. Receive Signal Strength greater than -85 dBm (any remote to master, master to any remote).
      d. Provide a written report of the results of the above tests to the Contractor.
   2. Comply with TIA-329.1-D.
   3. Comply with IEEE 1613 as applicable.

3.04 ADJUSTING AND CLEANING:

A. All network cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.

B. Prior to final acceptance all network equipment shall be wiped clean and free from dust.

3.05 TRAINING:

A. Provide a minimum of 4 hours of training at the customer's facility for operations, maintenance and service personnel of the installed network and SCADA radio system equipment.

1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
2. Topics covered shall include hardware layout and functions, programming and configuration, diagnostic indicators, faults, diagnostic tools, troubleshooting, and preventive maintenance.
3. Hands-on training shall be provided on equipment.
4. Documentation shall be provided which shall include actual hard copies of manuals for the equipment supplied for this project.

B. Subcontractor shall record the training sessions and provide a final edited version to the Owner on a video DVD-ROM and electronic video file format.

END OF SECTION 40 66 00

SECTION 40 67 00 – PROCESS CONTROL PANELS AND HARDWARE

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes requirements for process control panels and internal components. Process control panels shall include:
   1. Process Control Panel Enclosure
   2. Thermal Management
   3. Nameplates
   4. Circuit Breakers
   5. Control Power Transformers
   6. Surge Protective Devices
   7. Terminal Blocks
   8. Switch Action Fuse Blocks
   9. Push Buttons and Selector Switches
   10. Pilot Lights
   11. Control Relays
   12. Time Delay Relays
   13. Intrinsically Safe Barriers
   14. Power Supplies
   15. Uninterruptable Power Supply (UPS)
   16. Convenience Receptacles
   17. Interior Illumination
   18. Ethernet Switches
   19. Ethernet Radio
   20. Programmable Logic Controllers (PLC)
   21. Operator Interface Terminal (OIT)

1.02 RELATED REQUIREMENTS:

A. SECTION 01 33 00 – Submittals.
B. SECTION 01 40 00 – Contractor QA/QC.
C. SECTION 01 42 00 – Definitions and Standards.
D. SECTION 01 60 00 – Equipment and Materials.
E. SECTION 01 75 00 – Manufacturer's Field Services.
F. SECTION 01 78 36 – Warranties.
G. SECTION 26 05 73 – Electrical Studies.
H. SECTION 26 33 53 – Static Uninterruptible Power Supply.
I. SECTION 26 43 13 – Surge Protection Devices for Low-Voltage Electrical Power Equipment.
J. SECTION 40 60 00 - Process Control and Instrumentation General Requirements
K. SECTION 40 61 96 – Process Control System Programming and Reports.
L. SECTION 40 66 00 – Process Control Networks.
M. SECTION 40 68 00 – Process Control Software.

1.03 REFERENCE STANDARDS:

A. As specified in SECTION 01 42 00.
B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
C. Institute of Electrical and Electronic Engineers (IEEE):
   1. IEEE 802.1 – Local and Metropolitan Area Networks.
   2. IEEE 802.3 – Ethernet.

D. National Fire Protection Association (NFPA):
   1. NFPA 70 – National Electrical Code (NEC).
   2. NFPA 79 – Electrical Standard for Industrial Machinery.

E. National Electrical Manufacturers Association (NEMA):
   1. NEMA 250 – Enclosures for Electrical Equipment (1,000V maximum).
   2. NEMA ICS 1 – Industrial Control and Systems - General Requirements.
   3. NEMA ICS 2 – Industrial Control and Systems - Controllers, Contactors, and Overload Relays Rated 600 Volts.
   4. NEMA ICS 4 – Application Guideline for Terminal Blocks.
   5. NEMA ICS 5 – Industrial Control and Systems - Control Circuit and Pilot Devices.
   6. NEMA ICS 6 – Industrial Control and Systems - Enclosures.

F. Underwriters Laboratories (UL):
   1. UL 50 – Enclosures for Electrical Equipment.
   2. UL 489 – Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
   3. UL 508 – Industrial Control Equipment.
   4. UL 508A – Industrial Control Panels.
   5. UL 698A – Industrial Control Panels Relating to Hazardous (Classified) Locations.
   6. UL 869A – Service Equipment.
   7. UL 1449 – Surge Protective Devices.
   8. UL 1778 – Uninterruptible Power Systems.

1.04 SUBMITTALS:

A. In addition to the requirements of SECTION 01 33 00, submittals shall include the following:
   1. Product Data: Submit the following for each type of product specified:
      a. Specification data sheets.
      b. Catalog cut sheets.
      c. Fabricator's qualifications.
   2. Shop Drawings: Provide the following as minimum:
      a. Fabrication drawings, front elevation, wiring diagrams, and bills of material for control panels.
      b. General control panel arrangement drawings, front elevation, dimensions, wiring diagrams, and bill of materials.
      c. Submit power and control wiring diagrams and schematics.
      d. Wiring diagrams shall clearly indicate factory and field wiring with all termination locations clearly shown. All wiring shall be labeled and terminated on terminal blocks.
      e. Interconnection diagrams showing conductor sizes, types, cable number, and wire color for all field connections. Clearly indicate which conductors are to be provided and installed by others.
      f. Engraving schedule and physical dimensions for nameplates.
      g. Provide heat dissipation calculations for all panels containing solid-state controllers. Include calculations for ventilation fans for environmentally controlled areas, or heat exchangers/air conditioners in process spaces, if required.
      h. Nameplate Data for all motors in accordance with NEMA MG 1 nameplate requirements.
      i. Detailed control package summary including I/O lists, alarms, control loops, control schematics and integration of associated ancillary equipment. Control schematics shall provide all I/O requirements for motor control equipment provided by others.

j. Detailed description and PLC control logic for long-term storage (approx. 8 months) of the membrane modules.

3. Factory/Shop Test Plan:
   a. Provide a complete and detailed test plan for the supplied control panels.
   b. Include procedures for certification, validation, and testing.
4. Test and Evaluation Reports:
   a. Factory test reports.
   b. Field test reports.
5. Closeout Submittals: Final documentation shall include the following as minimum:
   a. Operation and Maintenance Manuals including the following:
      (1) Operation and maintenance manuals for all components furnished.
      (2) Certified "As-Built"/"As-Installed" drawings.
      (3) Copies of all approved Product Data.
      (4) Copies of all approved Test Reports.
      (5) Spare parts and supply list.
      (6) Warranty Information.
      (7) Subcontractor Information.
   b. Training Materials.

1.05 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.

B. Materials and Equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least 1 year prior to Bid opening.

C. Fabricator Qualifications:
   1. Prior to assembly and installation, submit data of fabricator's experience and qualifications.
   2. Fabrication shall be by a manufacturer or a particular division of a manufacturing firm specializing in control panel construction.
   3. Shall have a minimum of 10 years' experience in control panel fabrication.
   4. Panel shall be fabricated in a UL listed panel shop.

D. Factory Tests:
   1. The manufacturer shall conduct tests according to industry standard requirements.
   2. Perform factory tests on all control panels and components and subassemblies to assure that all devices and systems are in proper working order before delivery to jobsite.
   3. Test all power, controls, full I/O test, and communication systems for proper operation.
   4. Simulate actual system operation.
   5. Submit test reports as specified in Division 01.

E. All control panels and associated equipment shall conform to the requirements of NEMA ICS and UL 508A standards.

1.06 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.

B. Control panels and associate equipment shall be packaged and shipped to the project site in such a manner as to avoid damage.

C. All control panels shall be stored according to the manufacturer's instructions and in a conditioned space to avoid condensation, dust, and other environmental contaminants.

1.07 SITE CONDITIONS:

A. All Equipment provided as part of this system shall be rated for the temperature, seismic and elevations as specified in the Site Conditions in Section 26 00 00.

1.08 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Enclosures:
   1. B-Line, Eaton.
   2. Hoffman, Pentair PLC.
   3. Wiegmann, Hubbell, Inc.
   4. Milbank Manufacturing Company.
   5. Saginaw Control & Engineering.

B. Thermal Management Components:
   1. Hoffman, Pentair PLC.
   2. Noren Products, Inc.
   3. Pfannenberg.
   4. Saginaw Control & Engineering.

C. Surge Protective Devices:
   1. Refer to Section 26 43 13 Surge Protective Devices

D. Terminal Blocks:
   1. Allen-Bradley, Rockwell Automation, Inc.
   2. Buchanan, Tyco Electronics Corporation.
   3. Phoenix Contact.
   4. Square-D, Schneider Electric.
   5. Weidmuller.

E. Push Buttons, Selector Switches and Pilot Lights:
   1. Allen-Bradley, Rockwell Automation, Inc.
   2. Appleton, Emerson Electric Company.
   3. Eaton.
   4. IDEC Corporation.
   5. Killark, Hubbell, Inc.
   6. Square-D, Schneider Electric.

F. Control and Timing Relays:
   1. Allen-Bradley, Rockwell Automation, Inc.
   2. Eaton.
   3. IDEC Corporation.
   4. Phoenix Contact.
   5. Potter & Brumfield, Tyco Electronics Corporation.
   6. Square-D, Schneider Electric.
   7. Turck, Inc.

G. DC Power Supplies:
   1. Allen-Bradley, Rockwell Automation, Inc.
   2. IDEC Corporation.
   3. Phoenix Contact.
   4. PULS.

5. SolaHD, Emerson Electric Company.

H. Uninterruptible Power Supplies (UPS):
   1. Refer to Section 26 33 53 - Static Uninterruptible Power Supply

I. Convenience and UPS Receptacles:
   1. Cooper Industries, Eaton.
   2. Hubbell, Inc.
   3. Leviton Manufacturing Co., Inc.
   4. Phoenix Contact.

J. Interior Illumination:
   1. Acuity Brands, Inc.
   2. Hoffman, Pentair Inc.
   3. Hubbell, Inc.
   4. Stego, Inc.

K. Wiring Duct:
   1. Panduit Corporation, H-Type.
   2. Thomas and Betts Corporation, ABB Group.

L. Wire Markers:
   1. Brady Worldwide, Inc.
   2. Panduit Corporation.
   3. Thomas and Betts Corporation, ABB Group.

M. Ethernet Switches:
   1. Refer to Specification 40 66 00.

N. Ethernet Radio
   1. Coordinate with City of Broomfield

O. Programmable Logic Controllers (PLC):
   1. Allen-Bradley – ControlLogix and CompactLogix family, as required for proper operation.
   2. Approved equal.

P. Operator Interface Terminal (OIT):
   1. Red Lion
   2. Approved equal.

2.02 PROCESS CONTROL PANEL ENCLOSURE:

A. Totally enclosed panel with gasketed doors, continuous hinge, and three-point latching mechanism with lockable handle.

B. Sized to house all equipment and devices required, provide sufficient space for conduit entry, and provide sufficient heat dissipation for the installed components.

C. Unless specified or indicated otherwise provide the following NEMA 250 approved enclosure type(s):
   1. For the following areas:
      a. Indoor electrical rooms: NEMA Type 12 gasketed painted steel enclosures.
         (1) Painted enclosures shall have a light gray polyester powder coat finish on the exterior with a white polyester powder coat finish on the interior.
      b. Indoor and Outdoor process areas: NEMA Type 4X stainless steel.

D. Unless specified or indicated otherwise provide the following enclosure design:
   1. Wall Mount Design:
      a. Provide for enclosures with a vertical dimension less than 50-inches.
      b. Formed and welded construction, minimum 14-gauge.
      c. Interior 12-gauge minimum steel mounting panel(s).

d. Provide mounting tabs and required hardware for installation of enclosures.

2. Free Standing and Floor Mount Design:
   a. Provide for enclosures with vertical dimensions of 50-inches or greater.
   b. Formed and welded construction, minimum 12-gauge for single door enclosures. For multi-door enclosures provide a 10-gauge back.
   c. Interior 10 or 12-gauge steel mounting panel(s).
   d. Provide door mounted folding shelf for support of instruments and test equipment. Shelf shall be mounted on the interior of the door. For multi-door enclosures provide a shelf for each pair of doors.
   e. Provide with lifting eyes.

E. Provide lockable design.

F. Bond multisection control panels together using equipment bonding jumper sized per NFPA 70 (NEC).

G. Provide convenience receptacle as specified this Section.

H. Provide Thermal management as specified this Section.

I. Provide LED light with door switch as specified this Section.
   1. Provide at least one light per section capable of providing 50 footcandles at the panel bottom.

J. Accessories:
   1. Provide data pocket mounted on the interior of the panel for storage of wiring diagrams.
   2. Provide a door stop kit designed to secure the door in the 90 degree open position.

K. Shall comply with UL 50, UL 508A, and NEMA ICS 6 standards.

2.03 THERMAL MANAGEMENT:

A. Provide as required to maintain panel temperature below component ratings.

B. Provide for the following panels:
   1. Panels with PLCs installed,
   2. Or as specifically indicated.

C. Provide a compact 6-inch fan with rigid metal housing with finger guard. Motor shall be thermally protected and bearings shall be permanently lubricated ball bearings and design for a minimum of 50,000 hours of continuous operation. Impeller shall be polycarbonate. Powered from 120Vac.

D. Provide 14-gauge steel louver for the intake and exhaust openings. Louver finish shall match the finish on the panel. Provide an aluminum filter and gasket for each louver.

E. Provide all required mounting brackets for complete installation in the panel.

F. Temperature Switches:
   1. Provide single pole double throw (SPDT) temperature switch for each panel, wire the normally open (NO) contacts to the exhaust fan, and the normally closed contacts to the PLC high temperature alarm as indicated.
   2. The temperature control switches shall have an adjustable range of 30°F to 140°F.
   3. The temperature switch contact shall close on temperature rise and be rated 15A at 120Vac.
   4. Designed for DIN rail mounting.
   5. The high temperature alarm switch shall be set at 100°F and the fan switch shall be set at 80°F.
   6. Prewire high temperature alarm switch to a PLC digital input.

G. Provide one temperature transmitter for each electrical room. Refer to Section 40 70 00.

2.04 NAMEPLATES:

A. Fabricate from laminated phenolic sheeting with black core and satin finish melamine overlay.
B. Colors shall white with black letters.
C. Thickness: 1/16 inch nominal.
D. Bevel edges to expose black core on perimeter.
E. Engraved legend through overlay to expose core.
F. Attach to panels with industrial grade double-faced tape.
G. Refer to Section 26 05 53 – Electrical Identification for additional labeling requirements, including wire labeling format.

2.05 CIRCUIT BREAKERS:

A. Provide for main disconnecting means for panel and for power distribution within the panel for all voltages.
    1. 120/240Vac and 24Vdc:
        (1) Rated for 120/240Vac and 24Vdc as indicated.
        b. Thermal-magnetic trip units.
        c. Trip rating and curve as recommended by manufacturer of equipment being protected.
        d. DIN rail mounted on the inside of the control panel in a readily accessible location.
        e. Toggle-type handle with a quick-make, quick-break over-center switching mechanism that is mechanically trip-free.
    2. Minimum symmetrical interrupting capacity of 10,000 AIC, or available fault current, whichever is greater.
B. All circuit breakers must be UL 489 listed.

2.06 CONTROL POWER TRANSFORMERS:

A. Control Panels shall be provided with control power transformers. Refer to Section 26 22 13 – Low Voltage Distribution Transformers for requirements.

2.07 SURGE PROTECTIVE DEVICES (SPD):

A. Control Panels shall be provided with an integral Surge Protective Device (SPD). Refer to Section 26 43 13 – Surge Protection Devices for requirements.

2.08 TERMINAL BLOCKS:

A. 600V, sectional type polyamide blocks.
B. Rated a minimum of 24A. Provide higher Amp rated blocks as required.
C. Screw connection type.
D. Finger safe.
E. Slide in vinyl marking strip for terminal identification.
F. DIN rail mounted.
G. Terminal blocks shall comply with NEMA ICS 4.

2.09 SWITCH ACTION FUSE BLOCKS:

A. Rated 600V.
B. Screw connection type.
C. Finger safe.
D. DIN Rail mounted.

2.10 PUSH BUTTONS AND SELECTOR SWITCHES:

A. Heavy duty, 30 mm units with contacts rated 10A continuous at 120Vac.
B. NEMA 4X rated when installed in NEMA 12 or 4X enclosures.
C. Provide the number of contacts and contact development as indicated.
D. Operator colors shall comply with UL 508A and NFPA 79.
    1. Start or On push buttons shall have green operators.
    2. Stop or Off push buttons shall have red operators.
E. Emergency Stop push buttons shall have red mushroom head operators with a yellow base.
F. Provide hermetically sealed units when installed within a classified area.
    1. Suitable for installation in a Class I, Division 1 and 2, Group D area.
G. Push Buttons and Selector Switches shall conform to NEMA ICS 5.

2.11 PILOT LIGHTS:

A. Heavy duty, 30 mm units.
B. NEMA 4X rated when installed in NEMA 12 or 4X enclosures.
C. 120Vac or 24Vdc cluster LED type.
D. Green lights shall indicate “Equipment On”, “Running”, or “Valve Open”.
E. Red lights shall indicate “Equipment Off”, “Stopped”, or “Valve Closed”.
F. Amber lights shall indicate “Equipment Failure” or “Alarm”.
G. Blue lights shall indicate “Equipment in Auto”.
H. Push-to-test type.
I. Pilot lights shall conform to NEMA ICS 5.

2.12 CONTROL RELAYS:

A. Plug-in type relay with neon coil energization indicator.
B. Coil voltage: 120Vac or 24Vdc as required.
C. Contacts rated 10 Amps at 120Vac.
D. Number of contacts as required.
    1. Provide one spare N.O. and one spare N.C. contact (minimum).
    2. Spare contacts shall be as indicated.
E. Provide DIN rail mounted relay socket with screw type terminations.
F. Control relays shall conform to NEMA ICS 5.

2.13 TIME DELAY RELAYS:

A. Plug-in type digital based electronic timing relay with coil energization indicator.
B. Coil voltage: 120Vac or 24Vdc as required.
C. Contacts rated 10 Amps at 120Vac.
D. Timing range as indicated with a minimum setting accuracy of ±2% and repeat accuracy of ±0.1%.
E. The selection of timing range settings via DIP switches. The time delay within the range shall be set utilizing an adjustment dial.
F. Number of contacts as required.
    1. Provide one spare N.O. and one spare N.C. contact (minimum).
G. Provide DIN rail mounted relay socket with screw type terminations.
H. Time delay relays shall conform to NEMA ICS 5.

2.14 DC POWER SUPPLIES:

A. Provide industrial rated primary switched 24Vdc power supplies as specified and indicated.
B. Enclosed design with finger safe input and output terminal blocks.

C. Designed for DIN rail or back panel mounting.
D. DC power supply rated as follows:
   1. Input voltage: 95 to 130Vac.
   2. Output voltage: 24Vdc ±1%.
   3. Output current: 10A minimum with a minimum 25% spare capacity.
   4. Line regulation: ±0.2% maximum.
   5. Load regulation: ±1.5% maximum.
   6. Ripple: <50 mV pk-pk.
   7. No overshoot for turn on, turn off, or power failure.
   8. Operating temperature: -25°C to +60°C.
   9. Overload and short circuit protection.
   10. Indicating lights for status.
E. Redundancy Module.
   1. Provide DIN rail mounted redundancy module that provides complete isolation between two 24Vdc power supplies.
   2. Unit shall accept two 24Vdc inputs and provide one redundant 24Vdc output.
   3. Rated for a minimum of two 20A inputs and one 20A output.
   4. Operating temperature: -25°C to +60°C.
   5. Provide status light and dry output contact that opens when either of the 24Vdc inputs is lost. Output contact shall be rated a minimum of 2 Amps at 30Vdc.

2.15 UPS (LINE INTERACTIVE):

A. Network grade, uninterruptible power system completely self-contained module with an inverter, batteries and control system as specified in Section 26 33 53.
B. Shall be provided for PLC Cabinets and other control panels containing micro-processor based controllers.
C. Electrical Capacity: 1500VA minimum.
D. Provide all required mounting hardware to mount the panel ion a shelf within the PLC panel.
E. Provide three ½ amp fused terminals for 120 VAC UPS power to be wired by others to field devices.

2.16 CONVENIENCE RECEPTACLES:

A. Interior Mounted Receptacle:
   1. DIN rail mounted, 15-A duplex three-wire grounding GFCI type receptacle with enclosure.
   2. Equipped with terminal blocks for power connection.
   3. Outlet shall be protected with a 5 Amp circuit breaker labeled “FOR LAPTOP USE ONLY.”
   4. One mounted inside control panel for use in powering laptops and test equipment for service of the panel.

2.17 INTERIOR ILLUMINATION:

A. Provide LED type panel lights.
B. Minimum 50,000 hour life.
C. Size and quantity designed to provide a minimum 50 foot-candles at the base of the panel.
D. Powered from 120Vac. Provide required power supply.
E. Panel light shall be controlled by a door interlock switch.

2.18 POWER DISTRIBUTION:

A. Wiring:
   1. UL style 1015 (AWM), or UL style 1063 machine tool wire (MTW), 600V, 90°C.
   2. No. 14 AWG (minimum), 41 strand, for all control wiring.
   3. No. 18 AWG (minimum), shielded twisted pairs and triads as applicable for all instrumentation wiring.
      a. Color code shall be black/red pair (black/red/white triad) with black PVC jacket.
   4. Wire Colors (UL508A):
      a. Black: 240V or 480V AC wiring.
      b. Red: 120V AC wiring.
      c. White: AC neutral.
      d. Green: Ground.
      e. Blue: DC(+).
      f. White w/ Blue Tracer: DC(-) grounded.
      g. From alternate power source that remains energized when main disconnect is open:
         (1) Yellow: Un-switched power.
         (2) White w/Yellow Tracer: Un-switched neutral.

B. Wire Markers:
   1. Heat shrinkable, tube-type sleeve markers, constructed of polyolefin material.
   2. White sleeves with black thermal printed text.
   3. Identify both ends of wire with the same unique wire number.
   4. Assign wire numbers where specific designations are not indicated.
   5. Markers sized for snug fit for wire size.

C. Wiring Duct:
   1. Provide wide slot wiring duct in panel for routing of panel wiring. Slots shall be a minimum of 0.25-inches.
   2. Provide with dual hinge, push-on cover that opens a minimum of 100 degrees to either side.
   3. Wiring ducts shall be sized to accommodate all installed wire plus a minimum of 25% spare capacity.

D. Ground Bus:
   1. Provide copper ground bus for power circuits.
   2. Provide isolated copper ground bus for instrument shields.

2.19 ARC FLASH LABEL:

A. Provide a 6 x 4 inch (minimum), plastic arc flash label for each control panel.
B. Label shall be orange and white.
C. Label shall read as follows: WARNING – Arc Flash and Shock Hazard. Appropriate PPE and Tools Required When Working on this Equipment.
D. Coordinate with Section 26 05 73 – Electrical Studies.

2.20 SPARE PARTS:

A. Two spare LED indicating lamps for each type and color used.
B. Two spare indicating light assemblies.
C. Ten spare control fuses of each voltage and current rating used.
D. One aerosol cans of manufacturer's touch-up paint for each color used. Color shall match the original factory applied color.
E. Provide ten (10) spare fuses and breakers of each type used including those used in power supplies, processor and all I/O cards.

2.21 ETHERNET SWITCHES:

A. Refer to Specification 40 66 00.

2.22 ETHERNET RADIO:

A. Coordinate radio equipment requirements with City of Broomfield. Refer to Section 40 60 00 for required Radio Path Analysis.

2.23 PROGRAMMABLE LOGIC CONTROLLERS (PLC):

A. Provide SPD in process control panels on main power feed for all PLCs installations.
B. All analog inputs and outputs shall be individually fused.
C. All digital inputs and outputs shall be individually fused.
D. Provide PLC hardware.
    1. General:
        a. The programmable controller shall receive status intelligence, perform logic functions, issue control commands, and provide alarms and status information for the systems described in these Specifications.
        b. The programmable controller Equipment shall consist of a solid-state control system which has user programmable memory for storage of instructions to implement specific functions.
        c. The PLC Equipment shall be purposely designed as an industrial control system which can perform functions equivalent to a relay panel or a wired solid-state logic system.
        d. Maximum scan time of 25 ms for all channels.
        e. All PLC Equipment provided shall be capable of operation in ambient temperatures of 0°C to 60°C, and 5 to 95% relative humidity (non-condensing), without fans or other cooling equipment.
        f. All external connection points shall be capable withstanding the IEEE surge withstand capability (SWC) test as defined in IEEE C37.90.1.
        g. The PLC's shall be capable of being configured as a redundant controller.
    2. Chassis:
        a. Provide PLC chassis as required to accommodate the I/O and communications modules required and indicated.
        b. Provide slot fillers for all unused chassis spaces.
    3. Power Supplies:
        a. Provide power supplies for the processor chassis and expansion chassis as required.
        b. Power supply shall be sized to supply required power for all installed modules and any spare spaces within the chassis.
        c. Input voltage shall be 120Vac as indicated.
    4. Processor:
        a. Provide PLCs arranged with all necessary components and software for proper operation.
        b. The processor shall be of solid-state design on modular printed circuit boards.
        c. The processor shall be equipped with an additional communications port for programming.
        d. The processor shall have user-programmable memory with provisions to prevent unauthorized changes.
        e. The processor shall continuously perform diagnostics analysis with a predetermined failure mode in the event of a fault.

f. All I/O including analog shall be scanned and updated at a rate not to exceed 0.3 milliseconds per scan.
g. The processor shall allow the logic to be modified, while the processor is in the Run mode without affecting the operation of those portions of the logic not being modified.
h. The processor shall provide selectable timed interrupt capabilities for the user to incorporate into the running code.
i. The processor shall provide user defined fault routine capabilities.
j. The processor shall automatically clear all output and update all input on power-up and prior to scanning and solving any logic.
k. The processor shall provide the user with a status bit for use in the logic for initialization purposes. This status bit shall be set/reset based on the indicating the first program scan.
l. The processor shall provide a comprehensive instruction set including:
    (1) Relay Contact Input:
        (a) Normally open.
        (b) Normally closed.
        (c) Transitional.
    (2) Relay Coil Output:
        (a) Standard.
        (b) Retentive.
    (3) Timers:
        (a) On delay.
        (b) Off delay.
        (c) Duration.
        (d) Retentive
        (e) Time bases of 1.0 sec, 0.1 sec, and 0.01 sec.
    (4) Counters:
        (a) Count up.
        (b) Count down.
    (5) Arithmetic:
        (a) Single-precision.
        (b) Double-precision.
        (c) Integer.
        (d) Add.
        (e) Subtract.
        (f) Multiply.
        (g) Divide.
        (h) Square root.
        (i) Less than.
        (j) Greater than.
        (k) Equal.
    (6) Logical:
        (a) And.
        (b) Or.
        (c) Exclusive or.
        (d) Compare.
    (7) PID.

5. Communications Hardware:

a. Provide communication modules for communications via the communications network.
   (1) All data within a PLC shall be accessible to any operator workstation, PLC or OIT.
      (a) Programming functions shall be possible over the network.
      (b) Unloading and downloading of programs shall be possible over the network.
      (c) The operating mode of the PLC shall be changeable via the network.
b. Provide all required communication cables, connectors, and terminating resistors.

6. PLC Input and Output Modules:
   a. Digital Input Modules:
      (1) 120Vac nominal input voltage with an on state voltage of 79 to 132Vac and an off state voltage less than 20Vac.
      (2) Maximum hardware input delay time of 10 ms.
      (3) Maximum inrush current of 0.25 Amps.
   b. Relay Output Modules:
      (1) Rated 2.0 Amps nominal at 120Vac.
      (2) Maximum output delay time of 13 ms.
      (3) Make rating of 15 Amps and a break rating of 1.5 Amps at 120Vac.
      (4) Provide individual surge suppressors for each output to protect module from surges caused by inductive load switching.
   c. Analog Input Modules:
      (1) Individually isolated, 4-20 mA current inputs.
      (2) Each input shall have a minimum 16-bit resolution.
      (3) Programmable input filter.
   d. Analog Output Modules:
      (1) Individually isolated, 4-20 mA current outputs.
      (2) Each output shall have a minimum 16-bit current resolution.
      (3) Provide 1700Vdc channel to channel isolation and channel to backplane isolation.
   e. Provide screw clamp removable terminal block connectors for each module.

2.24 OPERATOR INTERFACE TERMINAL (OIT):

A. Provide for process control panels and Manufacturer supplied control panels.
B. Provide a 15.6" capacitive touch flat panel color TFT display (18-bit color, minimum). Resolution shall be 1920x1080 (16:9 aspect ratio), minimum.
C. Luminance shall be a minimum of 400 cd/m2 (Nits) LED backlight.
D. Operating systems shall be Microsoft Windows 10 IoT or newer.
E. CPU shall be dual-core 2.4 GHz clock speed, minimum.
F. Drive storage:
   1. 1 x bootable up to 128 GB CFast SATA III slot onboard with external front access
   2. 1 x onboard connector for direct insertion of mSATA up to 1 TB SSD SATA III
   3. 1 x onboard connector for 2.5” SSD SATA III up to 1 TB
   4. Storage amount provided to be determined by equipment supplier or system integrator with a minimum of 100% spare storage capacity
G. OIT unit shall have a minimum of 4GB or DDR4-2400 RAM. Size to be determined based on operating requirements for smooth operation.
H. Environmental operating temperature range shall be 0 to 55°C, at 5 to 95% non-condensing relative humidity.

I. Shall be panel mounted with a NEMA rating to match the associated enclosure rating.
J. Provide the following external ports and interfaces as minimum:
   1. One SD Card (SDHC).
   2. A minimum of 2 USB-3.0, and 2 USB-2.0 host ports for peripheral connections.
   3. 1 RS-232 port
   4. 1 DVI-D video port
   5. 1 PCIe x4 expansion port
K. Communication interfaces shall include the following:
   1. One RJ-45 Ethernet (10/100/1000 Mb Autosensing).
L. Shall accept input power from 24VDC. Provide DIN-rail 120Vac AC-to-DC power supply as required.
M. Shall be capable of communicating over the Control system network as indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Verify site conditions are suitable for installation of equipment.
B. For indoor control panels final or temporary HVAC systems shall be in place and operational to maintain the ambient temperatures and humidity conditions at occupancy levels prior to energizing panel and shall be maintained for the remainder of the construction period.

3.02 PANEL FABRICATION:

A. Install all components in the panel as required and recommended by the manufacturer.
B. Provide master nameplate and nameplates for all operator interfaces. Interior nameplates shall be provided for individual component identification including, but not limited to, power supplies, PLCs, control relays, terminal blocks, Ethernet switches, circuit breakers, etc.
C. Provide interior illumination for all panels.
D. Power Distribution:
   1. Provide circuit breakers for protection of equipment in the panel and distribution of power to equipment powered from the control panel.
   2. Provide main power disconnect operable from the exterior of the panel for all panels supplied with 480-volts. For panel supplied with 480-volt power provide properly sized control power transformer and required circuit breakers for distribution of power within the panel. Provide dedicated circuit breakers for all 480-volt equipment powered from the panel.
   1. Control panels shall include provisions for connection of a 120Vac, 20Amp supply, or as shown on the Drawings.
      a. Control panels served by a panel mounted UPS shall include provisions for connection of two (2) 120Vac, 20Amp supply circuits. One circuit shall be used as “House” power for lights, fans, receptacles, etc. The second circuit shall power the panel mounted UPS and shall power all PLC, network, and control system related loads.
   2. Provide 120Vac circuit breakers to distribute power within the control panel. Circuit breakers shall be sized based upon connected load. As a minimum, a dedicated circuit breaker shall be provided for the each of the following:
      a. Incoming power sources.
      b. UPS power source.
      c. Each device such as lights, fans, heaters, receptacles installed within the panel.
      d. 24Vdc power supplies.

e. Each 120Vac digital input or output module.
f. Each 120Vac instrument or device powered from the panel.

3. Provide 24Vdc circuit breakers to distribute power within the control panel. Circuit breakers shall be sized based upon connected load. As a minimum, a dedicated circuit breaker shall be provided for each of the following:
   a. Output of 24Vdc power supply.
   b. PLC power supply (24Vdc).
   c. Each 24Vdc digital input or output module.
   d. Each loop powered instrument.
   e. Each analog input module, if required.
   f. Each analog output module, if required.
   g. Each 24Vdc instrument or device powered from the panel.
4. Provide signage on panel to clearly indicate that the panel is powered from multiple sources, if applicable.

E. Surge Protection:
1. Provide surge protection on the incoming 480Vac supply and 120Vac distribution systems within the panel to protect electronic components from transient voltage surges.
2. Provide surge protection on all power circuits to instruments installed outside of the building envelope in which the control panel is installed. The terminal block type surge suppressor shall be the termination point for the field cabling.
3. Provide surge protection on all inputs and outputs that are connected to equipment outside of the building envelope in which the control panel is installed. The terminal block type surge suppressor shall be the termination point for the field cabling.

F. Component Mounting:
1. Operator interfaces and indicating lights shall be installed in the door of the panel at a convenient height for operator interaction with pilot devices and operator interfaces no higher than 72”, unless specifically noted otherwise.
2. Components shall be mounted to provide complete accessibility to all terminals, relay sockets, and other devices without dismantling of panel equipment.
3. Provide sufficient space around and layout components to allow for proper heat dissipation.
4. Provide sufficient space at the top of the panel for conduits and cable entry. Conduit entry locations shall be coordinated with the Subcontractor.

G. PLC I/O:
1. Provide interposing relays for all discrete outputs from the PLC including spare points.
2. Provide interposing relays for all relay outputs from the PLC driving loads that exceed 1.5A and when indicated.
3. Wire all inputs and outputs from the PLC to terminal blocks.

H. Wiring Methods:
1. Route main groups of wires in plastic nonflammable wiring duct.
2. Smaller groups of wire shall be cabled and secured with nylon cable clamps and ties or plastic spiral wraps.
3. Maintain physical separation of power, control and instrumentation cables within the panel.
4. Provide dedicated wiring ducts for management of field cables within the panel. Wiring ducts shall be sized to accommodate multi-conductor control cables. Assume a minimum of 25% spare conductors and provide a minimum of 25% spare capacity when sizing wiring ducts.

I. Terminal Blocks and Connections:
   1. Provide terminal blocks for all external connections.
   2. Make all connections on terminal blocks.
   3. Follow manufacturer's recommendations for terminal block installation.
   4. Connect terminal blocks for instrumentation cable shields to isolated ground bus.
   5. Provide required grounding type terminal blocks.

J. Spare Capacity:
   1. Provide a minimum of 25 percent, or 2 circuit breakers, whichever is greater, for each power source (Vac and Vdc) present within the panel. All spare circuit breakers shall be mounted, wired, and include provisions to terminate associated neutral or negative conductors.
   2. Provide a minimum of 4 spare slots in each PLC chassis. Provide blank filler modules for all empty slots.
   3. Provide a minimum of 20 percent or 4 points, whichever is greater, spare PLC inputs and outputs for each I/O type in each panel. All spare points shall be wired to field terminal blocks. Fifty percent of spare analog inputs shall be configured to provide loop power.
   4. Provide a minimum of 20 percent spare terminal blocks of each type mounted in the panel.
   5. Provide spare DIN rail space for the installation of terminal blocks for all spare slots in the PLC chassis.

K. Provide labeling on all terminal blocks, wiring and relays to match panel drawings.

3.03 UNINTERRUPTIBLE POWER SUPPLY INSTALLATION:

A. Refer to Specification 26 33 53 – Static Uninterruptible Power Supply.
B. Install UPS systems in control panel as specified.
C. Startup and initial charging shall be as required by the UPS manufacturer.
D. Install the Maintenance Bypass Switch and make the required connections to UPS and loads served.

3.04 ETHERNET SWITCH INSTALLATION:

A. Refer to Specification 40 66 00 – Process Control Networks.
B. Install Ethernet switches in control panels and make connections as indicated.
C. Arrange with proper clearances from other equipment and material to obtain accessibility for operation and maintenance.
D. Shall provide adequate ports for connection to the plant control system, PLC, OIT, door mounted RJ-45 port, and provide a minimum of one spare programming port.

3.05 PLC PROGRAMMING:

A. Refer to Section 40 61 96 – Process Control System Programming and Reports.

3.06 OIT PROGRAMMING:

A. Refer to Section 40 68 00 – Process Control Software for OIT and graphic programing requirements.

3.07 INSTALLATION:

A. Control Panels:
   1. Conform to manufacturer's written instructions.
   2. Surface-mount wall mount enclosures on structural supports or wall approximately 4 feet to center line above the floor when possible.

3. Install floor mounted enclosures where indicated and bolt to floor using expansion type concrete anchors.
4. Install all necessary openings in panels.
5. Arrange with proper clearances from other equipment and material to obtain accessibility for operation and maintenance.
6. Mount plumb and level.

B. Electrical Connections:
1. Install wire and cable as specified in Division 26.
2. Conform to manufacturer's wiring diagrams.
3. Install circuits to field-mounted equipment as indicated and required.
4. Installation shall conform to NFPA 70 (NEC).

C. Place arc flash label on equipment.

3.08 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services:
1. The panel supplier shall provide the field services of a trained technician for the amount of time required to commission, test and start-up all equipment provided.
2. All travel and living expenses shall be included for all trips to the site. All equipment required for testing, start-up and performance verification shall be provided by the start-up technician.

B. Check all internal and external connections and tighten as required.
C. Perform I/O checkout on all points and verify proper operation.
D. Verify proper connection of communication cabling and proper communication system configuration.
E. Field verify proper operation of all inputs and outputs.
F. Record results of I/O checkout and submit test reports as specified in Division 01.

3.09 FINISHES:

A. Control panel coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
1. Touch Up:
a. Subcontractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
b. Field painting shall be performed based on manufacturer's recommended procedures.
c. Subcontractor shall provide the necessary quantity of Manufacturer's touch-up paint to match the factory applied finish.

3.10 ADJUSTING AND CLEANING:

A. After field installation and final wiring terminations are completed the control panel wiring and cables shall be adjusted and neatly secured with tie wraps, hook-and-loop straps, or the like.
B. Wiring duct covers shall be replaced and secured as required.
C. Prior to final acceptance control panel interior and exterior shall be wiped clean and free from dust and debris.

3.11 TRAINING:

A. Provide a minimum of 4 hours of training for each panel provided at the customer's facility for operations, maintenance, and service personnel.

1. The training session shall include classroom discussion on the theory of operation of the equipment, as well as maintenance and service methods for the purchased equipment.
2. Topics covered shall include safety, hardware layout and functions, power and control wiring, diagnostic indicators, keypad/display interface, faults, diagnostic tools, troubleshooting, and preventive maintenance.
3. Hands-on training shall be provided on equipment.
4. Documentation shall be provided which shall include actual manuals for the equipment and drawings and schematics of equipment supplied for this project.

B. Subcontractor shall record the training sessions and provide a final edited version to the Owner on a video DVD-ROM and electronic video file format.

END OF SECTION 40 67 00

REFER TO ATTACHMENT – I/O LIST

ATTACHMENT

I/O LIST

Complete Tag	DESCRIPTION	Signal Type	Signal Level	Power Source	Controlled By	Description "0" Level	Description "1" Level	P&ID Drawing
HS-105-AUTO	NORTH TANK MXR-105 HANDSWITCH - AUTO	DI	24VDC	PLC-100	PLC-100	NAUTO	AUTO	0I-003
SC-105	NORTH TANK MXR-105 SPEED CONTROL	AO	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-003
YS-105-RC	NORTH TANK MXR-105 RUN CONFIRM	DI	24VDC	PLC-100	PLC-100	STOPPED	RUNNING	0I-003
JY-105-RUN	NORTH TANK MXR-105 RUN	DO	24VDC	VFD-MXR105	PLC-100	RUN	NORMAL	0I-003
YA-105-FLT	NORTH TANK MXR-105 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-003
LA-105-HIGH	NORTH TANK LEVEL - HIGH	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-003
LI-105	NORTH TANK (T-100) LEVEL INDICATOR	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-003
HS-106-AUTO	SOUTH TANK MXR-106 HANDSWITCH - AUTO	DI	24VDC	PLC-100	PLC-100	NAUTO	AUTO	0I-003
SI-106	SOUTH TANK (T-101) MXR-106 SPEED	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-003
SC-106	SOUTH TANK MXR-106 SPEED CONTROL	AO	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-003
YS-106-RC	SOUTH TANK MXR-106 RUN CONFIRM	DI	24VDC	PLC-100	PLC-100	STOPPED	RUNNING	0I-003
JY-106-RUN	SOUTH TANK MXR-106 RUN	DO	24VDC	VFD-MXR106	PLC-100	RUN	NORMAL	0I-003
YA-106-FLT	SOUTH TANK MXR-106 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-003
LA-106-HIGH	SOUTH TANK LEVEL - HIGH	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-003
LI-106	SOUTH TANK (T-101) LEVEL INDICATOR	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-003
JY-135-OPEN	BV-135 - OPEN	DI	24VDC	PLC-100	PLC-100	NOPEN	OPEN	0I-004
JY-135-CLOSE	BV-135 - CLOSE	DI	24VDC	PLC-100	PLC-100	NCLOSE	CLOSE	0I-004
HS-135-REM	BV-135 - REMOTE OPERATION	DI	24VDC	PLC-100	PLC-100	REMOTE	NORMAL	0I-004
HS-135-OPEN	BV-135 MOTOR TO OPEN POSITION	DI	24VDC	PLC-100	PLC-100	NOPEN	OPEN	0I-004
HS-135-STOP	BV-135 MOTOR TO CLOSE POSITION	DI	24VDC	PLC-100	PLC-100	STOP	NORMAL	0I-004
HS-135-CLOSE	BV-135 MOTOR STOP	DI	24VDC	PLC-100	PLC-100	NCLOSE	CLOSE	0I-004
ZS-135-OPEN	BV-135 POSITION - OPEN	DI	24VDC	PLC-100	PLC-100	NOPEN	OPEN	0I-004
ZS-135-CLOSED	BV-135 POSTION - CLOSED	DI	24VDC	PLC-100	PLC-100	NCLOSE	CLOSE	0I-004
YA-135-FLT	BV-135 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	STOP	NORMAL	0I-004
ZS-100-OPEN	FCV-100 POSITION - OPEN	DO	24VDC	VALVE	PLC-100	NOPEN	OPEN	0I-004
ZS-100-CLOSED	FCV-100 POSITION - CLOSED	DO	24VDC	VALVE	PLC-100	NCLOSE	CLOSE	0I-004
PI-110	POTABLEWATER TANKS - PRESSURE	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
ZS-134-OPEN	FCV-134 POSITION - OPEN	DI	24VDC	VALVE	PLC-100	NOPEN	OPEN	0I-004
ZS-134-CLOSED	FCV-134 POSITION - CLOSED	DI	24VDC	VALVE	PLC-100	NCLOSE	CLOSE	0I-004
YS-101-RC	PUMP P-101 RUN CONFIRM	DI	24VDC	PLC-100	PLC-100	STOPPED	RUNNING	0I-004
JY-101-RUN	PUMP P-101 RUN	DO	24VDC	PLC-100	PLC-100	RUN	NORMAL	0I-004
YA-101-FLT	PUMP P-101 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-004
HS-101-AUTO	PUMP P-101 HAND SWITCH - AUTO	DI	24VDC	PLC-100	PLC-100	NAUTO	AUTO	0I-005
SC-101	PUMP P-101 SPEED CONTROL FROM PLC	AO	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
TA-101-HIGH	PUMP P-101 TEMPERATURE ALARM HIGH	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-004
PA-101-HIGH	PUMP P-101 PRESSURE ALARM HIGH	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-004
YS-102-RC	PUMP P-101 RUN CONFIRM	DI	24VDC	PLC-100	PLC-100	STOPPED	RUNNING	0I-004
JY-102-RUN	PUMP P-102 RUN	DO	24VDC	PLC-100	PLC-100	RUN	NORMAL	0I-004
YA-102-FLT	PUMP P-102 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-004
HS-102-AUTO	PUMP P-102 HAND SWITCH - AUTO	DI	24VDC	PLC-100	PLC-100	NAUTO	AUTO	0I-004
SC-102	PUMP P-102 SPEED CONTROL FROM PLC	AO	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
SI-102	PUMP P-102 SPEED INDICATION FROM VFD	AI	4-20mA	VFD-P102	PLC-100	N/A	N/A	0I-004
TA-102-HIGH	PUMP P-102 TEMPERATURE ALARM HIGH	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-004
PA-102-HIGH	PUMP P-102 PRESSURE ALARM HIGH	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-004
AE-130A-COND	POTABLE SAMPLE LINE - CONDUCTIVITY	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
AE-130B-CL2	POTABLE SAMPLE LINE - CLORINE	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
AE-130C-TEMP	POTABLE SAMPLE LINE - TEMPURATURE	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
AE-130D-PH	POTABLE SAMPLE LINE - PH	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-004
YS-131-CONT. RUN	SUMP PUMP P-131 CONTINUE TO RUN	DI	24VDC	PLC-100	PLC-100	STOPPED	RUNNING	0I-004
YA-131-FLT	SUMP PUMP P-131 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-004
LA-131-HIGH HIGH	SUMP PUMP P-131 VERY HIGH LEVEL ALARM	DI	24VDC	PLC-100	PLC-100	VERY HIGH	NORMAL	0I-004
YS-103-RC	PUMP P-103 RUN CONFIRM	DI	24VDC	PLC-100	PLC-100	STOPPED	RUNNING	0I-005
JY-103-RUN	PUMP P-103 RUN	DO	24VDC	PLC-100	PLC-100	RUN	NORMAL	0I-005

Complete Tag	DESCRIPTION	Signal Type	Signal Level	Power Source	Controlled By	Description "0" Level	Description "1" Level	P&ID Drawing
YA-103-FLT	PUMP P-103 FAULT ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-005
HS-103-AUTO	PUMP P-103 HAND SWITCH - AUTO	DI	24VDC	PLC-100	PLC-100	NAUTO	AUTO	0I-005
SC-103	PUMP P-103 SPEED CONTROL FROM PLC	AO	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-005
SI-103	PUMP P-103 SPEED INDICATION FROM VFD	AI	4-20mA	VFD-P103	PLC-100	N/A	N/A	0I-005
TA-103-HIGH	PUMP P-103 TEMPERATURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-005
PA-103-HIGH	PUMP P-103 PRESSURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-005
PI-120	POTABLE WATER DISCHARGE PRESSURE	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-005
FI-121	POTABLE WATER DISCHARGE FLOW	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-005
LA-122-HIGH	POTABLE DISCHAGE TRENCH FLOOD ALARM	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-005
ZS-194A-OPEN	OPEN CONTACT - POTABLE ELECTRICAL ROOM 1	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-194B-OPEN	OPEN CONTACT - POTABLE ELECTRICAL ROOM 2	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-194C-OPEN	OPEN CONTACT - POTABLE PUMP ROOM	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-194D-OPEN	OPEN CONTACT - POTABLE GARAGE DOOR	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-195A-OPEN	OPEN CONTACT - PUMP STATION SWING GATE	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-195B-OPEN	OPEN CONTACT - PUMP STATION MAIN GATE	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-196A-OPEN	OPEN CONTACT - TANKS SWING GATE	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
ZS-196B-OPEN	OPEN CONTACT - TANKS MAN GATE	DI	24VDC	PLC-100	PLC-100	OPEN	NORMAL	0I-006
JY-195-ON	POTABLE LIGHTING CONTROL 1	DO	24VDC	PLC-100	PLC-100	OFF	ON	0I-006
JY-196-ON	POTABLE LIGHTING CONTROL 2	DO	24VDC	PLC-100	PLC-100	OFF	ON	0I-006
YS-197-OK	CARD ACCESS OK SIGNAL - POTABLE	DI	24VDC	PLC-100	PLC-100	OK	NORMAL	0I-007
YS -181-RUN	HVAC STATUS UNIT 181 - RUN COMMAND	DI	24VDC	PLC-100	PLC-100	RUN	NORMAL	0I-006
YA-181-FLT	HVAC STATUS UNIT 181 - GENERAL FAULT	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-006
YS -182-RUN	HVAC STATUS UNIT 182 - RUN COMMAND	DI	24VDC	PLC-100	PLC-100	RUN	NORMAL	0I-006
YA-182-FLT	HVAC STATUS UNIT 182 - GENERAL FAULT	DI	24VDC	PLC-100	PLC-100	ALARM	T	0I-006
ZA-190	POTABLE PLC-PS INTRUSION	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-006
TI-190	POTABLE WATER PLC-PS - TEMPERATURE	AI	4-20mA	PLC-100	PLC-100	N/A	N/A	0I-006
YA-190A	POTABLE UPS FAIL	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-006
YA-190B	POTABLE UPS ON BATTERY	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-006
YA-190C	POTABLE UPS SUPERVISORY	DI	24VDC	PLC-100	PLC-100	ALARM	NORMAL	0I-006
EI-193	POTABLE GENERATOR - VOLTAGE	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
II-193	POTABLE GENERATOR - CURRENT	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
JQI-193A	POTABLE GENERATOR - KW	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
JQI-193B	POTABLE GENERATOR - KVA	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
FI-193	POTABLE GENERATOR - FREQUENCY	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
YA-193	POTABLE GENERATOR - FAULT	NETWORK-IN	ETHERNET	N/A	PLC-100	FAULT	NFAULT	0I-006
EA-193-LOW	POTABLE GENERATOR - BATTERY VOLTAGE LOW	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
TA-193-HIGH	POTABLE GENERATOR - HIGH TEMP	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
LA-193	POTABLE GENERATOR - LOW COOLANT	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
PA-193-LOW	POTABLE GENERATOR - LOW OIL PRESSURE	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
YA-193-HIGH	POTABLE GENERATOR - OVERCRANK	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
LI-193	POTABLE GENERATOR - FUEL LEVEL	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
LA-193-L	POTABLE GENERATOR - LOW FUEL 20%	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
LA-193-LL	POTABLE GENERATOR - LOW FUEL 5%	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
LA-193-HIGH	POTABLE GENERATOR - FUEL LEAK	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
YS-191A	SWBD-1A ATS - UTILITY POWER AVAIBLE	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
YA-191A	SWBD-1A ATS - ON UTILITY POWER	NETWORK-IN	ETHERNET	N/A	PLC-100	ALARM	NORMAL	0I-006
YS-191B	SWBD-1A ATS - GENERATOR POWER AVAILABLE	NETWORK-IN	ETHERNET	N/A	PLC-100	NPOWER	POWER	0I-006
YA-191B	SWBD-1A ATS - ON GENERATOR POWER	NETWORK-IN	ETHERNET	N/A	PLC-100	NPOWER	POWER	0I-006
EI-192	SWBD-1A POWER MONITOR - VOLTAGE	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
II-192	SWBD-1A POWER MONITOR - CURRENT	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
JQI-192A	SWBD-1A POWER MONITOR - KW	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
JQI-192B	SWBD-1A POWER MONITOR - KVAR	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006

Complete Tag	DESCRIPTION	Signal Type	Signal Level	Power Source	Controlled By	Description "0" Level	Description "1" Level	P&ID Drawing
FI-192	SWBD-1A POWER MONITOR - FREQUENCY	NETWORK-IN	ETHERNET	N/A	PLC-100	N/A	N/A	0I-006
-								
-								
HS-205-AUTO	REUSE TANK MXR-205 HANDSWITCH - AUTO	DI	24VDC	PLC-200	PLC-200	NAUTO	AUTO	0I-007
SC-205	REUSE TANK MXR-205 SPEED CONTROL	AO	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-007
YS-205-RC	REUSE TANK MXR-205 RUN CONFIRM	DI	24VDC	PLC-200	PLC-200	STOPPED	RUNNING	0I-007
JY-205-RUN	REUSE TANK MXR-205 RUN	DO	24VDC	VFD-MXR106	PLC-200	RUN	NORMAL	0I-007
YA-205-FLT	REUSE TANK MXR-205 FAULT ALARM	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-007
LA-200-HIGH	REUSE TANK LEVEL - HIGH	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-007
LI-200	REUSE TANK LEVEL INDICATOR	AI	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-007
JY-235-OPEN	BV-235 - OPEN	DI	24VDC	PLC-200	PLC-200	NOPEN	OPEN	0I-008
JY-235-CLOSE	BV-235 - CLOSE	DI	24VDC	PLC-200	PLC-200	NCLOSE	CLOSE	0I-008
HS-235-REM	BV-235 - REMOTE OPERATION	DI	24VDC	PLC-200	PLC-200	REMOTE	NORMAL	0I-008
HS-235-OPEN	BV-235 MOTOR TO OPEN POSITION	DI	24VDC	PLC-200	PLC-200	NOPEN	OPEN	0I-008
HS-235-STOP	BV-235 MOTOR TO CLOSE POSITION	DI	24VDC	PLC-200	PLC-200	STOP	NORMAL	0I-008
HS-235-CLOSE	BV-235 MOTOR STOP	DI	24VDC	PLC-200	PLC-200	NCLOSE	CLOSE	0I-008
ZS-235-OPEN	BV-235 POSITION - OPEN	DI	24VDC	PLC-200	PLC-200	NOPEN	OPEN	0I-008
ZS-235-CLOSE	BV-235 POSTION - CLOSED	DI	24VDC	PLC-200	PLC-200	NCLOSE	CLOSE	0I-008
YA-235-FLT	BV-235 FAULT ALARM	DI	24VDC	PLC-200	PLC-200	STOP	NORMAL	0I-008
ZS-200-OPEN	FCV-200 POSITION - OPEN	DI	24VDC	VALVE	PLC-200	NOPEN	OPEN	0I-008
ZS-200-CLOSED	FCV-200 POSITION - CLOSED	DI	24VDC	VALVE	PLC-200	NCLOSED	CLOSED	0I-008
PI-210	PRESSURE FROM REUSE TANKS	AI	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008
ZS-234-OPEN	FCV-234 POSITION - OPEN	DO	24VDC	VALVE	PLC-100	NOPEN	OPEN	0I-004
ZS-234-CLOSED	FCV-234 POSITION - CLOSED	DO	24VDC	VALVE	PLC-100	NCLOSE	CLOSE	0I-004
YS-201-RC	PUMP P-201 RUN CONFIRM	DI	24VDC	PLC-200	PLC-200	STOPPED	RUNNING	0I-008
JY-201-RUN	PUMP P-201 RUN	DO	24VDC	PLC-200	PLC-200	RUN	NORMAL	0I-008
YA-201-FLT	PUMP P-201 FAULT ALARM	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-008
HS-201-AUTO	PUMP P-201 HAND SWITCH - AUTO	DI	24VDC	PLC-200	PLC-200	NAUTO	AUTO	0I-008
SC-201	PUMP P-201 SPEED CONTROL	AO	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008
TA-201-HIGH	PUMP P-201 TEMPERATURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-008
PA-201-HIGH	PUMP P-201 PRESSURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-008
YS-202-RC	PUMP P-201 RUN CONFIRM	DI	24VDC	PLC-200	PLC-200	STOPPED	RUNNING	0I-008
JY-202-RUN	PUMP P-202 RUN	DO	24VDC	PLC-200	PLC-200	RUN	NORMAL	0I-008
YA-202-FLT	PUMP P-202 FAULT ALARM	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-008
HS-202-AUTO	PUMP P-202 HAND SWITCH - AUTO	DI	24VDC	PLC-200	PLC-200	NAUTO	AUTO	0I-008
SC-202	PUMP P-202 SPEED CONTROL	AO	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008
SI-202	PUMP P-202 SPEED INDICATION FROM VFD	AI	4-20mA	VFD-P202	PLC-200	N/A	N/A	0I-008
TA-202-HIGH	PUMP P-202 TEMPERATURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-008
PA-202-HIGH	PUMP P-202 PRESSURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-008
AE-230-TURB	REUSE SAMPLE LINE - TURBIDITY	AI	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008
YS-231-CONT. RUN	SUMP PUMP P-231 CONTINUE TO RUN	DI	24VDC	PLC-200	PLC-200	STOPPED	RUNNING	0I-008
YA-231-FLT	SUMP PUMP P-231 FAULT ALARM	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-008
LA-231-HIGH HIGH	SUMP PUMP P-231 VERY HIGH LEVEL ALARM	DI	24VDC	PLC-200	PLC-200	VERY HIGH	NORMAL	0I-008
YS-203-RC	PUMP P-203 RUN CONFIRM	DI	24VDC	PLC-200	PLC-200	STOPPED	RUNNING	0I-008
JY-203-RUN	PUMP P-203 RUN	DO	24VDC	PLC-200	PLC-200	RUN	NORMAL	0I-008
YA-203-FLT	PUMP P-203 FAULT ALARM	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-008
HS-203-AUTO	PUMP P-203 HAND SWITCH - AUTO	DI	24VDC	PLC-200	PLC-200	NAUTO	AUTO	0I-008
SC-203	PUMP P-203 SPEED CONTROL	AO	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008
SI-203	PUMP P-203 SPEED INDICATION FROM VFD	AI	4-20mA	VFD-P203	PLC-200	N/A	N/A	0I-008
TA-203-HIGH	PUMP P-203 TEMPERATURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-008
PA-203-HIGH	PUMP P-203 PRESSURE ALARM	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-008
PI-220	REUSE DISCHARGE PRESSURE	AI	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008

Complete Tag	DESCRIPTION	Signal Type	Signal Level	Power Source	Controlled By	Description "0" Level	Description "1" Level	P&ID Drawing
FI-221	REUSE DISCHARGE FLOW	AI	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-008
LA-222-HIGH	REUSE DISCHAGE TRENCH FLOOD ALARM	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-008
ZS-294A-OPEN	OPEN CONTACT - REUSE ELECTRICAL ROOM 1	DI	24VDC	PLC-200	PLC-200	OPEN	NORMAL	0I-009
ZS-294B-OPEN	OPEN CONTACT - REUSE ELECTRICAL ROOM 2	DI	24VDC	PLC-200	PLC-200	OPEN	NORMAL	0I-009
ZS-294C-OPEN	OPEN CONTACT - REUSE PUMP ROOM	DI	24VDC	PLC-200	PLC-200	OPEN	NORMAL	0I-009
ZS-294D-OPEN	OPEN CONTACT - REUSE GARAGE DOOR	DI	24VDC	PLC-200	PLC-200	OPEN	NORMAL	0I-009
YS-297-OK	CARD ACCESS OK SIGNAL - REUSE	DI	24VDC	PLC-200	PLC-200	OK	NORMAL	0I-009
YS -281-RUN	HVAC STATUS UNIT 281 - RUN COMMAND	DI	24VDC	PLC-200	PLC-200	RUN	NORMAL	0I-009
YA-281-FLT	HVAC STATUS UNIT 281 - GENERAL FAULT	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-009
YS -282-RUN	HVAC STATUS UNIT 282 - RUN COMMAND	DI	24VDC	PLC-200	PLC-200	RUN	NORMAL	0I-009
YA-282-FLT	HVAC STATUS UNIT 282 - GENERAL FAULT	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-009
ZA-290	REUSE PLC-PS INTRUSION	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-009
TI-290	REUSE PLC-PS TEMP	AI	4-20mA	PLC-200	PLC-200	N/A	N/A	0I-009
YA-290A	REUSE UPS FAIL	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-009
YA-290B	REUSE UPS ON BATTERY	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-009
YA-290C	REUSE UPS SUPERVISORY	DI	24VDC	PLC-200	PLC-200	ALARM	NORMAL	0I-009
EI-293	REUSE GENERATOR - VOLTAGE	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
II-293	REUSE GENERATOR - CURRENT	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
JQI-293A	REUSE GENERATOR - KW	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
JQI-293B	REUSE GENERATOR - KVA	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
FI-293	REUSE GENERATOR - FREQUENCY	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
YA-293	REUSE GENERATOR - FAULT	NETWORK-IN	ETHERNET	N/A	PLC-200	FAULT	NFAULT	0I-009
EA-293-LOW	REUSE GENERATOR - BATTERY VOLTAGE LOW	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
TA-293-HIGH	REUSE GENERATOR - HIGH TEMP	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
LA-293	REUSE GENERATOR - LOW COOLANT	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
PA-293-LOW	REUSE GENERATOR - LOW OIL PRESSURE	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
YA-293-HIGH	REUSE GENERATOR - OVERCRANK	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
LI-293	REUSE GENERATOR - FUEL LEVEL	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
LA-293-L	REUSE GENERATOR - LOW FUEL 20%	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
LA-293-LL	REUSE GENERATOR - LOW FUEL 5%	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
LA-293-HIGH	REUSE GENERATOR - FUEL LEAK	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
YS-291A	SWBD-2A ATS - UTILITY POWER AVAIBLE	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
YA-291A	SWBD-2A ATS - ON UTILITY POWER	NETWORK-IN	ETHERNET	N/A	PLC-200	ALARM	NORMAL	0I-009
YS-291B	SWBD-2A ATS - GENERATOR POWER AVAILABLE	NETWORK-IN	ETHERNET	N/A	PLC-200	NPOWER	POWER	0I-009
YA-291B	SWBD-2A ATS - ON GENERATOR POWER	NETWORK-IN	ETHERNET	N/A	PLC-200	NPOWER	POWER	0I-009
EI-292	SWBD-2A POWER MONITOR - VOLTAGE	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
II-292	SWBD-2A POWER MONITOR - CURRENT	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
JQI-292A	SWBD-2A POWER MONITOR - KW	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
JQI-292B	SWBD-2A POWER MONITOR - KVAR	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009
FI-292	SWBD-2A POWER MONITOR - FREQENCY	NETWORK-IN	ETHERNET	N/A	PLC-200	N/A	N/A	0I-009

SECTION 40 68 00 – PROCESS CONTROL SOFTWARE

PART 1 - GENERAL

1.01 SUMMARY:

A. Furnish a complete control system software package including Run Time and Development for the Pump Station. Provide all software packages latest versions and required license for the control network. The control network shall consist of the following as minimum:
   1. Provide the enterprise software package for the Control System hardware as specified in Section 40 67 00. Including:
      a. Engineering software for managing databases and programing the PLCs.
      b. Operator Interface Terminal (OIT) programing software.
      c. Operator Interface Terminal (OIT) graphic software.
      d. The data archival, analysis, and trending software.
      e. Report generation software.
   2. The development and report generation software packages shall be provided and installed on the OIT and Laptop Workstation.
   3. Each system shall have client nodes as follows:
      a. One Operator Laptop Workstation client node run time and development.
      b. Touchpanel OIT on the PLC control panel.
   4. All software packages shall have the latest service packs installed.
      a. Operating system service packs shall be the latest that is compatible with the current shipping version of the control system software.

1.02 RELATED REQUIREMENTS:

A. SECTION 40 61 96 - Process Control System Programming and Reports
B. SECTION 40 66 00 - Process Control Networks
C. SECTION 40 67 00 - Process Control Panels and Hardware
D. SECTION 40 68 00 - Process Control Software

1.03 REFERENCE STANDARDS:

A. Applicable Codes and Standards: Furnish software which conforms in all respects to applicable industry standards and sound engineering practice.
B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
C. International Society of Automation (ISA).
   1. ISA 101.01 – Human Machine Interfaces for Process Automation Systems.

1.04 SUBMITTALS:

A. Submit in accordance with Section 01 33 00.
B. Product Data:
   1. Software package sales brochure
C. Closeout Submittals: Final documentation shall include the following as minimum:
   1. Operation and Maintenance Manuals including the following:
      a. Software all approved Product Data and licenses.
      b. Software Technical Support Information.
      c. Preliminary Software Programing
      d. Preliminary Graphics
      e. Final Software Programing.
      f. Final Graphics
      g. Supplier Information.

D. Maintenance Material Submittals:
   1. Software:
      a. Original CD/DVD-ROM disks and/or flash drives containing all software furnished.

1.05 QUALITY ASSURANCE:

A. All software furnished shall have an acceptable history of satisfactory use and reliability for a period of at least two years.
B. Newly released versions of the software will be considered if it has been adequately tested and proven in the market, meets the requirements of this Contract, and is approved by Contractor. Such software shall be noted in the proposal for review.
C. Installer Qualifications:
   1. Prior to installation and development, submit data of installer's experience and qualifications.
   2. Installers shall have experience with the provided software which shall include 3 years on projects of similar complexity.
   3. Include installers specific experience history in installing and developing with the specified software for projects of similar design.
   4. Include names and locations of two projects successfully completed using the specified software platform.
   5. Include written certification from users that systems have performed satisfactorily for not less than 18 months.

PART 2 - PRODUCTS

2.01 GENERAL:

A. SI shall provide the enterprise software package based on the control system hardware equipment Manufacturer as specified in Section 40 67 00.
B. Supplier shall provide all software and application specific firmware for all devices connected to the network to provide a control system which meets the functional requirements of this Section.
C. The control software shall be a full function process monitoring and control package. It shall be capable of simultaneously performing all of its functions in a multi-tasking environment.
D. The SI shall use the Manufacturers planning software to determine the system loading and work with the manufacturer to provide a manufacturer certified integrated package.
E. The Supplier shall furnish a complete control software package including Run Time and Development. Provide all software packages and required license for the control network. The control network shall consist of the following as minimum:
   1. All software modules and options to provide a complete integrated software package.
   2. All software packages shall have the latest service packs installed.
      a. Operating system service packs shall be the latest that is compatible with the current shipping version of the control system software.
F. The control software shall provide at least the following capabilities as an integrated function:
   1. Input/output functions.
   2. Modulating controls.
   3. Digital controls.
   4. Data processing and communications.
   5. Alarm functions.
   6. Sequence of events.

7. Log functions.
8. Operator display functions.
9. Printing functions.
10. Operator console functions.
11. Programming functions.
12. Historical data storage.
13. Historical and real-time trending functions.
14. Support thin client remote desktop services.
15. Operator Interface graphics
16. Graphics trends and displays
17. Default system and equipment configuration libraries

G. The control software shall provide a mechanism to generate data to files with a standard format. These data files shall be accessible to other programs such as spreadsheets and database managers and shall be used to generate reports and perform data analysis outside of the control program itself.

H. The development, design, and implementation of the control system software shall comply with ISA 101.01 – Human Machine Interfaces for Process Automation Systems.

2.02 SOFTWARE AND LICENSES:

A. Provide software and licenses required for a fully operational system. All required licenses shall be turned over to Owner upon Project Completion.

2.03 COMMUNICATIONS AND PREPROCESSING:

A. General: The communications and preprocessing portion of the control software shall perform the following functions:
1. Communicate with the PLC's located on the plant control system network.
2. Support mutual data exchange between operator stations and PLCs on network.
3. Support multiple communications networks and protocols concurrently.
4. Validate, convert, process and alarm check all data received by any of the communications interfaces according to the criteria selected for each data point.
5. Scans shall be performed continuously on all communications channels. Scans shall be sequential for those devices on the same communications network and the different communications networks shall be scanned in parallel.
6. Periodic scan rates at different priorities shall be definable on an individual point basis or by groups of points. The scan rates shall be definable.
7. Unsolicited messages shall be accepted and processed when sent over any of the communication networks.
8. Processing by exception will be allowed provided the deadband is operator assignable on a point basis. The deadband will be used to inhibit preprocessing of data which has not changed by more than the preset deadband from the previous scan. The deadband shall be assignable in engineering units or as a percentage of the scale range. An entry of zero (0) shall be acceptable for the deadband.
9. If the preprocessing functions have not been completed for certain data before new data for the same points is received in the next scan, appropriate diagnostic messages shall be directed to output devices, operator screen, printer, audible alarm, and related items, selected during system configuration.
10. Communications throughput shall be limited solely by the communications networks and not by the control software/hardware provided in this Section.

11. Provide the means to control the plant equipment or to initiate start and stop sequences from any operator station. From the operator station the operator shall have complete control of the PLC's.
12. Update displays for all points at least once every 50 milliseconds. The system shall update its own data base simultaneously. Screen call-up time for any graphic shall not exceed 3 seconds for static and dynamic data.

B. PLC Communications:
1. The control software shall include the communications interface to the process control network. Refer to the Contract Drawings for the process control network architecture.
2. Multiple scans per PLC at different priority scan rates shall be supported.
3. The software shall perform any and all translations of PLC communication messages that may be required to transfer/receive data between the real-time database and the communications protocol.
4. The communications interface shall provide all necessary error-checking and retransmission capabilities to ensure no data transmission errors.

C. Data Preprocessing:
1. Analog Inputs:
   a. The system shall perform calculations required in the handling of analog input data including but not limited to averaging, time integrations, ranging, summations on flow measurements, and square root extractions.
   b. All analog input points shall be checked against high and/or low process limits. An analog input outside these limits shall be considered in alarm.
   c. All analog input points shall have re-alarm capabilities. Once a point is in alarm, it will re-alarm if its value continues to increase or decrease beyond the re-alarm limit assigned to that point. Re-alarm limits shall be specified in percent of input range.
   d. All analog input points shall have the capability of being assigned high and low alarm dead bands. Alarm dead bands represent the value that an input point must decrease or increase above or below an alarm set point before it activates a high or a low alarm.
   e. It shall be possible to automatically inhibit the alarming of any analog input or composed point (either analog or digital) by the state of one or more contact closure input, digital logic output, or the values of analog variables in order to eliminate nuisance alarms (e.g. low temperatures alarms disabled during start-up). The inhibiting contact closure or analog value could be different for each analog or composed point if required. When inhibiting, no alarm indication will be given to the operator and it will not be shown on alarm groups. Upon restoration of alarm functions, the point will be scanned for alarming and, if in alarm, the normal operator indication shall occur.
   f. All inhibited alarms shall be automatically logged. A summary of inhibited alarms shall be provided.
   g. Provisions shall be made to avoid erroneous alarms on rate of change alarms when scanning of a point first resumes.
   h. A method of differentiating between high or low alarms and "BAD" (alarms outside reasonable limits for a point) alarms should be used so that types of alarms are easily identifiable.
2. Analog Composed Points:
   a. Analog composed points are defined as points resulting from calculations involving two or more analog points. The results of these calculations shall be assigned point numbers and shall be capable of being alarmed, displayed, trended, or logged.

b. Each subsystem shall have the capacity to process analog composed points. This number is in addition to any composed points per subsystem required by the system for logs. It is also in addition to any integrations, averages, weighted averages, and necessary calculations of input points.
c. Analog composed point capabilities shall be the same as specified for analog inputs.

2.04 ALARM FUNCTIONS:

A. General:
1. The system shall compare all analog input points, composed points, etc., against high and/or low alarm limits. If an input is determined to be beyond either of these limits or if a contact input designated as an alarm is determined to be in alarm, the system shall record a time-tagged alarm message to the alarm database. Simultaneously, a similar alarm message will be displayed on the operator workstation screen.
2. Once an analog point is in alarm, it shall re-alarm if its values continue to increase or decrease beyond the re-alarm limit.
3. All alarms shall have an assignable time delay to prevent an alarm message from being printed or displayed until the alarm has been present for the duration of the time delay.

B. Alarm Priorities/Levels:
1. The system shall have the capabilities to assign different priorities to points in alarm. There shall be at least four levels of alarm priorities for combinations of display, print out, or audible.
2. All points shall have the capability of pre-assignment to one of four levels for the operator screen display color to identify the alarm criticality.

C. Alarm sequence shall be as follows:
1. Alarm Occurs (Priority 1): Event recorded to alarm log and the operator screen displays alarm with a similar message in flashing red.
2. Alarm Acknowledgement (Priority 1): Operator onscreen alarm display remains red but stops flashing and alarm acknowledgement recorded to alarm log.
3. Return to Normal (Priority 1): Alarm display changes to light red. Alarm display clears when the point has been acknowledged. A return to normal is recorded in the alarm log.
4. Re-alarms: Re-alarms are treated like new alarms.
5. Alarm Priorities (1 through 4): Additional priority alarm assignments shall be treated in similar fashion but with alternate color assignments. Color assignments for priority levels shall be as defined below:
a. Priority 1: Red / Light Red.
b. Priority 2: Orange / Light Orange.
c. Priority 3: Magenta / Light Magenta.
d. Priority 4 (or Warning): Yellow / Light Yellow.
6. Additional alarm management and classifications: Alarms shall be capable of being suppressed, inhibited, and shelved. In these cases, color assignments shall uniquely identify the alarm status and current alarm classification.

D. One common alarm acknowledgement scheme shall be used for all alarms on the operator screens so that only one action is required by the operator to acknowledge.

2.05 EVENT NOTIFICATION:

A. The control software shall provide a fully integrated event notification package for annunciation of alarm events to personnel.

B. The following methods shall be available for communication of alarms:
1. Local visual annunciation.

2.06 OPERATOR CONTROLS

A. Supplier shall design and program all equipment using the control system manufacturer's standard library and programing blocks.

B. Each piece of equipment shall be programed with manual mode and automatic mode of operation.
   1. Manual mode the operator shall be able to start and stop the equipment as desired to open, run, test and maintain the equipment.
   2. Automatic mode the equipment shall operate as designed, intended and protected by the Supplier.

C. Equipment override stops, alarms or fault conditions shall stop the equipment and reject the equipment to manual mode so that auto logic cannot restart the equipment without operator action.

D. Coordinate all programing and graphics and displays with the Owner and SI.

2.07 OPERATOR DISPLAY FUNCTIONS:

A. General:
   1. All standard displays shall be accessible from any operator workstation on the network. Displays shall be in high resolution color graphics.
   2. The system shall have full flexibility in specifying or changing tags, tag descriptions, ranges, scale factors, or grouping the various displays.
   3. All graphic displays should be built interactively using the supplied control system software CAD-type development program with the maximum flexibility for ease of graphics building or revision.
   4. Displays shall allow windowing for additional graphics and faceplates.
   5. The operator shall be able to use a variety of input devices to interact with the control software including keyboard, mouse, touchscreen, etc.

B. Trend Displays:
   1. The system shall have the capability to trend single variables or groups of variables simultaneously on the operator screens.
   2. The system shall allow the operator to define a minimum of 50 group trend displays.
   3. Any analog or composed point may be assigned by the operator to the trend display.
   4. Trend display for each point shall include the point description, time base, and ordinate magnitude.
   5. The trend time base shall be assignable.
   6. Trending of historical information shall be available. The operator shall be able to scroll backward or forward through data.

C. Custom Graphic Displays:
   1. The system shall have capabilities to easily design and display custom displays. These displays may take the form of 3D modeled graphics, plant schematics, bar graphs, and tabular data.
   2. Customized displays shall be capable of showing animated graphics based on the state of the system.
   3. The custom displays shall be fully interactive displays providing full process monitoring and manipulation. This interaction shall allow for the changing of set point, output, mode, ratio, bias, and function for modulating parameters. The interaction shall also allow for issuance of start/stop and open/close commands for loops.
   4. The system shall have a standard group of symbols from which shapes can be made and stored in a shape library. Manufacturer standard shapes shall also be provided in the library.

5. Pixel manipulation of shapes and creation of symbols and graphics for library storage shall be available.

D. Alarm Displays:
   1. Alarm Summary Display:
      a. The alarm summary display shall differentiate between the priority levels of alarm.
      b. The highest priority alarm summary shall list all primary alarms as well as points exceeding re-alarm limits. These alarms shall be listed in the sequence they were detected with the newest alarm at the top of the page.
      c. The other alarm summaries shall be displayed below the primary alarms. These alarms shall also be listed in order of detection.
      d. A point in alarm shall flash on either alarm summary display until acknowledged from the keyboard or pointing device.
      e. Messages for alarms, displayed on the screens, shall include the following information:
         (1) Point tag (ID).
         (2) Point description.
         (3) Value or status.
         (4) Engineering units (if applicable).
         (5) Limit exceeded (if applicable).
      f. At least 10 full pages of alarms should be available for historical operator information, and the operator shall be able to shift pages for alarm review.
   2. Alarm Group Display:
      a. Alarm groups shall be able to be displayed on any operator workstation. Each alarm group shall represent those alarm points associated with a specific piece of equipment, operating unit, or portion of the plant.
      b. The point ID of a point in alarm shall flash on the alarm group display, until it is acknowledged from the keyboard or pointing device. The size of each alarm group shall be selectable.
      c. Any alarm group shall be capable of being disabled in its entirety or individual alarms shall be capable of being disabled selectively.
   3. Alarm Diagnostics: The alarm diagnostic function shall be available to the Operator for programming specific recommended actions to the acting operator when certain alarms occur. The recommendations shall appear on the operator workstation screen in response to certain alarm conditions as an aid in operator response.

E. Point Summary Displays:
   1. It shall be possible for the operator to display summaries listed below.
   2. Display of a point summary shall include at least the following:
      a. Time.
      b. Summary heading.
      c. Point ID and description for each point in the summary.
      d. Pertinent data for each point in the summary, such as value, alarm status, alarm limits, etc.
      e. Point summaries available for operator print or display shall include at least the following:
         (1) Analog input points.
         (2) Composed points.
         (3) Contact input points.
         (4) Alarm summary.
         (5) Inputs deleted from scan.

(6) Inserted value summary.
(7) Bad inputs summary.
(8) High/low reasonable limit summary.
(9) Sequence of events logs.

3. It shall be possible for the operator to cancel a running summary at any time.
4. Summaries shall be displayed on any of the operator screens.

2.08 PROGRAMMING FUNCTIONS:

A. The system shall permit the plant personnel to perform programming functions listed below. It shall be possible to perform these functions with the system on-line. All programming functions shall be under password protection.
B. All operations required to implement these changes shall be accomplished in a conversational mode via the operator screens and keyboards.
C. Programming functions shall include at least the following:
   1. Add and define new input points up to the system capacity.
   2. Modify point definition.
   3. Delete input points.
   4. Add or delete points for any group log, except for those group logs reserved for operator definition.
   5. Add or delete points to any periodic log. Change headings of period logs.
   6. Construct new graphic displays or modify existing ones.
   7. Prepare special summaries.
   8. Have the capability to add new logic programs or modify existing system logic programs with the system on-line.
   9. Modify or add performance calculations as required.
   10. Modify or add reports as required.
D. Software Maintenance:
   1. All programs required to enable the programmer to perform software maintenance functions shall be provided.
   2. These shall include program routines to permit dumping of memory, loading of memory, memory print, and related operations.
E. The control software shall include an integral interface supporting access to all real-time database entries.
   1. All database entries shall be accessible for reading, modifying and updating. Calculated results shall be capable of being stored directly onto the database.
   2. The control software shall process all data modified or stored in the database by the user programs in the same manner as all other database entries.
F. The control software shall include an integral interface allowing direct real-time access to all database items by Microsoft EXCEL and the specified historian and reporting applications.

2.09 SECURITY:

A. The control software shall provide a fully integrated password protection scheme by restricting access to system features, functions, and database points. The password protection scheme shall consist of multiple levels of access one of which shall be full access.
B. The ability to assign and modify the access levels shall be restricted to the full access level.
C. The system shall allow assignment of multiple passwords to each access level.
D. The assignment of functions to the various access levels shall be user configurable and restricted to the full access level.

2.10 UTILITY AND SUPPLEMENTAL PROGRAMS:

A. Device Communication Management Software:
   1. The management software shall provide the necessary interface for accessing the communication enabled instrumentation through the use of the network and PLCs communication enabled input cards.
   2. The system shall allow the plant network to be mapped and allow documents to be stored for each associated device node.
   3. All required CommDTMs, DTMs and iDTMs or as applicable to the equipment Manufacturer hardware shall be provided for each associated node.
   4. Instruments shall be capable of being configured and monitored using the management software.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Client Software:
   1. Install all the software and configure system for proper operation.
   2. Configure client software for automatic failover as specified.
   3. Configure system to automatically logoff workstations installed after 10 minutes of inactivity. Time period shall be adjustable by the Owner.
   4. Provide "staging," checkout, training, and start-up as specified and indicated.

B. Utility and Supplemental Software:
   1. Install all the software and configure system for proper operation.

3.02 CUSTOMIZED PROGRAMMING AND SCREEN DEVELOPMENT:

A. Refer to Section 40 61 96 – Process Control Descriptions for customized programming and screen development requirements.

3.03 TRAINING:

A. Refer to Section 40 61 96 – Process Control Descriptions for training requirements.

END OF SECTION 40 68 00

SECTION 40 70 00 – INSTRUMENTATION FOR PROCESS SYSTEMS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the instrumentation requirements for measuring and controlling equipment.

1.02 REFERENCE STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. ASTM International (ASTM):
   1. ASME B16.5 – Pipe Flanges and Flanged Fittings.
C. International Society of Automation (ISA).
   1. ISA S20 – Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
D. National Electrical Manufacturers Association (NEMA).
E. Underwriter's Laboratories (UL).
F. Federal Communication Commission (FCC) – Part 15

1.03 SUBMITTALS:

A. Submit in accordance with Division 01.
B. Product Data:
   1. Specification Datasheets, Manufacturer Cut sheets and installation requirements.
C. Shop drawings
   1. Electrical and mechanical connection diagrams.
   2. Outline drawings.
D. Test and Evaluation Reports:
   1. Factory test and calibration reports.
   2. Field test and calibration reports.
E. Closeout Submittals: Final documentation shall include the following as minimum:
   1. Operation and Maintenance Manuals including the following:
      a. Operation and maintenance manuals for all instruments furnished.
      b. Copies of all approved Product Data.
      c. Copies of all approved Test and Calibration Reports.
      d. Spare parts and supply list.
      e. Warranty Information.
      f. Subcontractor Information.
      g. Training Materials. Includes final edited training videos.

1.04 SITE CONDITIONS:

A. Refer to Specification 26 00 00.

PART 2 - PRODUCTS

A. MANUFACTURERS:
   1. Instrument manufacturer shall be selected based on the Control System Manufacturer where possible as specified in Section 40 67 00.
      a. For Rockwell Automation systems - Allen Bradley is selected as the control system, where possible Endress+Hauser shall be the instrumentation.
B. Field Communicator:
   1. As required to match the majority of transmitters provided by this Contract

C. Instrument Tubing (Rigid & Flexible):
   1. Swagelok
   2. Parker
D. Chlorine Analyzers:
   1. Hach Company (CL17)
E. Conductivity Analyzer:
   1. ABB.
   2. Foxboro, Schneider Electric.
   3. Hach Company.
   4. Krohne, Inc.
   5. Rosemount, Emerson Electric Co.
F. Flow Indicating Transmitters (FIT) (Magnetic):
   1. Emerson
   2. Endress+Hauser
   3. Krohne
   4. ABB
   5. Yokogawa
G. Level Indicating Transmitters (LIT) (Radar):
   1. Emerson
   2. Krohne
   3. VEGA Americas
   4. Endress+Hauser
   5. Ametek
H. Level Switches (LS*) (Suspended Float Switches):
   1. Magnatrol
   2. Mercoid
   3. Wika USA
I. pH/Temp Analyzers:
   1. Hach Company.
   2. Engineer Approved Equal
J. Pressure Indicating Transmitters (PIT):
   1. Emerson
   2. Endress+Hauser
   3. Honeywell
   4. Yokogawa
   5. Siemens
K. Temperature Elements (TE) (RTD):
   1. Emerson
   2. Endress+Hauser
   3. ABB
   4. WIKA
   5. JMS Southeast
L. Temperature Indicating Transmitters (TIT):
   1. Emerson
   2. Endress+Hauser
   3. Honeywell
   4. Yokogawa
   5. ABB

M. Turbidity Analyzer:
   1. Hach Company

2.02 GENERAL:

A. Provide instruments as indicated on the instrument schedule.
B. Tag all instruments with Contractors Tag number before shipping to site with stainless steel Device Tag as specified.
C. Transmitters shall have an output signal of 4 to 20 mA dc into a minimum load range of 0-600 ohms at 24Vdc, capable of HART communication protocol in accordance with the control system manufacturer to provide instrument calibration and diagnostic information.
D. All analog indicating and recording receivers shall have evenly graduated scales.
E. Provide all mounting brackets, pipe stands and accessories required to install all field mounted instruments. All mounting brackets and hardware for instruments installed in exterior locations or within process areas shall be stainless steel.
F. Furnish and install all accessories required for complete and working systems as specified and indicated.
G. Provide sun shades for all exterior mounted transmitters.
H. All flanged instruments shall comply with ASME B16.5.
I. Instruments located in hazardous locations as indicated on the instrument schedule shall be rated for use in Class I, Division 1 hazardous environments. Provide intrinsically safe barrier in source control panel as required. Barriers shall be as specified in Section 40 67 00.
J. Where 4-wire instruments require external power, the instrument shall be powered from 120 VAC UPS power from control panels as specified in the Section 40 67 00.
K. Provide LCD displays for all transmitters.
L. Provide transient protection terminal blocks for all outdoor located equipment when available.

2.03 DEVICE TAGGING:

A. Device tags shall be stainless steel minimum 0.040-inch thickness with correct Contractor tag number and service description stamped, engraved, or laser etched clearly into the metal.
B. Device tags shall be permanently attached with minimum 18-gage stainless-steel wire to the stem or case of each Instrument, use of string or tape is unacceptable.
C. The Contractor’s tag number and service description is listed in the Instrument Schedule.
D. Provide device tag for each device furnished by this Contract prior to shipment.
E. Provide and attach a device tag to all devices received that do not have a device tag, whether furnished by this Contract or by others, and as directed by the Contractor.

2.04 FIELD COMMUNICATOR:

A. Furnish to the Owner a battery-operated portable field HART Communicator, for device configuration, calibration, and setup of site transmitters.
B. Manufacture shall be the same as manufacturer as the majority of transmitters provided to the site.
C. Communicator shall be the latest available with the latest available software revisions.

2.05 FLEXIBLE INSTRUMENT TUBING:

A. Flexible instrument tubing shall be corrugated hose braided and reinforced, with permanently attached male nominal pipe thread ends.
B. Manufacturer, Product:
C. Braid: 316 or 321 stainless steel.
D. Fittings: 316 stainless steel.

E. Length: Nominally 36 inches unless otherwise specified.

2.06 CHLORINE ANALYZER:

A. The chlorine analyzer shall employ a DPD colorimetric method of measurement using DPD indicator and a buffer solution.
B. The analyzer shall be capable of measuring free or total residual chlorine by changing the indicator and buffer solutions.
C. A measurement shall be taken every 2.5 minutes and results displayed by a three-digit LCD readout in the range of 0 to 5 mg/L.
D. The analyzer shall be designed for 30-days unattended operation.
E. The analyzer shall operate with an LED light source with a peak wavelength of 510 nm.
F. The instrument shall measure a sample blank before each sample measurement to provide automatic zero reference to compensate for sample color and turbidity and changes in light intensity due to voltage fluctuations or light source aging.
G. The instrument shall provide a minimum detection limit of 0.035 mg/L or better, precision better than ± 5% or 0.005 mg/L as Cl2, and accuracy better than ± 5% or 0.035 mg/L as Cl2.
H. The analyzer shall be microprocessor-controlled and provide a 4-20 mA analog signal.
I. The microprocessor shall provide self-diagnostic functions accessible through an alphanumeric, menu-driven keyboard.
J. Analog output span minimum and maximum values shall be operator programmable at the menu-driven keypad over the entire operating range.
K. The chlorine analyzer shall be housed in an IP-62 rated, ABS plastic enclosure designed for wall mounting.
L. The enclosure shall have two clear polycarbonate windows for viewing the measurement readout and reagent levels.
M. 1/4-inch sample connection and 1/2-inch drain connection.
N. Operate from 120V, 60 hertz. Provide with cord and plug connection.
O. Accessories:
    1. Provide 1 year maintenance kit with preassembled tubing.
    2. Provide 60 days of buffer and indicator solution.
P. Hach Company Chlorine Analyzer Model CL17, or approved equal.

2.07 CONDUCTIVITY MONITOR:

A. Monitoring system shall consist of a conductivity cell, cell mounting assembly, and monitoring transmitter.
B. Conductivity Cell:
    1. Designed for insertion or direct flange mounting as required for the application.
    2. Electrode material shall be 316 stainless steel. Cell constant and measuring range shall be suitable for the application.
    3. Electrodes shall be resistant to polarization.
    4. Shall contain a temperature sensor for temperature compensation.
    5. Cell electrodes shall be guarded to protect them from damage.
C. Analyzer/Transmitter.
    1. The transmitter shall be a microprocessor-based controller with plug and play connection of sensors.
    2. Menu driven software to allow for straight forward calibration and selection of display parameters.
    3. A backlit LCD display and keypad shall be provided for programming and displaying operating parameters.

4. Transmitter shall be rated for -20 to 40°C operation at 25W or less sensor load.
5. Capable of monitoring two separate sending probes as specified.
6. Transmitter shall store all user settings in non-volatile memory (EEPROM).
7. Provide the following outputs:
8. Two independent analog 4-20mA outputs. Capable of handling an output impedance of up to 500 Ohms.
9. Enclosure shall be rated NEMA 4X and shall be capable of wall, pipe, or panel mounting.
10. Shall operate on 24Vdc.

2.08 DIGITAL DISPLAY UNITS

A. Display units:
   1. NEMA 4X rated.
      a. Provide in NEMA 4X stainless steel enclosure maintaining the NEMA rating.
   2. Input: 4-20mA
   3. Output: 4-20mA
   4. Power Source: 24VDC, 4-20mA Loop Powered
   5. Display digits: As required for the analog process indication across the entire range of operation accurate to 2 decimals, unless the process unit is in decimals.

2.09 FLOW INDICATING TRANSMITTER

A. Flow Transmitter:
   1. Where required, provide integral mount smart digital flow transmitter.
   2. 120 VAC external power.
   3. 4-20mA output signal.
   4. Aluminum IP68 rated enclosure with corrosion resistant coating.
   5. ½" NPT Cable glands.
   6. Provide dry contacts rated for 120 VAC, 1 amp
      a. Flow direction.
      b. Flow totalization.
   7. Accuracy including hysteresis, linearity, and repeatability shall be within ±0.20% of reading.
B. Flow Element:
   1. Hastelloy electrodes, carbon steel flanges.
   2. Sized per the process line indicated on the P&ID.
   3. ANSI B16.5 150 lb class flanges.
   4. IP68 rated corrosion resistant coating.
   5. Coating shall be EPDM, PFA + or Contractor approved equal.
   6. Provide a stainless steel grounding rings on the inlet and outlet.

2.10 LEVEL INDICATING TRANSMITTER

A. Electronic, two-wire type with a 4-20mA output and integral LCD display.
B. Aluminum IP66 rated enclosure with corrosion resistant coating.
C. Stainless steel wetted parts.
D. Accuracy including hysteresis, linearity, and repeatability shall be within ±0.20% of reading.
E. 80 Ghz radar level transmitter.
F. The cone shall be sealed from the process environment.
G. Including software algorithms filter out interference caused by buildup on the antenna system and obstructions in the system.

H. Provide process connection and mounting brackets as indicated on the instrument schedule.

2.11 LEVEL SWITCHES (SUSPENDED FLOAT)

A. Suspended float switch for water waste-water applications. Float tips when immersed triggering the switch.
B. IP68 Sealed polypropylene housing.
C. Shall be mercury and lead free.
D. The float shall have two color tones with the lighter color on the dome for easier viewing underwater when tilted up.
E. The floats shall operate in liquid temperatures of 32 to 130°F (0 to 55°C). The floats shall have an ambient air standby operating temperature rating of -15 to 155°F (-25 to 70°C).
F. Mechanical snap switch single pole double throw (SPDT) rated at 120 VAC, 10 amp.
G. Provide float switch 30 foot extension cable.

2.12 PRESSURE OR DIFFERENTIAL PRESSURE INDICATING TRANSMITTERS:

A. Electronic, two-wire type with a 4-20mA output and integral LCD display.
B. Aluminum body with stainless steel wetted parts.
C. Sensor fill fluid shall be silicone oil.
D. Measuring element shall be isolation diaphragm type.
E. Accuracy including hysteresis, linearity, and repeatability shall be within ±0.20% of reading.
F. Provide zero, span, and damping adjustments. Zero adjustment shall be external.
G. Zero suppression or elevation shall be adjustable to a minimum of 100% of calibrated span.
H. Enclosure shall be NEMA 4X or equivalent IP rating in epoxy coated aluminum.
I. Pressure sensing instrument accessories as specified or indicated.

2.13 PRESSURE-SENSING INSTRUMENT ACCESSORIES:

A. General:
    1. Pressure-sensing instrument accessories are required to complete the installation of pressure-sensing instruments.
    2. Install per manufacturers recommendations.
B. Siphon Tube:
    1. Manufacturer, Type:
        a. Anderson Greenwood Co. Type CT7S-44.
C. Diaphragm Seal:
    1. General:
        a. Factory assemble pressure device to diaphragm seal, evacuate and fill with fill fluid into the complete unit.
        b. For every flushing connection furnish plug in same material as flushing ring.
    2. For Pressure Gauges:
        a. For threaded pipe connection use Ashcroft 101 diaphragm seal 1/2 inch NPT with 316 stainless-steel diaphragm, top housing and flushing ring.
    3. For Pressure Transmitters, as indicated on the P&IDs:
        a. Provide transmitter assembled to 1199 diaphragm seal (S1) on high side, fill with DC 200 Silicone, 20FT of 0.04-inch armored sleeve, ANSI B16.5 with 1/2-inch NPT Connection, 2,500 lb. Rating, 316 SS Upper, Lower housing, diaphragm and plugs, two 1/4-inch flushing connections. Model number 1199 W D C 15 Threaded Seal A RTW 3 0 DA A 3 4 G.
        b. Provide transmitter assembled to 1199 diaphragm seal (S1) on high side, fill with DC 200 Silicone, 20FT of 0.04-inch armored sleeve, 2-inch ANSI B16.5 SS Flange,

Flushed Surface, Hastelloy C Diaphragm, lower housing and plugs, 316 SST upper housing. Model number 1199 W D C 15 Flanged Seal A FFW G 1 DB B 3 D.

c. Provide transmitter assembled to Red Valve Pressure Sensor Series 40 annular diaphragm seal with 316 SS ANSI B16.5 flange installation fill with Ethylene glycol and water fill fluid.

2.14 PH/TEMP ANALYZERS:

A. System shall consist of a digital sensor electrodes, preamplifier, and analyzer/transmitter.

B. pH Sensor:
1. Differential type with two measuring electrodes and an internal reference electrode.
2. Replaceable salt bridge.
3. Encapsulated electronics.
4. Built-in temperature sensor for automatic temperature compensation and transmitter display.
5. Operating range shall be 2-12 pH.
6. Combination measuring/reference assembly.
7. Operating Range of -5 to 70°C.
8. Measuring electrode shall be glass tip with silver-chloride internal element.
9. Reference electrode shall be gel type, non-flowing silver-chloride in saturated potassium chloride electrolyte.
10. Hach Company pH sensor Model DPD1P1, or approved equal.

C. Electrode Mounting Assembly:
1. Convertible style with 1-inch NPT threads on each end and suitable for flow through, insertion, or immersion as specified in this Section.
2. Shall be provided with a guard to protect glass electrode tips from breakage.
3. Wetted parts shall be constructed of a material compatible with the solution being measured.
4. Provide with a temperature sensor for automatic temperature compensation.
5. Provide a preamplifier mounted in the transmitter enclosure.
6. Provide required cable length between sensor and transmitter.

D. Analyzer/Transmitter.
1. The transmitter shall be a microprocessor-based controller with plug and play connection of sensors.
2. Menu driven software to allow for straight forward calibration and selection of display parameters.
3. A backlit LCD display and keypad shall be provided for programming and displaying operating parameters.
4. Transmitter shall be rated for -20 to 40°C operation at 25W or less sensor load.
5. Capable of monitoring two separate sensing probes as specified.
6. Transmitter shall store all user settings in non-volatile memory (EEPROM).
7. The transmitter unit shall have a built in data logger function.
8. Provide the following outputs:
   a. Four SPDT, user programmable contacts each rated 5A at 120Vac.
   b. Two independent analog 4-20mA outputs. Capable of handling an output impedance of up to 500 Ohms.
9. Provide with Hart communication capability. Provide device type manager (DTM) software module for use in Hart device setup and monitoring software if required.
10. Enclosure shall be rated NEMA 4X and shall be capable of wall, pipe, or panel mounting.
11. Provide a sun shield to protect unit from direct sun contact.

12. Shall operate on 120Vac.
13. Provide SC4500 controller with optional sun shield as manufactured by Hach Company.
    a. When instrumentation requires more than two digital sensors at a given location provide an additional SC4500 controller or provide an SC1000 controller with capacity for four sensors and four 4-20mA outputs and associated display module.
    b. Coordinate with other instrument sensors this Section.

E. Accessories:
1. Provide one pint of each standard 4 and 7 pH buffer solutions for calibration.
2. Provide all required valves, fittings, and accessories for complete installation.
3. Provide flow cell with clear body and quick disconnect for sensor removal.
    a. The flow cell shall be Hach Company Model 7300800.

F. Mounting Panel:
1. Transmitter, sensor, flow cell and sample piping shall be factory mounted, wired, and plumbed on an aluminum plate suitable for wall mounting.
2. See Division 46 for additional mounting panel requirements.

2.15 TUBING:

A. General:
1. Tubing shall be:
2. Seamless fully annealed and suitable for bending.
3. Stainless-steel ASTM A269 or A213 min or average wall tubing.
4. Hardness not greater than Rockwell B90.
5. 1/2-inch OD with 0.049-inch wall thickness, Grade TP316.

2.16 TUBING FITTINGS:

A. All tubing fittings provided by this Contract shall be by the same manufacturer.
B. Grip type flareless tubing fittings shall be one of the following:
1. Swagelok.
C. Parker A-lok.

2.17 INSTRUMENT SHUTOFF AND BLOWDOWN VALVES:

A. General:
1. Body sizes: Same as connecting tubing or piping.
2. End connections:
    a. Tubing systems: Use integral tube fittings or adapter tubing fittings. Fittings shall be as specified in this Section PART 2 - TUBING FITTINGS.
    b. Piping systems: Match respective process pipe line or 316 stainless steel.
3. Type: Ball valve.
4. Body: Bronze, rated 400 psig at 150ºF.
5. Packing: Reinforced Teflon.
6. Seats: Reinforced Teflon.
7. Trim: 316 stainless-steel ball and stem.
8. End Connections: 1/2-inch FNPT.
9. Manufacturer, Product:
    a. Apollo, Series 70-100.
    b. Nibco, Series 580 and 585.

2.18 INSTRUMENT MANIFOLD VALVES:

A. General:

1. Shop or field fabrication of manifold instrument valves using individual instrument valves and tubing or piping is not acceptable.
2. Include all necessary flange bolts and flange seals.
3. Provide 2-inch pipe mounting bracket.
4. Provide metal to metal seats.
5. Include plugged test connection on each process sensing line for calibration without removing manifold instrument valve.
6. Furnish with 1/4-inch stainless-steel plugs for test connections.
7. Body: 316 stainless steel.
8. Packing: PTFE
9. Trim: Stainless steel.
10. Connections: 1/2-inch FNPT.
11. Manufacturer, Product:
    a. Anderson Greenwood & Co.
    b. Swagelok.
    c. Parker.

2.19 TEMPERATURE TRANSMITTERS:

A. Provide for monitoring air temperature of electrical room.
B. Provide loop powered temperature transmitter for monitoring air temperature .
C. NEMA 12 aluminum housing with LCD display.
D. Provide 4-20mA analog signal proportional to temperature.
E. Suitable for wall mounting.
F. RTD sensing element.
G. Provide compact stainless steel sensing element when used for ambient air sensing applications.

2.20 TURBIDITY ANALYZER (TURBIDIMETER):

A. Low Range Analyzer:
    1. The turbidimeter shall be a microprocessor-based, continuous reading, on-line nephelometric instrument. A single transmitter shall be capable of servicing two sensors.
    2. The turbidimeter shall measure turbidity in the range of 0.001-700 NTU.
    3. Accuracy shall be ±2% of reading or ±0.015 NTU whichever is greater from 0 to 40 NTU; ±10% of reading from 40 to 700 NTU.
    4. Repeatability shall be better than ±1.0% of reading or ±0.002 NTU whichever is greater.
    5. The turbidimeter shall meet all design and performance criteria specified by USEPA method 180.1.
    6. Sensor:
        a. 1/4-inch NPT sample inlet, 1/2-inch NPT drain outlet.
        b. Light shall be directed through the surface of the sample and the detector shall be immersed in the sample.
        c. Optical components shall be mounted in a sealed head assembly that can be removed for calibration/ service without disturbing sample flow.
        d. Shall be constructed of corrosion-resistant polystyrene.
        e. Where required, an internal bubble removal system shall be included to vent entrained air from the sample stream.
        f. Provide interconnecting cable between sensor and transmitter.
        g. Hach Company sensor TU5300sc or approved equal.

7. Accessories:
    a. Provide a high pressure flow reducer where sample line pressures are above 12 psi.
    b. Provide interconnecting cable between instrument body and transmitter.
    c. Provide formazin calibration kit.
    d. Provide self-cleaning module for sensors deployed in Raw Water service.

B. Standardized by inserting a secondary standard reflectance rod into the light beam.

C. Instrument Body:
1. Molded ABS structural foam with PVC fittings.
2. Designed for sample flows of 250-500 ml per minute at a pressure range of 2 to 12 psi.

D. Analyzer/Transmitter:
1. The transmitter shall be a microprocessor-based controller with plug and play connection of sensors.
2. Menu driven software to allow for straight forward calibration and selection of display parameters.
3. A backlit LCD display and keypad shall be provided for programming and displaying operating parameters.
4. Transmitter shall be rated for -20 to 40°C operation at 25W or less sensor load.
5. Capable of monitoring two separate sensing probes as specified.
6. Transmitter shall store all user settings in non-volatile memory (EEPROM).
7. The transmitter unit shall have a built-in data logger function.
8. Provide the following outputs:
    a. Four SPDT, user programmable contacts each rated 5A at 120Vac.
    b. Two independent analog 4-20mA outputs. Capable of handling an output impedance of up to 500 Ohms.
9. Provide with Hart communication capability. Provide device type manager (DTM) software module for use in Hart device setup and monitoring software if required.
10. Enclosure shall be rated NEMA 4X and shall be capable of wall, pipe, or panel mounting.
11. When installed outdoors provide a sun shield to protect unit from direct sun contact.
12. Shall operate on 120Vac, 60Hz or 24Vdc.
13. Provide SC200 controller with optional sun shield as manufactured by Hach Company.
    a. Coordinate with other instrument sensors this Section.
14. Mounting Panel:
    a. Transmitter, sensor, flow meter, and sample piping shall be factory mounted, wired, and plumbed on an aluminum or stainless-steel plate suitable for wall mounting.
    b. See Division 46 for additional mounting panel requirements.

PART 3 - EXECUTION

3.01 GENERAL:

A. Perform all Work necessary to install, connect, tube, wire, pipe and calibrate:
1. In strict accordance with the manufacturer's recommendations.
2. To make instruments and controls ready for successful operation.
3. As specified and indicated on the instrument schedule and the Instrument Installation Details included on the Process and Instrumentation diagrams (P&IDs), and Electrical Plan Drawings.

B. Provide all material to mount on floor or wall.

C. Mount instrument plumb and level.

D. Mount instrument four feet above floor unless indicated otherwise and instrument case spaced at least 1/2-inch away from wall.

E. Provide all equipment, materials, scaffolding, rigging, and tools to complete the Work.
F. Provide all labor, including expert and common, specialized personnel, fitters, electricians, instrument technicians, and attendance of such personnel.
G. Coordinate all installation activities involving others. Identify restraints caused by others which affect performance of the Work. Resolve such restraints where possible, and notify the Engineer when additional action is required to complete the Work.
H. Electrical Plan Drawings shall be used to determine approximate location of instruments to be installed and their sensing line connections. Subcontractor shall advise the Contractor of interferences.
I. Instruments not indicated on the Electrical Plan Drawings but listed in the Instrument schedule, shall be field located by the Subcontractor with the assistance of the Contractor.
J. Install device tags for all devices without tags or as directed by the Contractor.
K. Apply lubricant to threads of screwed transmitter covers prior to installation.

3.02 TUBING AND PIPING:

A. Fabricate and erect each sensing line from the root valve to the instrument, including tubing, piping, fittings and supports for each device.
B. Tubing and piping arrangements shall be as indicated. Install offsets, fittings, unions, vents, drains, and supports to make a complete installation.
C. Install unions or flanges for each instrument or control device to allow convenient removal as follows:
    1. Install so lines may be broken for maintenance, valves removed and equipment disconnected.
    2. Install in lines erected without such unions or flanges but, in the opinion of the Contractor, cannot be properly maintained without them.
    3. Install flanges with bolt insulator kits or dielectric insulated unions for joining dissimilar piping materials, such as copper to iron or steel. Install such insulating devices in positions which receive axial loads only with no bending loads.
D. Support tubing as follows:
    1. Support individual copper tubing continuously along the entire length.
    2. Support stainless-steel tubing either continuously or from individual supports with spacing not to exceed the following distances:
        a. For 1/4-inch OD tubing, use 3 feet maximum spacing.
        b. For 3/8-inch OD tubing, use 4 feet maximum spacing.
        c. For 1/2-inch OD tubing, use 5 feet maximum spacing.
    3. Supports shall allow for thermal expansion of tubing and equipment.
    4. Provide vibration isolating materials, which in the opinion of the Contractor are required to prevent tube surface damage due to rubbing on supports.
E. Tubing and piping shall be installed either perpendicular to or parallel, to the building structure, the floor or the major equipment.
F. Tubing and piping shall be installed with a minimum clearance of 7 ft.-6 inches over passageways and walkways.
G. Verify tube fitting pull-up with the manufacturer's gap inspection gage.
H. Clean and blow out all tubing with compressed air prior to connecting to instruments.
I. Verify that the tubing systems are tight and do not leak. Repair all leaks found.
J. Install flexible instrument tubing in sensing lines where substantial relative movement occurs between the instrument and the process connection. Install where required and directed by the Contractor. Flexible tubing end connections shall be installed in the same plane and free from all torsion effects during service conditions and non-operating periods.

3.03 VALVES IN TUBING:

A. Install Instrument Shutoff Valve or Instrument Manifold Valve for each device as indicated on the Instrument Installation Details. Type of valve shall be as indicated on the Instrument Installation Details.
B. Install Instrument Manifold Valve for the sensing lines to each differential pressure device.
C. Install blowdown valves for each remote-mounted devices as indicated on the Instrument Installation Details. Type and quantity of valves shall be as indicated on the Instrument Installation Details.

3.04 INSTRUMENT STANDS:

A. Install Instrument Stands with mounting plates, floor stands, brackets, and supports to provide rigid installation.
B. Freestanding Instrument Stands shall be suitably braced and attached to the floor or supporting structure to provide a rigid mounting structure for the instruments.
C. Provide one inch of grout under concrete floor mounted instrument stands.
D. Instrument Stands and other mountings in platform grating areas shall be attached to structural steel or rigid structures. For instrument stands on platforms, weld base plates to building steel.
E. Furnish all anchors, channels, brackets, and supports for a secure, rigid, and complete installation for the Instrument Stands and installed instruments. Do not support Instrument Stands from grating or handrails.
F. Mounting plates and miscellaneous supports shall be attached to structural steel or rigid structures.
G. Instruments shall be mounted such that they are protected from physical damage, weather, heat, and vibration.
H. Instruments shall be mounted to provide easy access for calibration, repair, disconnection, removal, and replacement.
I. Mount Instrument Blowdown Valves to the Instrument Stand with mounting plates, brackets, and clips.

3.05 INSTRUMENT ENCLOSURES:

A. Instrument Enclosures or sun shields shall be furnished for instruments located outdoors.
B. Instrument Enclosures or sun shields shall be rigidly mounted to Instrument Stands.

3.06 GROUT:

A. Provide one inch of grout under concrete floor mounted supports.
B. Provide grout as indicated on the Instrument Installation Details.
C. Material shall be as specified in Division 3.

3.07 PRESSURE-SENSING INSTRUMENT ACCESSORIES:

A. Install pulsation dampeners on all line-mounted pressure-sensing instruments where:
    1. Process fluid pulsing is detected.
    2. The instrument measures a pump's discharge pressure.
    3. Install siphon tubes on all line mounted steam pressure sensing instruments where the instrument is mounted above the process connection.

3.08 TEMPORARY INSTRUMENTATION:

A. Furnish temporary gauges for pressure and temperature measurement during piping system flushes and hydrostatic testing.
B. No permanent instrumentation shall be in service at this time.

3.09 TESTING:

1. Leak Testing of Tubing Systems: Initial service leak testing shall be performed on all sensing and signal line tubing systems. This includes all tubing, piping, instrument shutoff valves, manifold valves, and blowdown valves, located after the root valve. Repair any leaks found.

3.10 DEVICE CALIBRATION:

A. General:
   1. Industry standards and manufacturers' recommendations shall be followed in the execution of this Work.
   2. Whenever possible, devices shall be calibrated prior to installation according to the calibration procedures specified below.
   3. Provide all test instruments, calibration standards, and devices required to perform calibration and testing procedures. Alternative test equipment must be approved by the Contractor.
   4. Instrument calibration shall be witnessed by the Owner, Contractor or any other person assigned by the Owner or Contractor. Provide to the Contractor daily calibration Work schedule.
   5. Coordinate the Work with others so that calibration is completed prior to equipment startup or system turnover dates or as directed by the Contractor.
   6. Calibrate in strict accordance with manufacturers' recommendations. Instruction books are available from the Contractor for instruments furnished by others.
   7. Power all transmitters from system power supplies for calibration. Allow manufacturer's recommended warm up time prior to start of calibration of device. Use of portable power supplies or batteries to power transmitters for Device Calibration is not allowed.
   8. Calibrate all instruments to the calibration ranges and set points specified on the respective instrument datasheets or as indicated on vendor drawings.
   9. If the instrument is of the "smart" family, verify the internal configuration data is as specified on the respective instrument datasheet.
   10. Immediately after Device Calibration, attach a calibration label or self-adhesive calibration sticker to the device with the name of the person performing the calibration and date of calibration.
   11. When devices are removed from equipment, ensure the connection is protected from contamination. Clean devices such that reinsertion or installation of the device does not contaminate the equipment.
   12. Report defective equipment to the Contractor.
   13. Assist and cooperate with Contractor at all times through the calibration of the instruments to insure that such activities do not interfere with the planned operation of the facility.

B. Pressure or differential pressure devices:
   1. All pressure devices shall be calibrated to read the pressure at the process root valve.
   2. If pressure device does not have a Q4 calibration sheet:
      a. Use certified dead weight tester, manometer or Wallace and Tiernan pneumatic calibration unit to validate all certified calibration pressure gauges used in the calibration of all other non-calibrated devices.
      b. Adjust zero and span of device to read the pressure at the process root valve.
      c. Use a vacuum or pressure hand pump and certified calibration pressure gauge to verify and record device pressure output readings at 0, 25, 50, 75, and 100% of input value.

d. Record alarm point and failed sensor values.
e. Record device hysteresis.
f. Remove test equipment and verify that the instrument output reads the correct pressure.

3. A device provided with a factory calibration sheet can be considered calibrated unless it is in a service with a static liquid leg or similar application, calibrate the device with the procedure outline above to provide appropriate static liquid correction so zero is measured at the root valve.

C. Temperature devices:
1. Thermocouples and extension lead wire shall be checked for proper type polarity and grounding. The temperature element will be check with an ohm meter for continuity. Record the resistance
2. RTD wiring shall be checked for proper type polarity and grounding. The temperature element will be check with an ohm meter for continuity. Record the resistance.
3. Temperature switches shall be checked by immersion in a temperature regulated oven or bath. Record actuation point and any dead ban.

D. Level controllers and liquid level switches:
1. Fill the float chamber with water observe the operation of the device.
2. Lift float switches to activation point.
3. Record the controller output over the entire range of the input, verify the correct controller response or the activation of the switch occurs at the level setpoint specified.

E. Switches, other than liquid level:
1. All switch positioning shall account for dimensional changes that may occur when the equipment is placed in service.
2. Apply process input and adjust switch actuation points to specified value.
3. Record if switches make and break with an electrical continuity check.
4. Adjust dead band if applicable.
5. Verify repeatability of switch actuation points after adjustments are completed.

F. Other transmitters and signal converters:
1. Apply power, input signal, and process input, as applicable.
2. Adjust zero and span.
3. Calibrate per manufacturer instructions for the applicable process measurement.

G. Motor operated valves:
1. Apply power to the motor.
2. Use the control system to stroke the valve.
3. Record valve position over the entire input signal range; confirm whether valve is direct acting or indirect acting as required by the application.
4. Record readings or output of device at 0, 25, 50, 75, and 100% of input value.
5. Record device hysteresis.
6. Adjust limit switches to actuate at values indicated. Confirm switches make or break with an electrical continuity check.
7. Apply power to the position transmitter and adjust zero and span to represent 0 to 100% open position of the control valve.

H. Magnetic flow meters:
1. Apply power and allow the manufacturer's recommended warm-up time.
2. With a HART Communicator calibrate the meter using the manufacturers recommended procedure.

I. Receiving devices, including recorders and indicators:
1. Apply applicable electrical or pneumatic input signals and power.

2. Adjust zero and span for reach range.
3. Record readings or output of device at 0, 25, 50, 75, and 100% of input value.

3.11 INSTALLATION VERIFICATION:

A. Confirm that the instrument is mounted as indicated on the installation details and P&IDs.
B. Confirm the sensing lines are:
   1. Connected to the proper pipeline, vessel or other equipment.
   2. Connected to the proper instrument connections, hi side or low side.
   3. Installed and adequately sloped in the appropriate direction with no pockets that would trap process material.
C. Confirm that the installation is properly supported, and there is no excessive vibration.
D. Confirm that level measuring devices are installed at the proper elevation.
E. Confirm that instrument air supplies are properly connected and adjusted to the correct pressure.
F. Confirm that signal lines are properly connected to the correct receiving device.
G. Confirm instrument is rated for electrical power run to the device and that it is correctly terminated.

3.12 LOOP TESTING:

A. General:
   1. Coordinate with the Contractor and operator for the for all loop testing activities.
   2. After Device Calibration and Verification of Installation has been completed for all devices in a loop, perform Loop Testing to functionally check all signals and devices within the loop display and operate correctly from the PCS. Loop Testing shall be performed on all control loops.
   3. Verify operation of each instrument relative to transmitting and receiving devices in the loop.
   4. Verify calibration of each instrument within the loop.
   5. Verify performance of instruments that are part of electrical control schemes in order to assist the Equipment manufacturer's service representative or Contractor to functionally test the schemes.
   6. Recalibrate, replace, or repair all of the loop devices as required to obtain the stated accuracy.
B. Modulating Loops:
   1. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION or for smart transmitters manually control the output of the loop primary sensing device. Set the process to 50% of range and verify whether the loop is direct acting or indirect acting as required by the application.
   2. Apply process values equal to 0, 25, 50, 75, and 100% of range of primary sensing device. Record readings of all receiving devices at each of these input values. Also record value of primary sensing device output signal at each point.
   3. Adjust receiving device and transmitting device as required so that readout from receiving devices is within 1% of the value of the process input.
   4. Verify that the direction of response is consistent with the control system output.
   5. For output signal values of 0, 25, 50, 75, 100% from the control system, record the loop final element position in percent or degrees open.
   6. If loop contains a signal converter device, such as an I/P converter, record for each output signal value from the faceplate control station the value of the input and output signals of the converter.

7. For control valve positioner or I/P converter recalibrate to obtain desired relationship between faceplate control station output and control valve position.
8. Make adjustments as required to the control drive linkage, for control drive or I/P converter recalibrate to obtain desired relationship between faceplate control station output and damper position.
9. For limit switches, verify that actuation point of limit switch is within 2% of the value specified. Adjust or recalibrate switch if required.
10. For modulating output signals from the control system to receiving devices:
    a. Have the DCS operator place the output signal in manual.
    b. Apply signal values equal to 0, 25, 50, 75, and 100% of output signal range.
    c. Record readout of receiving devices for each value of input signal above.
    d. Adjust or recalibrate receiving device as required so that readout of device is within 1% of input signal value.
11. For modulating loops containing transmitters, receiving devices and final control elements, proceed as follows:
    a. Loop test transmitters and receiving devices in the loop.
    b. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION or for smart transmitters manually control the output to loop transmitters. Verify that output of controllers is in the proper direction for process input values above and below controller set point.
    c. Verify null calibration of controllers by setting process input to set point and increasing controller reset adjustment. Adjust or calibrate controller as required so that controller output does not change under these conditions.
    d. Verify that direction of response of loop final control elements is in the direction specified for process input values above and below controller's set point.
    e. Record reading of the position of final control elements for input signal values of 0, 25, 50, 75, and 100% to these devices. Adjust or recalibrate final control device to obtain desired relationship between input signal value and final control element position.
    f. If final control devices have limit switches, verify that actuation point of limit switch is within 2% of value specified. Adjust or recalibrate switch if required.

C. Discreet Loops:
1. Functionally test electrical control schemes designed for the purpose of controlling operation of equipment, including motors, pumps, motor-operated valves, solenoid-operated pneumatic valves and similar field equipment. By performing all of the functions described below. These functions shall be performed under the coordination and supervision of the Contractor.
    a. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION.
    b. Verify that switch actuation point is within 1% of that specified. Verification of switch actuation shall be by electrical continuity test.
    c. Remove process input from instrument, when requested, and verify switch returns to "on the shelf" state.
    d. Repeat a. and b. above as required for Contractor to witness the operation from the plant PCS to complete functional test of control scheme.
    e. Verify that final control devices are interfaced to the control system operate as intended by the design of the control scheme. If final control device has limit switches, verify that these actuate within 2% of specified actuation value.

2. If a non-modulating type instrument is utilized to provide an input to the control system, perform a loop test as follows:
    a. Apply process input as specified in this Section PART 3 - DEVICE CALIBRATION.
    b. Verify that actuation point of switch is within 1% of that specified and that the input is received at the terminals of the control system. Verification shall be by electrical continuity test.

3.13 TUNING:

A. After Loop Testing or during start-up of the process system or equipment, tuning adjustments are required to obtain safe and smooth control action within the range of design limits of the equipment. SI shall tune all loop, including PID controllers and constants wired to the control system.
B. Verify that the instrumentation is operating within design limits and at design point.
C. Vary the process load, and verify that the control system or instrument response is within design limits over the entire range.
D. Stroke remotely operated valves and dampers as required for loop tuning.
E. Ramp variable frequency drives through their operating range with setpoint changes as required for loop tuning.
F. Adjust controllers for optimum response. Adjust proportional band, reset, rate and set point as required to obtain safe and smooth control action within the range of design limits of the equipment.
G. Provide expert attendance and labor to manufacturer's representative for adjustments to the control system.
H. Record and submit all tuning constants to the Contractor and the Owner on the loop checkout sheets.

3.14 TESTING:

A. Cooperate and coordinate with other contracts as required when the testing of all devices, as outlined below, involves such other contracts. This shall include, but not be limited to, coordinating the following:
    1. Scheduling as directed by the Contractor.
    2. Manpower requirements, including expert and common labor, specialized personnel and supervision.
    3. All equipment and testing devices required.

END OF SECTION 40 70 00

REFER TO ATTACHMENT – INSTRUMENT LIST

ATTACHMENT

INSTRUMENT LIST

TAG NUMBER	PUMP STATION/SYSTEM	DESCRIPTION	DEVICE TYPE	CONTROL POINT	SET POINT	CAL. RANGE MIN	CAL. RANGE MAX	SET POINT / CAL. RANGE UNIT	FURNISHED BY	INSTALL DETAIL	WIRED BY	ELECTRICAL DWG / SPEC.	PIDDwg
LS-105-H	POTABLE	NORTH WATER TANK LEVEL SWTICH	LEVEL SWITCH	PLC-100	30	N/A	N/A	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-003
LE/LIT-105	POTABLE	NORTH WATER TANK LEVEL RADAR	RADAR LEVEL TRANSMITTER	PLC-100	N/A	0	32	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-003
LI-105	POTABLE	NORTH WATER TANK LEVEL INDICATOR	LEVEL GAUGE	PLC-100	N/A	0	32	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-003
LS-106-H	POTABLE	SOUTH WATER TANK LEVEL SWTICH	LEVEL SWITCH	PLC-100	30	N/A	N/A	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-003
LE/LIT-106	POTABLE	SOUTH WATER TANK LEVEL RADAR	RADAR LEVEL TRANSMITTER	PLC-100	N/A	0	32	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-003
LI-106	POTABLE	SOUTH WATER TANK LEVEL INDICATOR	LEVEL GAUGE	PLC-100	N/A	0	32	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-003
ZS-135-OPEN	POTABLE	BV-135 POSITION - OPEN	POSITION SWITCH	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-004
ZS-135-CLOSE	POTABLE	BV-135 POSITION - CLOSE	POSITION SWITCH	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-004
ZS-100-OPEN	POTABLE	FCV-135 POSITION - OPEN	POSITION SWITCH	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-004
ZS-100-CLOSE	POTABLE	FCV-135 POSITION - CLOSE	POSITION SWITCH	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-004
ZS-134-OPEN	REUSE	FCV-134 POSITION -OPEN	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-008
ZS-134-CLOSE	REUSE	FCV-134 POSITION -CLOSE	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-008
PIT-110	POTABLE	WATER TANKS PRESSURE TRANSMITTER	PRESSURE TRANSMITTER	PLC-100	110	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-004
TE-101	POTABLE	PUMP P-101 TEMPURATURE RTDS	TEMPURATURE RTDS	PLC-100	N/A	MOTOR MFR.	MOTOR MFR.	F	MOTOR MFR.	MOTOR MFR.	CONTRACTOR	1EI-101	0I-004
PI-101	POTABLE	PUMP P-101 PRESSURE GAUGE	PRESSURE GAUGE	PLC-100	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
PS-101-H	POTABLE	PUMP P-101 HIGH DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	PLC-100	112	N/A	N/A	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-004
TE-102	POTABLE	PUMP P-102 TEMPURATURE RTDS	TEMPURATURE RTDS	PLC-100	N/A	MOTOR MFR.	MOTOR MFR.	F	MOTOR MFR.	MOTOR MFR.	CONTRACTOR	1EI-101	0I-004
PI-102	POTABLE	PUMP P-102 PRESSURE GAUGE	PRESSURE GAUGE	PLC-100	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
PS-102-H	POTABLE	PUMP P-102 HIGH DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	PLC-100	112	N/A	N/A	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-004
AE/AIT-130A	POTABLE	SAMPLE LINE CONDUCTIVITY ANALYZER	CONDUCTIVITY	PLC-100	N/A	0	1000	µS/cm	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
AE/AIT-130B	POTABLE	SAMPLE LINE CHLORINE ANALYZER	CHLORING ANALYZER	PLC-100	N/A	0	10	mg/L	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
AE/AIT-130C-TEMP	POTABLE	WATER SAMPLE LINE TEMPERATURE ANALYZER	TEMPURATURE ANALYZER	PLC-100	N/A	32	90	F	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
AE/AIT-130C-PH	POTABLE	WATER SAMPLE LINE PH ANALYZER	PH ANALYZER	PLC-100	N/A	1	14	PH	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
LS-131-L	POTABLE	WATER SUMP LEVEL SWITCH - LOW	LEVEL SWITCH	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
LS-131-H	POTABLE	WATER SUMP LEVEL SWITCH - HIGH	LEVEL SWITCH	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
LS-131-HH	POTABLE	WATER SUMP LEVEL SWITCH - HIGH HIGH	LEVEL SWITCH	PLC-100	3" AFF	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-004
TE-103	POTABLE	PUMP P-103 TEMPURATURE RTDS	TEMPURATURE RTDS	PLC-100	N/A	MOTOR MFR.	MOTOR MFR.	F	MOTOR MFR.	MOTOR MFR.	CONTRACTOR	1EI-101	0I-005
PI-103	POTABLE	PUMP P-103 PRESSURE GAUGE	PRESSURE GAUGE	PLC-100	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-005
PS-103-H	POTABLE	PUMP P-103 HIGH DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	PLC-100	112	N/A	N/A	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-005
PT-120	POTABLE	PUMP DISCHARGE PRESSURE TRANSMITTER	PRESSURE TRANSMITTER	PLC-100	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-005
PI-120	POTABLE	PUMP DISCHARGE PRESSURE GAUGE	PRESSURE GAUGE	PLC-100	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-005
FE-121	POTABLE	PUMP DISCHARGE FLOW ELEMENT	FLOW ELEMENT	PLC-100	N/A	0	18	MGD	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-005
FIT-121	POTABLE	DISCHARGE FLOW TRANSMITTER	FLOW TRANSMITTER	PLC-100	N/A	0	18	MGD	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-005
LS-122-H	POTABLE	PIPE TRENCH FLOOD SWITCH - HIGH	SWITCH - HIGH	PLC-100	3" AFF	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-005
ZS-194A-O	POTABLE	DOOR CONTACT - ELECTRICAL ROOM SWITCH 1	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
ZS-194B-O	POTABLE	DOOR CONTACT - ELECTRICAL ROOM SWITCH 2	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
ZS-194C-O	POTABLE	DOOR CONTACT - PUMP ROOM	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
ZS-194D-O	POTABLE	DOOR CONTACT - GARAGE DOOR	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006

TAG NUMBER	PUMP STATION/SYSTEM	DESCRIPTION	DEVICE TYPE	CONTROL POINT	SET POINT	CAL. RANGE MIN	CAL. RANGE MAX	SET POINT / CAL. RANGE UNIT	FURNISHED BY	INSTALL DETAIL	WIRED BY	ELECTRICAL DWG / SPEC.	PIDDwg
ZS-195A-O	POTABLE	DOOR CONTACT - VEHICLE SWING GATE (PUMP STATION)	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
ZS-195B-O	POTABLE	DOOR CONTACT - MAIN GATE (PUMP STATION)	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
ZS-196A-O	POTABLE	DOOR CONTACT - VEHICLE SWING GATE (TANK)	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
ZS-196B-O	POTABLE	DOOR CONTACT - MAIN GATE (TANKS)	DOOR CONTACT	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
JY-195-ON	POTABLE	PUMP STATION LIGHTING CONTROL	POWER RELAY	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
JY-196-ON	POTABLE	TANK PARKING LIGHTING CONTROL	POWER RELAY	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
YS-197-OK	POTABLE	CARD ACCESS "OK" SIGNAL	CARD READER	PLC-100	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-006
LS-200-H	REUSE	WATER TANK LEVEL SWTICH	LEVEL SWITCH	PLC-200	30	N/A	N/A	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-007
LE/LIT-200	REUSE	WATER TANK LEVEL RADAR	RADAR LEVEL TRANSMITTER	PLC-200	N/A	0	32	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-007
LI-200	REUSE	WATER TANK LEVEL INDICATOR	LEVEL GAUGE	PLC-200	N/A	0	32	FT	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-007
ZS-235-OPEN	REUSE	BV-235 POSITION - OPEN	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-004
ZS-235-CLOSE	REUSE	BV-235 POSITION - CLOSE	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-004
ZS-200-OPEN	REUSE	FCV-200 POSITION -OPEN	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-008
ZS-200-CLOSE	REUSE	FCV-200 POSITION -CLOSE	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-008
ZS-234-OPEN	REUSE	FCV-234 POSITION -OPEN	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-008
ZS-234-CLOSE	REUSE	FCV-234 POSITION -CLOSE	POSITION SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-105	0I-008
PIT-210	REUSE	WATER TANK PRESSURE TRANSMITTER	PRESSURE TRANSMITTER	PLC-200	15	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	0ES-101	0I-008
TE-201	REUSE	PUMP P-201 TEMPURATURE RTDS	TEMPURATURE RTDS	PLC-200	N/A	MOTOR MFR.	MOTOR MFR.	F	MOTOR MFR.	MOTOR MFR.	CONTRACTOR	1EI-101	0I-008
PI-201	REUSE	PUMP P-201 PRESSURE GAUGE	PRESSURE GAUGE	PLC-200	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
PS-201-H	REUSE	PUMP P-201 HIGH PRESSURE SWITCH	PRESSURE SWITCH	PLC-200	67	N/A	N/A	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-008
TE-202	REUSE	PUMP P-202 TEMPURATURE RTDS	TEMPURATURE RTDS	PLC-200	N/A	MOTOR MFR.	MOTOR MFR.	F	MOTOR MFR.	MOTOR MFR.	CONTRACTOR	1EI-101	0I-008
PI-202	REUSE	PUMP P-202 PRESSURE GAUGE	PRESSURE GAUGE	PLC-200	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
PS-202-H	REUSE	PUMP P-202 HIGH PRESSURE SWITCH	PRESSURE SWITCH	PLC-200	67	N/A	N/A	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-008
AE/AIT-230-TURB	REUSE	SAMPLE LINE TURBIDITY ANALYZER	TURBIDITY ANALYZER	PLC-200	N/A	0	1000	µS/cm	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
LS-231-L	REUSE	SUMP LEVEL SWITCH - LOW	LEVEL SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
LS-231-H	REUSE	SUMP LEVEL SWITCH - HIGH	LEVEL SWITCH	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
LS-231-HH	REUSE	SUMP LEVEL SWITCH - HIGH HIGH	LEVEL SWITCH	PLC-200	3" AFF	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
TE-203	REUSE	PUMP P-203 TEMPURATURE RTDS	TEMPURATURE RTDS	PLC-200	N/A	MOTOR MFR.	MOTOR MFR.	F	MOTOR MFR.	MOTOR MFR.	CONTRACTOR	1EI-101	0I-008
PI-203	REUSE	PUMP P-203 PRESSURE GAUGE	PRESSURE GAUGE	PLC-200	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
PS-203-H	REUSE	PUMP P-203 HIGH DISCHARGE PRESSURE SWITCH	PRESSURE SWITCH	PLC-200	67	N/A	N/A	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-008
PT-220	REUSE	PUMP DISCHARGE PRESSURE TRANSMITTER	PRESSURE TRANSMITTER	PLC-200	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-008
PI-220	REUSE	PUMP DISCHARGE PRESSURE GAUGE	PRESSURE GAUGE	PLC-200	N/A	0	150	PSIG	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
FE-221	REUSE	PUMP DISCHARGE FLOW ELEMENT	FLOW ELEMENT	PLC-200	N/A	0	8	MGD	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
FIT-221	REUSE	PUMP DISCHARGE FLOW TRANSMITTER	FLOW TRANSMITTER	PLC-200	N/A	0	8	MGD	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
LS-222-H	REUSE	PIPE TRENCH FLOOD SWICTH	SWITCH - HIGH	PLC-200	3" AFF	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-101	0I-008
ZS-294A-O	REUSE	DOOR CONTACT - ELECTRICAL ROOM SWITCH 1	DOOR CONTACT	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-009
ZS-294B-O	REUSE	DOOR CONTACT - ELECTRICAL ROOM SWITCH 2	DOOR CONTACT	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-009
ZS-294C-O	REUSE	DOOR CONTACT - PUMP ROOM	DOOR CONTACT	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-009

TAG NUMBER	PUMP STATION/SYSTEM	DESCRIPTION	DEVICE TYPE	CONTROL POINT	SET POINT	CAL. RANGE MIN	CAL. RANGE MAX	SET POINT / CAL. RANGE UNIT	FURNISHED BY	INSTALL DETAIL	WIRED BY	ELECTRICAL DWG / SPEC.	PIDDwg
ZS-294D-O	REUSE	DOOR CONTACT - GARAGE DOOR	DOOR CONTACT	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-009
YS-297-ON	REUSE	CARD ACCESS "OK" SIGNAL	CARD READER	PLC-200	N/A	N/A	N/A	N/A	CONTRACTOR	SEE DRAWINGS	CONTRACTOR	1EI-100	0I-009

DIVISION 41 – MATERIAL PROCESSING AND HANDLING EQUIPMENT

SECTION 41 22 00 – CRANES AND HOISTS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following types of Equipment:
   1. Electrically Operated Trolley Hoist.
B. General requirements for each crane and hoist required are defined on the Data Sheets at end of this Section.

1.02 RELATED REQUIREMENTS:

A. Electrical: Division 26.
B. Manufacturer's Field Services: Division 01.

1.03 REFERENCES STANDARDS:

A. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.
B. Applicable Standards:
   1. American National Standards Institute (ANSI/ASME):
   2. American Society of Civil Engineers (ASCE):
      a. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.
   3. ASME International (ASME):
      a. ASME B30.2 - Overhead and Gantry Cranes (Top-Running Bridge, Single or Multiple Girder, Top-Running Trolley Hoist).
      b. ASME B30.11 - Monorails and Underhung Cranes.
      c. ASME B30.16 - Overhead Hoists (Underhung).
      d. ASME HST-1 - Performance Standard for Electric Chain Hoists.
      e. ASME HST-2 - Performance Standard for Hand Chain Manually Operated Chain Hoists.
      f. ASME HST-4 - Performance Standard for Overhead Electric Wire Rope Hoists.
   4. ASTM International (ASTM):
      a. ASTM A27/A27M - Standard Specification for Steel Casting, Carbon, for General Application.
      b. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
      c. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
      d. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      e. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      f. ASTM A148/A148M REV A - Standard Specification for Steel Castings, High Strength, for Structural Purposes.
      g. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      h. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon-Steel Structural Tubing in Rounds and Shapes.
      i. ASTM A536 - Standard Specification for Ductile Iron Castings.
      j. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.

k. ASTM A759 - Standard Specification for Carbon-Steel Crane Rails.
l. ASTM A992/A992M - Standard Specification for Structural Steel Shapes.
m. ASTM B695 - Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
n. ASTM B766 - Standard Specification for Electrodeposited Coatings of Cadmium.
o. ASTM F1554 - Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
p. ASTM F3125 – Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated.

5. American Welding Society (AWS):
   a. AWS D14.1/D14.1M - Specification for Welding of Industrial and Mill Cranes and other Material Handling Equipment.
6. Crane Manufacturers Association of America (CMAA):
   a. No. 74 - Specification for Top Running & Under Running Single Girder Electric Traveling Cranes Utilizing Under Running Trolley Hoists.
7. Federal Specification (FS):
   a. RR W 410 Wire Rope.
8. Institute of Electrical and Electronics Engineers (IEEE).
9. National Electrical Code (NEC), Article 610.
10. National Electrical Manufacturers Association (NEMA).
11. Occupational Safety and Health Administration (OSHA) - All applicable OSHA regulations, including but not limited to 29CFR Part 1910 and part 1926.

1.04 SUBMITTALS:

A. Submit as specified in Division 01.
B. Include, but not limited to, the following:
   1. Product Data:
      a. Specifications and manufacturer's data.
      b. Catalog cuts.
      c. General Arrangement Drawings including general arrangement of all components in plan, elevation, and end views; hook approaches on all four sides, clearances and principal dimensions, assemblies of hoist, trolley drives, and complete schematic wiring diagram with description of operation, and runway electrification system. Include weights of components and maximum wheel loads and spacing.
      d. Operation and maintenance manuals.
      e. Spare Parts List.
      f. Factory Load Test Certification.
      g. Coatings Product Data.
      h. Fabrication and erection drawings and details.
   2. Field Load Test.
   3. Structural Submittal Requirements:
      a. Structural Submittal requirements where supporting foundation or structure will be provided by others. Supplier shall provide and submit all information necessary to facilitate structural design, support, and attachment of Equipment and Materials provided by this equipment. Structural Submittal requirements shall include and/or take into account the following:

(1) Identify and provide all applicable equipment reaction loads applied to supporting structure or foundation to include in accordance with CMAA individual load and load combinations. Direction of each load shall be indicated and defined.
(2) Provide required structural bolt sizing and orientation for all applicable load points, structural bolts shall be ASTM F3125, Type 1, unless indicated otherwise.
(3) Provide general arrangement drawings of bridge cranes showing length of travel, required length of crane rails or support beams, tight or floating rail clips, other rail required rail clamp fastenings, and rail to rail or beam to beam centerline dimension, crane elevations below and above the rails, and hook elevations in the fully retracted and fully extended condition.
(4) Provide drawings of required clearances to supporting structure.
(5) Provide detail of crane bumpers and maximum loads as required for Engineer to design stops.

1.05 WIND AND SEISMIC LOADS:

A. Wind loads:
   1. Crane located indoors shall be designed for interior wind loads in accordance with ACSE 7.
B. Seismic Loads: Cranes shall be designed for the seismic criteria provided in the Contract Drawings.
   1. Design lifted load at time of seismic event:
C. Seismic restraints:
   1. Provisions shall be made to prevent the bridge or trolley(s) from "jumping" the rails anywhere in the range of operations during a seismic event.

1.06 QUALITY ASSURANCE:

A. Provide the services of a factory representative to place cranes and hoists in service in the event it does not function in an acceptable manner, or in the event of erection difficulties requiring expert advice from the manufacturer.
B. When more than one electric trolley hoist is furnished under this Contract, all electric trolley hoists shall be supplied by one manufacturer only.
C. Overload Limit Device: Shall be connected into the hoist control circuit that will prevent the hoist from lifting a freely suspended load outside of its rated tested capacity.
D. Certified Factory tests in accordance with ANSI/ASME requirements.
E. Field Testing: Field tests of all cranes, monorail beams, trolley hoists and their supporting structural elements shall be conducted in accordance with OSHA 1910 and as required by ANSI/ASME.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Deliver, store and handle equipment and materials to prevent warping or racking of members.
B. Protect all equipment and materials from damage by weather and operations on the Site.
C. Store lubricants, and other materials in enclosures and as recommended by material manufacturer. Crane supplier shall provide storage requirements for lubricants and other materials as recommended by manufacturer.

D. Provide notice to Construction Manager prior to delivery of crane and other components or equipment, in accordance with Division 01.

1.08 PRECONSTRUCTION CONFERENCE FOR CRANES AND HOISTS:

A. The crane subcontractor(s) shall attend a preconstruction conference no later than seven days prior to the start of crane installation. The purpose of the conference is for participants to provide information and to coordinate various crane-related items and procedures. The crane supplier shall attend the preconstruction conference if requested by Engineer.
B. The conference shall include representatives of Owner, Contractor, and Subcontractors.
C. The following items shall be discussed at the conference:
   1. Review of hoist-related design documents, changes, and RFIs.
   2. Review status of supporting steel erection and foundations preparation.
   3. Review of electrical power supply preparation.
   4. Verification that all submittals have been approved.
   5. Review construction sequencing, manpower and equipment requirements, and schedules.
   6. Review safety procedures.
   7. Review testing requirements.

1.09 DATA SHEETS:

A. For design criteria of each type of trolley and hoist, see Data Sheets at end of this Section.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Subject to compliance with requirements specified, provide products of one of the following:
   1. Trolley Hoists:
      a. ACCO Material Handling Solutions.
      b. Coffing.
      c. ACE Industries Inc.
      d. Demag Cranes and Components Company.
      e. Ace World Companies, Inc.
      f. Engineered Material Handling, Inc. (EMH)
      g. Harrington Hoists, Inc.
      h. Chesterfield Hoist Company.
      i. Columbus McKinnon Corporation.
      j. R&M Material Handling Inc.
      k. STAHL Crane Systems Inc.
      l. Yale Lift-Tech.
      m. Engineer-approved equal.

2.02 TROLLEY HOIST(S):

A. General Requirements:
   1. Conform to ANSI/ASME B30.16, applicable ASME-HST and as otherwise indicated.
   2. Conform to requirements for individual cranes and trolley hoists as indicated on Data Sheets.

3. Paint system shall be safety yellow, or safety orange as specified, standard of manufacturer. Supply for approval manufacturer's product descriptions and color samples. Supply one gallon of touch up by others after trolley-hoist installation.
4. Rated capacity shall be permanently marked one each side of unit.

B. Electric Motor Operated Trolley Hoist(s):
1. Type: Chain Hoist or Wire Rope Hoist as indicated on Data Sheets.
   a. Hoist: Electric, heavy-duty, lug-mount, hook mounted, or trolley-mounted as indicated on Data Sheets.
   b. Standard or low headroom as indicated on Data Sheet.
   c. Single or double reeved, wire rope as indicated on Data Sheet.
   d. Single or two speed lift as indicated on Data Sheet.
   e. Trolley to be push, geared, or motorized type as indicated on Data Sheet.
2. General Construction:
   a. Conform to ASME HST-1 or ASME HST-4 and as indicated below. Minimum duty service as indicated on Data Sheets.
   b. Hoist Breaks: Shall have automatic stop and hold in the event of a power failure, control the load during lowering, have upper-limit and lower limit switches.
   c. Over load limiting devise shall be furnished for all hoists that will limit the hoist from operating above its rated test load.
   d. Hoist Bearings shall have the minimum L10 life equal to the duty classification of the hoist, but not less than 10,000 hours.
   e. Electrical trolleys shall be equipped with bumpers.
   f. Motor(s) shall be fully enclosed, squirrel cage nonventilated, heavy-duty, with high starting torque and class B insulation. Motors shall be designed to operate at an ambient temperature of 104ºF, unless ambient temperature range listed in design conditions is higher.
   g. Trolley(s) shall be provided with soft-start controllers for smooth starting.
   h. Control panels and junction boxes shall be enclosed in nonventilated enclosures conforming to NEMA Publication ICS-1-110 (type 3S for outdoor service, type 12 for indoor service, type 4X 316 stainless steel for corrosive environments), or as indicated in Data Sheets.
   i. Controllers: Squirrel caged motors with speed magnetic control. Unit(s) shall be suitable for operation on the monorail beam indicated or the bridge or jib crane specified.
3. Electric Operation:
   a. Operation shall be by means of control pendant suspended from trolley hoist for operation with top of station located 4 ft.-6 inches above floor. Control pendant shall be retractable from cable reel if indicated on Data Sheets.
   b. Individual push buttons to control crane bridge, (boom), hoist, and trolley for electric operation as indicated on Data Sheets. For bridge cranes, pendant shall also have "start-stop" button to actuate the main line contactor.
   c. Pendant shall be of nonconductive material.
   d. Control(s) shall be single-speed or two-speed as indicated on Data Sheets, magnetic-type consisting of heavy-duty reversing type contactors interlocked and energized by push buttons. Control voltage shall be 24Vac.
   e. Controls shall be weather proof construction.
   f. Provide one adjustable upper and one adjustable lower limit switch.

4. Electrification:
   a. Electric Power: 3 phase, 60 Hz, 460Vac.
   b. Electrical system shall be [cable reel as indicated on Data Sheets.
   c. System: Flexible conductor cable with cable trolleys.
      (1) Conductor Cable Size: Conform with the National Electrical Code NFPA 70, Cable type SO or W, suitable for 0 to 110ºF.
      (2) Cable trolleys: To adequately support cable so that the cable does not drop below halfway between bottom of bridge or monorail beam and the hook at top position.
      (3) Cable shall be easily removed and replaced. Supply power from point indicated to trolley hoist.
      (4) System shall be of weatherproof and oil resistant construction.
   d. System: Cable reel.
      (1) Conductor Cable Size: Conform with the National Electrical Code NFPA 70 and recommendations of trolley hoist manufacturer.
      (2) Provide with mechanism to guard against instant release of cable tension, and to keep cable taut and at proper tension.
      (3) Reel shall be suitable for mounting on beam, ceiling, or wall as required and to supply power to trolley hoist for length of trolley travel.
      (4) System shall be of weatherproof and oil resistant construction.
      (5) Accessories shall include the following:
         (a) Roller cable guides.
         (b) Pivot base.
         (c) Guide rails.
   e. System: Insulated bar conductors.
      (1) Be enclosed type solid copper or copper-clad steel with matching collectors manufactured by Insul-8-Bar or approved equal.
      (2) System shall include the following for both bridge crane and trolley hoist electrification:
         (a) Insulated bar conductors and end covers.
         (b) Insulated hanger clamps.
         (c) Power feed.
         (d) Spring slide collectors.
         (e) Collector poles.
         (f) Brackets for mounting and support of system.
         (g) Other components as required for system operation.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Inspect all areas and surfaces for conditions detrimental to proper installation. Do not proceed with installation until conditions are satisfactory.

3.02 INSTALLATION:

A. Provide a complete installation including all Materials and Equipment necessary for operation of the Equipment. Place all specified Equipment into operation, including machinery lubrication.

B. Install bridge crane(s) level and in alignment.
C. Adjust Equipment to operate properly, including adjustment of stops to prevent over travel, and tension to prevent travel when not in use.
D. Touch-up damaged paint surfaces with matching paint system same as used in the shop.
E. Lubricate all bearings, gears, and other items requiring lubrication before placing crane in operation.

3.03 TESTING:

A. Prior to initial use and at other intervals until date of acceptance, test crane(s) as required by Occupational Safety and Health Administration Part 1910.179.
B. Send copies of test report to Engineer and Owner and place on file at Project Site.
   1. Testing shall be performed by Contractor or under direction of authorized persons.

END OF SECTION 41 22 00

TROLLEY HOIST AT POLYMER ROOM – DATA SHEET

1. Location: Polymer Room, Dewatering Building
2. Tag No. 1
3. Rated Capacity: 1.5 tons
4. Type: Underhung
5. Required Hook Lift:

   a. From Operating Floor: 10 feet 0 inches
6. Footwalk: N/A
7. Approximate Length of Runway: 16 feet 9 inches
8. CMAA Duty Classification: Class C
9. Crane to Operate: Indoors
10. Current: 208-230/460 Volts, 3 Phase, 60 Hertz, A.C.
12. Trolley Drive: Electric
    a. Electric drive requirements

       Single speed: 40 feet per minute

       Two speed: 40/80 feet per minute

       Bridge Conductors: Manufacturer's Standard

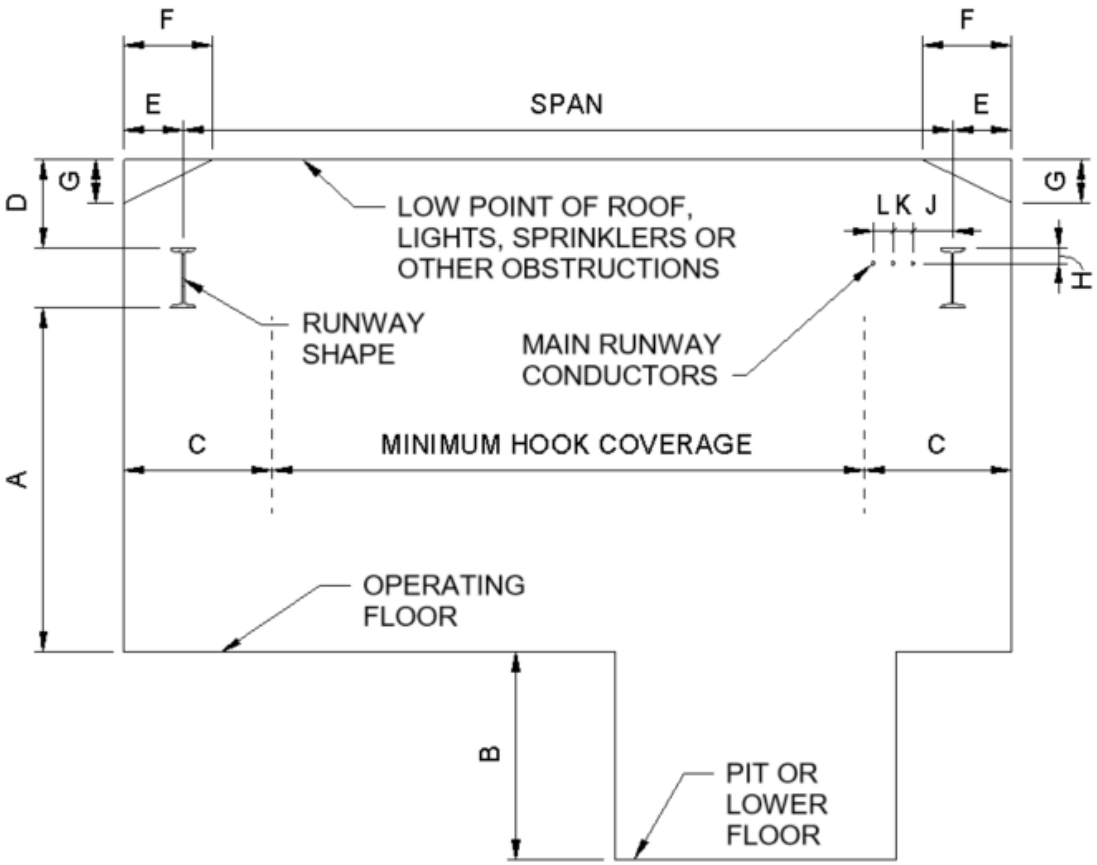
       Electric Operation: Pendant Control
13. Hoist: Electric Cable Hoist, Harrington Electric Chain Hoist or Approved Equal:
    a. Hand Chain coating: Galvanized
    b. Electric Hoist Requirements: Standard headroom, Double reeved
    c. Hoist Classification: H4 – Heavy Duty

       Single speed: 40 feet per minute

       Two speed: 40 / 80 feet per minute

       Electric Operation: Pendant Control
14. Span and building clearances are as indicated on the following clearance drawing:
15. Connect to point of electrical feed as described below or indicated on the following sketch:
16. Control Panel and Junction Boxes: Type 12

CRANE DATA SHEET BUILDING CLEARANCE FOR UNDER RUNNING CRANES



RUNWAY SHAPE:	S12X50
SPAN:	BRIDGE CRANE 1 = 42'-0"
	BRIDGE CRANE 2 = 38'-6"
REQ'D HOOK HEIGHT:	10'-0" ABOVE OPERATING FLOOR
LENGTH OF RUNWAY:	65'-0"
DIM A:	14'-9""
DIM B:	8'-0"
DIM C:	2'-3" MAX (MINIMIZE)
DIM D:	COORDINATE WITH DT MFR/ROOF SLOPE
DIM E:	2'-6"
DIM F:	N/A
DIM G:	N/A
DIM H:	TBD BY CONTRACTOR
DIM J:	TBD BY CONTRACTOR
DIM K:	TBD BY CONTRACTOR
DIM L:	TBD BY CONTRACTOR

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

SECTION 46 05 13 – COMMON MOTOR REQUIREMENTS FOR WATER AND WASTEWATER EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section includes the following:
   1. Motors and accessories for mechanical, process, and other equipment.
   2. Unless specified or indicated otherwise, motors 1/2-horsepower or smaller shall be single phase and motors 3/4 horsepower or larger shall be polyphase.

1.02 RELATED REQUIREMENTS:

A. SECTION 01 33 00 – Submittals.
B. SECTION 01 40 00 – Contractor QA/QC.
C. SECTION 01 42 00 – Definitions and Standards.
D. SECTION 01 60 00 – Equipment and Materials.
E. SECTION 01 75 00 – Manufacturer's Field Services.
F. SECTION 01 78 36 – Warranties.
G. SECTION 26 05 26 – Grounding and Bonding for Electrical Systems.
H. SECTION 26 29 23 – Variable Frequency Motor Controllers

1.03 REFERENCE STANDARDS:

A. Applicable Standards:
   1. American National Standards Institute (ANSI).
      a. ANSI B11.19 – Performance Criteria for Safeguarding.
   2. American Bearing Manufacturers Association (ABMA).
      a. ABMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
   3. Institute of Electrical and Electronic Engineers (IEEE).
      a. IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
   4. National Electrical Manufacturers Association (NEMA):
      a. NEMA MG 1 – Motors and Generators.

1.04 SUBMITTALS:

A. Submit as specified in Division 01.
B. Product Data: Submit the following as minimum:
   1. Nameplate information consisting of the following:
      a. Manufacturer's name and serial number.
      b. Horsepower output.
      c. Temperature rise and method indicated.
      d. Maximum ambient temperature.
      e. Rated Altitude
      f. Insulation class.
      g. Rpm at rated load.
      h. Operating frequency range.
      i. Number of poles.
      j. Number of phases.
      k. Voltage.
      l. Rated load amperes.

m. Locked rotor amperes or code letter.
n. Service factor.
o. Power factor.
p. Maximum noise level of pump/motor unit (dBA).
q. Efficiency, determined in accordance with IEEE 112, Method B.

2. Dimensions for enclosure and shafts.
3. Weight.
4. Bearing information.
5. Schematic diagrams for motor and specified motor accessories.
6. Statement from motor manufacturer specifying the variable frequency drive requirements for the motor to meet all requirements and recommendations of NEMA MG 1 - Part 31 for all operational load and speed conditions specified and required.

C. Test and Evaluation Reports:
1. Factory test reports.
2. Field test reports.

D. Closeout Submittals: Final documentation shall include the following as minimum:
1. Operation and Maintenance Manuals including the following:
a. Operation and maintenance manuals for all components furnished.
b. Copies of all approved Product Data.
c. Copies of all approved Test Reports.
d. Warranty Information.
e. Contractor Information.

1.05 DELIVERY, STORAGE, AND HANDLING:

A. As specified in SECTION 01 60 00.
B. Motors shall be packaged, skidded and shipped to prevent damage during shipment.
C. Stored motors shall be environmentally protected and maintained according to manufacturer's recommendations.
D. If supplied, energize space heaters during storage to prevent condensation within the motor enclosure.

1.06 QUALITY ASSURANCE:

A. As specified in SECTION 01 40 00.
B. Factory test motors 50 Hp and over using manufacturer's standard test process. Document test procedure and all measured values, including but not limited to, motor winding resistance, insulation resistance, and motor efficiency. Provide test results. Motors not passing shall not be shipped to the project site.

1.07 WARRANTY:

A. The warranty shall comply with the requirements of SECTION 01 78 36.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Motors:
1. Baldor Electric Company.
2. General Electric Company.
3. Marathon Electric Manufacturing Corporation.

4. Reliance Electric.
5. Siemens Energy and Automation, Inc.
6. TECO-Westinghouse Motor Company.
7. U.S. Motors, Nidec Motor Corporation.
8. WEG Electric Corporation.

B. Shaft Grounding Ring:
1. AEGIS, Electro Static Technology, Division of Illinois Tool Works Inc.
2. Inpro/Seal, Waukesha Bearings Corporation.
3. Engineer approved equal.

C. Couplings:
1. Rexnord Corporation, Division of RBS Global.
2. Waldron Hartig Machinery Division, Midland Ross Corporation.
3. Engineer approved equal.

2.02 HORIZONTAL SINGLE-PHASE MOTORS:

A. Rated for 40°C ambient temperature and continuous operation.
B. Voltage: 115V or 115/230V, 60 hertz.
C. RPM: 1750 unless indicated or specified otherwise.
D. Minimum service factor of 1.15.
E. Efficiency: Shall meet the premium efficiency motor standards as defined by NEMA MG 1.
F. Permanent split capacitor designed for low starting torque loads and applications requiring silent operation.
G. Capacitor start designed for high starting torque loads.
H. Adequate to drive equipment over the full operating range without exceeding service factor.
I. Bearings as specified in HORIZONTAL POLYPHASE MOTORS (200HP AND LESS), this Section.
J. Totally enclosed, fan cooled for all enclosures.
K. Manufacturer shall prepare surfaces, prime, and finish paint all surfaces with manufacturer's standard coating system. Coating system and color shall be suitable for intended service.
L. Stainless steel nameplate data on enclosure with all lubrication and electrical data.

2.03 HORIZONTAL POLYPHASE MOTORS (200HP AND LESS):

A. Rated for 460-volt, 3 phase, and 60-hertz operation and operation with variable frequency drive, when indicated.
B. Squirrel cage induction type for across-the-line or reduced voltage starting, as indicated.
1. Where reduced-voltage starting is indicated or specified the motor shall have torque requirements capable of bringing up the specified load to full speed. The reduced voltage starting shall be limited to 65% of nominal.

C. NEMA Design:
1. NEMA B: Normal starting duty applications.
2. NEMA C: High starting duty applications.

D. NEMA Class F insulation.
E. When controlled by variable frequency drive motors, comply with NEMA MG 1 Part 31.
F. Efficiency: Shall meet the premium efficiency energy efficient motor standards as defined by NEMA MG 1.
G. Enclosures:
1. Totally-enclosed for outdoor service or wet areas indoors.
2. Explosionproof in explosive atmospheres.

H. Horsepower Rating Requirements:
   1. Ambient Temperature: 40°C.
   2. 1800 rpm unless specified or indicated otherwise.
   3. Service factor of 1.15.
   4. Adequate to drive equipment without using service factor except in emergency conditions.

I. Bearings:
   1. Pre-lubricated ball bearings shielded to prevent entrance to foreign materials.
   2. Re-lubrication fittings and flushing system.
   3. Minimum L10 bearing life for continuous operation of 100,000 hours to conform to ABMA 9.

J. Sound Pressure Levels (SPL) of the motor shall not exceed the maximum levels as specified in NEMA MG 1 Table 9-1.

K. Manufacturer shall prepare surfaces, prime, and finish paint all surfaces with manufacturer's standard coating system. Coating system and color shall be suitable for intended service.

L. Stainless steel nameplate with all electrical and lubricating information.

M. See paragraph ACCESSORIES.

2.04 ADDITIONAL MOTOR REQUIREMENTS (200 HP AND LARGER)

A. Apply as required for vertical motors and horizontal motors.

B. Refer to above motor paragraphs for required characteristics not listed below.

C. Polyphase multi-pole squire-cage induction motor.

D. Rated for 460-volt, 3 phase, and 60-hertz operation.

E. Service factor:
   1. For constant speed motors 1.15.
   2. For Variable speed service refer to motor requirements for Variable Speed AC drives.
   1. Adequately sized to drive the connected load as indicated without using service factor except in emergency conditions.

F. Horsepower and speed rating shall be as defined in NEMA MG1 Part 20 for Large Machines.

G. Rated for 40°C ambient temperature and continuous operation.

H. Design:
   1. Operating Characteristics:
      a. Have high-starting torque, high-power factor, and efficiency consistent with good engineering practice.
   2. Starting in-rush kVA limited to Code G.
   3. Stator and rotor windings insulation shall be Class F and not to exceed Class B temperature rise by resistance while operating at rated 1.0 SF loading Additionally, all motors shall not exceed 90 deg C rise by the resistance method at service factor (1.15 SF) loading. The motor shall be rated for continuous operation at fill load and service factor load with a 40 deg C ambient. (NEMA MG 1 - 21.10).
   4. Windings shall be copper.
   5. Provide Epoxy VPI (vacuum pressure impregnation) of the motor windings for protection in humid and corrosive environments. Shall meet or exceed the requirements of NEMA MG1 and IEEE specifications for sealed windings.
   6. Stator windings and end turn connections shall be fully braced to withstand all mechanical, electrical, and thermal stresses.
   7. Motor Efficiency:

a. Test constant speed motors in accordance with IEEE 112, Test Method B shall meet the premium efficiency standards in NEMA MG1 Table 12-12.
b. For Variable speed service refer to motor requirements for Variable Speed AC drives.

8. Rotor shall be factory (statically and dynamically) balanced with completed windings and insulation in place to meet refined vibration standards.
9. Ambient Temperature rise: 40°C.
10. Temperature Rise Per Table:

Continuous Rated Motors (All Enclosures)	Class B Insulation	Class F Insulation	Class H Insulation
	Temperature Rise by Resistance - °C		
S.F. 1.0	80	105	125
S.F. 1.15	90	115	---
	Temperature Rise by Embedded Detector - °C		
S.F. 1.0	90	115	140
S.F. 1.15	100	125	---

11. Adequate to drive equipment without using service factor except in emergency conditions.
12. Vibration and Sound Pressure Levels (SPL) of the motor shall not exceed the maximum levels as specified in NEMA MG 1.
13. Frame made of cast iron or heavy fabricated steel of such design and proportion as to hold all motor components in proper position. Design to facilitate proper alignment to the mechanical load without any harmonic related vibration during motor operation.

I. Bearings:
1. Designed for static and dynamic, and continuous and momentary thrusts as required by the driven equipment.
2. Grease lubricated bearings shielded to prevent entrance to foreign materials
3. Re-lubrication fittings and flushing system.
4. Antifriction or Kingsbury type.
5. Minimum L10 bearing life for continuous operation of 100,000 hours to conform to ABMA 9.
6. Provide an insulated top bearing.

J. Provide motor surge protection capacitors and arrestors as recommended by the motor manufacturer.
K. Motor conduit boxes shall be oversized to permit solderless connection of external leads; properly insulated for voltage rating.
L. Motor leads permanently identified and of sufficient length to allow easy connection of external leads.
M. Include provisions for lifting the motor.

2.05 ACCESSORIES:
A. For vertical turbine pumps, provide non-reversing ratchets.
B. Provision for grounding motor frame.

C. For motors controlled by variable frequency drives, provide factory installed, maintenance free, circumferential, conductive micro-fiber shaft grounding ring to discharge shaft currents to ground. Motors rated 100HP and greater shall provide an insulated opposite drive end bearing.
D. Temperature switches: For 5 to 50 hp motors or where indicated or specified,
   1. Two normally closed temperature switches embedded in each phase winding for high temperature protection. Switches shall be rated for use with 120VAC at 5 amps and 120 Vdc at 1 amp.
   2. The temperature setpoint to open the contacts and protect the motors shall be based on motor design to minimize damage to the motor due to overheating.
   3. A separate low voltage conduit box for the temperature element leads.
E. Winding RTDs: For 100 hp and above, or where specified or indicated.
   1. The motor stator windings shall be provided with two Pt-100 ohm RTD embedded in each phase winding for high temperature protection. The RTD leads shall be terminated in an accessible junction box mounted as directed. Motor manufacturer to recommend high temperature shut down level.
   2. Provide DIN-rail mount temperature monitoring relay compatible with sensor provided for remote mounting and integration into the indicated motor controls. The temperature setpoint to open the contacts and protect the motors shall be based on motor design to minimize damage to the motor due to overheating.
   3. Provide sensor with sufficient length of cable to allow splicing for connection to the remote mounted temperature monitoring relay.
   4. A separate low voltage conduit box for the temperature element leads.
F. Motor Space Heaters: for Outdoor installations, or where indicated or specified.
   1. Motor space heaters shall be securely attached to the motor windings and sized to maintain the motor internal temperature above the dew point when the motor is not running.
   2. Space heaters shall be silicon rubber type designed for long life and low skin temperature.
   3. Motor space heaters shall be operated at 120Vac.
G. Provide lubricants as required for factory testing, start-up, and field-testing.
H. All motor conduit boxes shall be oversized to permit solderless connection of external leads.
I. All motor leads permanently identified and of sufficient length to allow easy connection of external leads.

2.06 BELT GUARDS:

A. Fully enclose belts on both sides except where equipment forms one side.
B. Size to enclose next larger size driven pulley.
C. Two-piece construction when driven equipment and motor are on opposite sides of the belt guard.
D. Provide with tachometer holes and covers.
E. Protective guard shall conform to ANSI B11.19 – Performance Requirements for Safeguarding.

2.07 BELT DRIVES:

A. Single or multiple V-belt.
B. Rated 140% of motor horsepower.
C. Adjustable speed with maximum belt speed of 4,500 fpm.
D. Matched sets of belts on multiple belt drives.
E. Adjustable slide rail motor mounts.

F. Adjustable screw type LVP or MVP for over one groove on motors less than 50 hp.
G. Motors 50 hp and larger may be furnished with two nonadjustable motor pulleys, one for testing and for final operation.

2.08 COUPLINGS:
A. Type as required for specific application as acceptable to Engineer.
B. Protective guard shall conform to ANSI B11.19 – Performance Requirements for Safeguarding.

PART 3 - EXECUTION

3.01 INSTALLATION:
A. Install to conform to manufacturer's instruction.
B. Lubricate all bearings, gears and items requiring lubrication before placing equipment in operation.

3.02 FIELD QUALITY CONTROL:
A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust motors, assemblies, and associated equipment installations, including connections.
B. Field Testing:
1. Provide manufacturer recommended testing prior to startup of motors.
2. Testing shall be performed in accordance with IEEE 112.
3. Measure the insulation resistance of the stator winding before applying voltage. Compare this measured value against the manufacturer's value. If there is no insulation resistance value furnished by manufacturer, use the following:

Motor Voltage	Insulation Resistance
600 volts and below	5 megohms

a. If measured resistance values are lower than above, record room temperature and humidity and submit readings to Engineer before energizing. Dry out motors as required by accepted method of application of external heat, and do not apply voltage to motor until substandard resistance condition is corrected. Megger readings are to be one-minute duration, using a 500V megger for all motors 600V and below.
4. Prior to final equipment alignment, disconnect motor from driven equipment where necessary to check lubrication, starter, and control circuits. If motor is free of dirt and dust, rotate rotor by hand to determine that motor turns freely. Clean out motor if necessary. Apply voltage momentarily and note direction of rotation. Correct rotation if necessary. Reconnect motor to driven equipment.
5. After the motor is placed in operation, observe the motor for heating at the bearings or windings. If the motor appears to be running hot, notify Engineer.
a. Note: General purpose motors may reach temperatures up to 176ºF with a room temperature of 104ºF.
6. Take motor full load amps readings on all phases.
7. Prepare all results and submit field testing and startup report to Engineer.

3.03 FINISHES:

A. Equipment coatings shall be free from scratches, rust, or other defects.
B. All damaged or defective coatings shall be repaired prior to final acceptance.
C. Field Painting:
    1. Touch Up:
        a. Contractor shall prepare surfaces and touch up manufacturer applied coatings as required for any damage during shipment and installation.
        b. Field painting shall be performed based on manufacturer's recommended procedures.
        c. Motor manufacturer shall furnish Contractor with an adequate quantity of touch-up paint to match the factory applied finish.

END OF SECTION 46 05 13

SECTION 46 41 23 – SUBMERSIBLE MIXERS

PART 1 - GENERAL

1.01 SUMMARY:

A. This Section covers furnishing, installing, and testing submersible mixers and appurtenances for use in potable water storage facilities.

B. Equipment shall be furnished complete with all components, hardware, motors, controls, and all other parts and accessories indicated, specified, or required for proper installation, operation, and maintenance.

C. All Equipment specified in this Section shall be provided by the same manufacturer and shall be suitable for installation in the structures as indicated. Any revisions necessary to accommodate the Equipment furnished shall be the responsibility of the Contractor.

1.02 RELATED WORK SPECIFIED ELSEWHERE:

A. General Requirements: DIVISION 01

B. Protective Coatings: DIVISION 09.

C. Motors and electrical: DIVISION 26.

1.03 REFERENCES:

A. Applicable Standards:

1. American Bearing Manufacturers Association (ABMA).
2. American Gear Manufacturers Association (AGMA).
3. American Iron and Steel Institute (AISI).
4. American Society of Mechanical Engineers (ASME).
5. American Society for Testing and Materials (ASTM):
   a. A36 - Structural Steel
   b. A303/304 - Stainless Steel Bolts
   c. A380 - Standard Practice for Cleaning, Descaling, and Passivation of Stainless-Steel Parts, Equipment, and Systems
   d. D471-98 - Standard Test Method for Rubber Property – Effect of Liquids
   e. D2240 – Standard Test Method for Rubber Property – Durometer Hardness
6. American Welding Society (AWS).
7. International Standards Organization (ISO)
   a. ISO 21630:2007 - Pumps –Testing – Submersible mixers for wastewater and similar applications.
8. National Electric Code (NEC).
9. National Electrical Manufacturers Association (NEMA).
10. National Sanitation Foundation (NSF):
    a. 61 - Drinking Water System Components - Health Effects.

1.04 SUBMITTALS:

A. Submit as specified in DIVISION 1.

B. Includes, but not limited to, the following:

1. Manufacturer's specifications including brake horsepower, power input, and design operating conditions.
2. Detailed equipment and installation drawings including all weights and dimensions.
3. Electrical schematic and connection drawings for all equipment including auxiliary control devices.
4. Motor nameplate data as specified in DIVISION 26.

5. Operation and maintenance manual.
6. Materials of construction.
7. Factory and field test reports.
8. Validation of Long-term performance: The mixing system designer/supplier must supply at least one inspection report showing proper operation after being in service in a water tank mixing application for a minimum of 10 years.
9. NSF61 Certification.
    a. Copy of the NSF61 Certified listing for the appurtenances used in the mixing system.
10. System Installation Drawings: The manufacturer shall be responsible for providing engineering installation drawings of the complete system as supplied by the manufacturer. These drawings shall include plan view arrangement, sections and elevations as required, and all dimensions required for locating the system within the specified dimensions of the tank.

C. Design Calculations
1. All Design Calculations, curves, and reference information listed below must be submitted by system supplier.
2. Computational Fluid Dynamics (CFD) Modeling: A representative CFD model evaluation of the proposed system configuration applied within a similarly sized reservoir. Model output documentation shall include all design variables applied for the simulation, plot of the 3-D geometry showing the mesh definition, velocity magnitude vector and contour plots at different cross-sections throughout the water volume. CFD modeling shall be performed for minimum, average, and peak flow rates. CFD modeling must verify the mixing system design achieved complete mixing.
3. Calculations showing the time required, under isothermal conditions, for a similarly sized reservoir to achieve complete mix of the reservoir volume at minimum, average and peak fill rates. Complete mixing defined as 95% homogenous solution. The theory and equations used in calculating the mixing times may be derived from the CFD analysis of a similarly sized reservoir or from a published AWWA reference manual or paper. The reference document(s) must be submitted with the equations and calculations.

D. Installation, Operation and Maintenance Manuals as required in Section 01 33 00 and below.
1. Copy of design calculations as defined in the previous section.
2. Copy of complete set of the installation plans.
3. Copy of NSF61 Certified Listing for the appurtenances.
4. Parts and equipment list with specification numbers for ordering of replacement parts.
5. Installation guidelines for the mixing system.
6. Operational procedures for the mixing system.
7. Guidelines for repair and/or replacement of system components.
8. Schedule for suggested periodic maintenance of the mixing system.

E. Certificates and Affidavits: Furnish the Following Prior to Shipment:
1. Affidavit of compliance with applicable standard.
2. Test certificates.

1.05 QUALITY ASSURANCE:

A. Experienced in the design and manufacture of the supplied equipment as specified for a minimum period of five (5) years.

B. All equipment shall be designed, fabricated and assembled in accordance with the best engineering and shop practices. The equipment shall be new, not have been in service at any time prior to delivery, except as required by tests.

C. Factory Testing:
   1. Each mixer shall be given a performance test during which the mixer is run at its design speed for a minimum of four hours. Tests shall show that the mixer has the general characteristics of horsepower without experiencing overheating, cavitation, or excessive vibration.
   2. Significant vibration shall be corrected prior to installation in the tank.
   3. Test reports shall include the following at a minimum:
      a. Raw data sheets.
      b. Certified test results including:
         (1) Input power (hp).
   4. Mixers that do not meet the specified input kW (hp) values will not be accepted for this project.
   5. The Engineer reserves the right to witness the full-scale testing at the manufacturer's facility.

1.06 WARRANTY

A. Manufacturer shall warrant that all equipment shall be free from defects caused by faulty material or workmanship for a minimum period of five (5) years from the date of Construction Acceptance.
B. Multiple warranties for individual components will not be acceptable.

1.07 DELIVERY, STORAGE, AND HANDLING:

A. Mixer units shall be completely shop assembled and aligned prior to shipping.
B. After completion of the specified factory tests, equipment shall be prepared for shipment with the minimum amount of disassembly, and such that no field disassembly, cleaning, or flushing is required.
C. Any components removed for shipping shall be match-marked prior to removal and shipment.
D. Deliver, store and handle all equipment and materials in a manner to ensure installation in sound and undamaged condition, to prevent damage from exposure to the elements, and in accordance with the requirements in DIVISION 1.
E. Adequately seal and protect equipment for outdoor storage at project site.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS:

A. Furnish 2 submersible mixers and all necessary components for the 3 MG potable water storage tanks (one submersible mixer per tank). Furnish 1 submersible mixer and all necessary components for the 4 MG reuse water storage tank.
B. The submersible mixers shall include all equipment specified herein. The equipment shall include, but not be limited to, the following:
   1. Passivated stainless steel 316 impeller.
   2. Water-cooled motor.
   3. Control center dry assembly with SCADA compatibility.
   4. NEMA 4X Enclosure.
   5. Motor controller/VFD.
   6. SCADA outputs.
   7. Impeller cable, flat jacketed 4-conductor.
   8. Tripod assembly.
      a. Stainless steel 316 legs.

b. Chlorine/chloramine resistant rubber foot pad.
9. Long bail stainless steel 316 handle and chain.
10. Tank penetration accessories.
11. All necessary inter-wired controls.

C. Supply equipment for performance testing, including but not limited to:
1. Temperature string with minimum of 3 battery-operated temperature data loggers to measure temperature stratification in tank(s).

2.02 ACCEPTABLE MANUFACTURERS:

A. Acceptable manufactuerers include those regularly engaged in Submersible Mixing Equipment with a history of successful installations in the United States:
1. PAX Water Technologies of Richmond, CA
2. No Approved Equal

2.03 DESIGN REQUIREMENTS:

A. Mixer must be able to provide complete water circulation to create a well-mixed environment within the potable water storage tank.
B. Mixer shall be able to be easily accessed for inspection and service.
C. The mixer and its appurtenances must be capable of continuous submergence underwater without loss of watertight integrity to a depth of at least 32 feet.
D. Mixer shall be designed for continuous duty.
E. The mixers shall have the following operating characteristics as defined in the submersible mixer schedule:

	(T-100)	(T-101)	(T-200)
Tag No(s).	MXR-105	MXR-106	MXR-205
Number of Units	1	1	1
Tank Volume, cu ft	410,543	410,543	537,236
Tank Depth, ft	32	32	32
Max. Impeller Diameter, in	5	5	5
Max. Impeller Height, in	8	8	8
Max. Impeller RPM	2500	2500	2500
Max. Motor Size, Hp	0.5	0.5	0.5
Electrical Data	(230/60/3)	(230/60/3)	(230/60/3)
Cable Length, ft.	130	130	130

F. Mixer Construction:
1. Major mixer components shall be of AISI Type 304 stainless steel, AISI Type 316 stainless steel, or Engineer Approved equivalent.
2. All mating surfaces where watertight sealing is required shall be machined and fitted with nitrile rubber O-rings. Fitting shall be such that sealing is accomplished by metal-to-metal contact between surfaces, resulting in controlled compression of the nitrile rubber O-rings without a specific torque limit.
3. All exposed nuts and bolts shall be of AISI Type 316 stainless steel.
4. Mixer unit shall be provided with an adequately designed cooling system.

G. Shafts:
1. The impeller shaft shall be AISI Type 316 stainless steel or Engineer Approved equivalent.
2. Shaft shall be passivated per ASTM A380.

3. The impeller shaft shall rotate on two permanently lubricated bearings. The bearings shall be designed for an L_{10} life of 200,000 service hours at full load.

H. Impeller:
1. Impeller shall be dynamically balanced.
2. No impeller jet ring is required unless otherwise indicated.
3. Impeller shall be constructed from AISI Type 316 stainless steel or Engineer Approved equal.
4. Impeller shall be passivated per ASTM A380.

I. Motor:
1. Motor shall be fully submersible type.
2. Motor shall have AISI Type 304 stainless steel body or Engineer Approved equivalent.
3. Rubber seals shall be chlorine/chloramine resistant.
4. Motor shall be water-filled and water-lubricated.
5. Power Cable:
   a. Provide with a power cable of sufficient length to reach from the motor to the junction box.
   b. The cable shall be properly sized for the horsepower of the motor in accordance with NEC and DIVISION 26.
   c. The cable shall be provided and installed with proper strain relief and holders to protect the cable from physical damage.
6. A sufficient length of cable, rated for submergence in potable water, shall be provided to terminate at the junction box.

J. Mounting Assembly:
1. Mounting shall be AISI Type 316 stainless steel or Engineer Approved equal.
2. Mounting shall contain NSF 61 certified EPDM rubber, non-skid, and non-scratching or insulating pad.
3. Attachments shall secure motor cable away from impeller.

K. Electrical Systems:
1. Each unit shall be 115VAC and equipped with all necessary controls, inter-wired, to provide the following minimum functions:
   a. On/Off switch to control power to mixer.
   b. Automatically activated motor shut-off if water level drops below motor height in tank.
   c. Sine filter.
   d. Any other controls shown on electrical and instrumentation drawings.

L. Motor controller/VFD shall:
1. Be rated to 1.0 HP.
2. Operatire within temperature range of -4 ºF to 129 ºF (-20 ºC to 54 ºC).
3. HOA swtich.
4. Manual speed control.
5. Thermal shut-off protection built in.
6. Current overload protectin built-in.
7. SCADA outputs shall include:
   a. Digital Output signal indicating motor running.
   b. Digital Output signal indicating fault.
   c. Digital Input/output signal allowing remote motor on/off.
   d. RS-485 or Dry Contact connections.
   e. 4-20mA Signal.

8. Control panel shall be equipped with 115VAC 20-Amp main breaker for branch circuit protection.

M. Control Center Enclosure:
1. Enclosure shall be a NEMA Type 4X lockable enclosure for weather resistance.
2. GFCI-protection shall be included inside control center.
   a. 115VAC
   b. Single-phase
   c. 300 mA trip level
3. Indicator LED ligths required to show motor status and power.
4. Cooling fan required.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Installation: Install to conform with manufacturer's recommendation and in locations indicated.
1. Tank penetration shall be above tank water line through hatchway.
   a. Fitting must be horizontally oriented and prevent moisture intrusion into tank.
   b. Fitting shall be 1-inch diameter to allow cable to pass through.
   c. Strain relief for power cable shall be part of contractor-supplied fittings.
2. Mixer must be able to be installed through a minimize 12”x12” hatch and must be able to be installed without draining the tank or taking the tank out of service.
   a. The mixer’s outside-of-tank components must weigh less than 55 lbs.
   b. The mixer’s inside-tank components must weigh less than 75 lbs.
   c. Both outside and inside components of mixer must be able to be hoisted, installed, and/or removed by on-site personnel without additional equipment needed, and so that there is no crush hazard or entanglement hazard present, and so that the weight of the mixer on the tank floor does not cause damage to interior coating.
3. Mixer and other in-tank components shall be installed in accordance with approved procedures and manufacturer’s instruction, unless otherwise approved in writing from the manufacturer, using one of the following methods:
   a. Installation by a factory-trained and drinking-water-certified potable water tank diver.
   b. Installation by personnel with confined space training while the tank is drained and empty.
   c. Installation by tank manufacturer personnel during tank manufacture.
   d. Installation below a hatch opening in a full tank utilizing a chain.
4. Mixer controls and other outside-of-tank components shall be installed in accordance with approved procedures and manufacturer’s instruction, unless otherwise approved in writing from the manufacturer, using one of the following methods:
   a. Third party representatives or manufacturer according to the manual provided.
   b. Utility personnel according to the manual provided.

B. Manufacturer's Field Services:
1. Field service shall be provided by an experienced representative of the equipment manufacturer in accordance with DIVISION 1.
2. Manufacturer shall certify in writing that all equipment has been properly installed and are operating satisfactorily prior to initial start-up.
3. Services are to be provided:
   a. As required during installation to ensure proper installation of all equipment.

b. Minimum of 24 hours and as required during start-up to make any final adjustments required.
c. One additional 8-hour day to instruct the Owner's personnel in the operation and maintenance of the equipment.

4. Mixing system shall completely mix reservoir according to the following minimum performance requirements. These requirements can be measured and validated after installation by operators with readily available tools such as temperature probes and total chlorine grab samplers.
   a. Temperature Uniformity
      (1) All temperatures shall converge to within 0.9 ºF (0.5 ºC) within 24 hours after mixer is installed and activated.
   b. Disinfectant Residual Uniformity
      (1) Disinfectant resiudals within top 5 feet of tank and bottom 5 feet of tank will converge to within 0.20 ppm within 24 hours after mixer is installed and acctivated.
      (2) During continous oepration of the mixer, under normal disinfectant dosing paramters, disinfectant residual will converge to within 0.20 ppm at least once every 24 hours.
5. All work shall conform to manufacturer's recommendations and the requirements of DIVISION 1.
   a. Equipment test shall be as follows:
      (1) Check for proper installation and performance of all components.
      (2) Check for proper alignment, tolerances, and any excessive noise or vibration.
      (3) Check for proper lubrication.
6. Modify equipment at no additional cost to Owner if criteria are not met.
7. Perform in the presence of the Owner and/or Engineer.

END OF SECTION 46 41 23

SCOPE NARRATIVE

GENERAL REQUIREMENTS

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

1. The following estimate narrative is intended to provide a more descriptive characterization of our interpretations, budgetary pricing, and assumptions made in preparing this estimate.
2. This estimate is based on the 100% Design Drawings for the Broomfield Tanks and Pump Station, dated May 2025.
3. This estimate is based off the Anthem Filing #24 Neighborhood 5 As-built drawings dated September 15, 2016.
4. This estimate is based off the Broomfield Tanks and Pump Station 100% Design specifications dated May 2025.
5. This estimate is based off the Geotechnical Engineering Study and Pavement Thickness Design Proposed Broomfield Water Tanks and Pumpstation Geotechnical Report provided by Kumar & Associates, Inc., August 22, 2023, revised March 12, 2024.
6. A project duration of 24 months is assumed. Pricing is based on a October 28th, 2025 approval date and a January 5th, 2026 construction start date.
7. An Owner's Contingency of 5.0% has been included.
8. A Material Escalation Contingency of 1.5% has been included. This is to cover 2026 & 2027 potential material increases.
9. A Subcontractor Escalation Contingency of 1.5% has been included. This is to cover 2026 & 2027 potential subcontractor increases.
10. A Preconstruction Contingency of 0% has been included.
11. A Tariff Contingency of 1.0% has been included.
12. SRF Funds have been excluded per Broomfield.
13. A Bond Fee of 0.65% has been included.
14. An Insurance Fee of 1.50% has been included.
15. A Construction Fee of 10.00% has been included.
16. An Owner/Engineer office trailer has been included per the specification 01 52 00-1, 2.01, C.

17. No Prevailing Wages, Buy-American or MBE/WBE requirements have been included.
18. No Franchise tax, materials sales tax and gross receipts tax have been included.
19. Builders Risk Insurance is included.
20. We have excluded all costs for prairie dog protection, wetland protection, or any other state or federally protected entities.
21. We have excluded all Testing (i.e., compaction, subgrade, concrete, welding, etc.) per Broomfield Email (3/28/2025).
22. We have excluded all Special Inspections based on specification 01 11 00-2, 1.09 per Broomfield Email (3/28/2025).
23. We assume we will use the Fire Hydrant 275’ North of the existing parking lot of the New Pump station on the East side of King Court (Per Owner) for construction water.
24. We did not include the purchase of construction water. Owner to carry temporary construction water costs. CMAR will cover the cost of the water meter for the duration of the job.
25. General Conditions costs included in this estimate are for services required by the project and typically provided by the general contractor. These would include the following services, personnel, and temporary on-site facilities for the completion of the project to include:
    - 25.1. Senior Project Manager.
    - 25.2. Project Engineer.
    - 25.3. Senior/General Superintendent.
    - 25.4. Field Engineer.
    - 25.5. Safety/QC Engineer.
    - 25.6. Outside registered surveyor.
    - 25.7. Project/Building Layout.
    - 25.8. Contractor office trailer, equipment, furnishings, and temporary utilities.
    - 25.9. Temporary construction utilities such as electricity, telephone service, construction water, sanitary facilities, and usage fees.
    - 25.10. Progress photos & video survey.
    - 25.11. Submittals and shop drawings.
    - 25.12. Project signs.
    - 25.13. Permits based on specification 01 11 00-2, 1.09.
    - 25.14. Temporary facilities, such as shops and sheds.
    - 25.15. Spill containment facility.

25.16. Small tools and miscellaneous rental.

25.17. First Aid / Safety measures.

25.18. Weekly cleanup.

25.19. Safety shutdowns, and meetings.

25.20. Safety rails, barricades, and toe boards.

25.21. Winter protection for concrete and masonry.

25.22. Temporary building heat.

25.23. Snow removal.

25.24. Trash containers and dump fees.

25.25. Field startup and warranty support.

25.26. Final job clean-up.

26. All BDA Systems have been excluded for this job.

DIV 2 – SITE CONSTRUCTION

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

TANK & PUMP STATION SITE

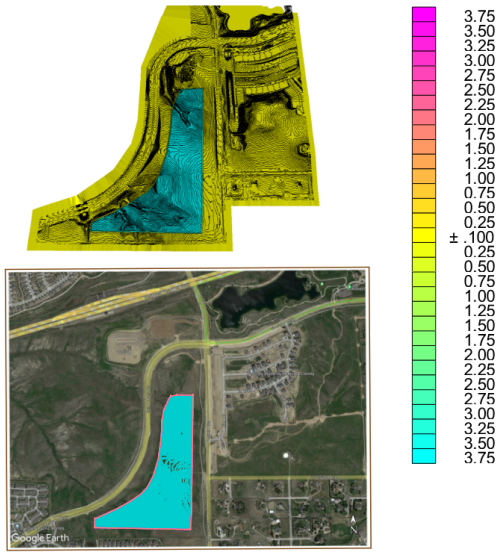
27. All Potholing of existing utilities has been included.
28. No Subsurface Utility Engineering “Sue” or Geotechnical Instrumentation & Monitoring has been included.
29. Included 24 months of maintenance for temporary laydown and roads.
30. Included 24 months of street sweep for paved roads.
31. Included a water truck for compaction and dust control for the entire project duration.
32. We have included all permits based on specification 01 1100-2, 1.09.
33. Erosion Control is based off the erosion control drawing provided and best use of BMP’s.
34. We included a 260’ x 160’ laydown yard and 500’ x 20’ temporary access road. Laydown yard and access road to included 8” of rock over filter fabric.
35. We will be using existing on-site access roads/trails for construction.
36. We have included maintenance of the laydown yard and temporary access road for 24 months.
37. All topsoil has been striped/replaced at 12” thick based on drawing SHT. 0L-102, Note 1. All topsoil will be stockpiled on the south-east corner of the site.

38. Included all storm piping per the drawings and specifications.
39. All riprap and spillways are per the drawings and specifications.
40. No HAZMAT demolition or requirements have been included.
41. All asphalt paving, concrete flatwork, landscaping, trails, fencing, piping, trees, demolition, etc. is based on the drawings and Google Earth.
42. All demolition items that have been scheduled for salvage will be stored appropriately and re-installed at a later date.
43. No excavation dewatering has been included (i.e., wells or well-point systems). We have included miscellaneous sumping/drainage/surface water control for storm events.
44. No shoring for excavations has been included. All excavations will be open cut per OSHA standards/guidelines.
45. We have included bedrock slope protection against moisture changes.
46. We have excluded bedrock subgrade void filling with concrete because it was removed from the 90% design specification 31 23 16-5, 3.01.
47. We have excluded the concrete seal coat 3” thick because it was removed from the 90% design specification 31 23 16-5, 3.01.
48. A “Liquid Bituminous Water Proofing Layer” has been included under the tanks per Kumar’s Geotechnical Report.
49. We have included an 18” thick working platform above the bedrock subgrade for all structures per specification 31 23 16-3, 3.01., F.
50. All excavated clay/fill/sand material will be stockpiled on the south-east corner of the site for later use. The clay will be used for the 24” thick clay cap, and the clay/fill/sand material will be used to backfill the tanks crane work platform and ramp.
51. All structures to be backfilled with imported CDOT Class 1 Structural Backfill at a 1.5:1 slope because onsite material will not meet the specification 31 23 26-2 and the geotechnical report. Burns & McDonnell has been notified.
52. We have included a 24” thick clay cap over all excavations at the proposed site grades per the specifications and geotechnical report. All clay cap material will be from on-site excavated material.
53. All Weathered Sandstone/Claystone and Bedrock Sandstone/Claystone will be hauled to the permanent spoil disposal area on the west side of Lowell Blvd. No Weathered Sandstone/Claystone and Bedrock Sandstone/Claystone will be used for construction.
54. All tank builder winding tracks and work platforms have been included. To be 6” thick road base over Mirafi.

55. We have included foundation drains for the tanks and pump station per the drawings and details. All foundation drains include piping, bedding, aggregate, wall drainage panels, filter fabric, cleanouts with concrete anchors, and testing.
56. Traffic control has been included for the King Court Entrance and 30” Potable Tank Fill, 4” Sanitary Sewer tie-in in King Court and 30” Overflow Drain crossing King Court.
57. All crusher fines trails and gravel surfacing have been included per the drawings.
58. All new asphalt paving has been included per the drawings and specifications.
59. All replaced asphalt patching has been included per the drawings, specifications and Google Earth. We will match existing.
60. All new concrete flatwork has been included per the drawings and specifications.
61. All replaced concrete flatwork has been included per the drawings, specifications, and Google Earth. We will match existing.
62. We have included temporary chain link security fencing around the entire site for 24 months.
63. New 7’ Ameristar fencing, and gates have been included per the drawings and specifications.
64. A concrete mow strip has been provided under the new fencing per the Owner/Engineer. To be 24” wide x 6” thick over 6” thick ABC.
65. All new/replaced landscape irrigation has been included per the drawings, specifications, and Google Earth. We will match existing.
66. No temporary irrigation for seeded areas has been included.
67. All new/replaced landscaping has been included per the drawings, specifications, and Google Earth.
68. We have included 12 months of maintenance for the landscaping/landscape irrigation.
69. Anything not specified above has been excluded.

PERMANENT SPOILS DISPOSAL AREA WEST OF LOWELL BLVD.

70. No drawings were provided. Based on Google Earth imagery. We assumed using 25.5 acres per the image below.



71. Assumed a project duration of 12 months.
72. Assumed using existing on-site access roads for construction.
73. Included 12 months of maintenance for temporary roads.
74. No Subsurface Utility Engineering “Sue” or Geotechnical Instrumentation & Monitoring has been included.
75. No erosion control plan was provided. We assumed the best use of BMP’s.
76. All topsoil has been striped/replaced at 6” thick based per the specifications. No import of topsoil has been included.
77. No storm piping has been included.
78. We included a 100’ x 50’ riprap drainage ditch. Riprap to be 24” thick over 12” thick bedding over filter fabric.
79. All asphalt paving, concrete flatwork, and fencing demolition are based on Google Earth.
80. No dewatering has been included.
81. No shoring for excavations has been included.
82. No structural excavation has been included.
83. All Weathered Sandstone/Claystone and Bedrock Sandstone/Claystone will be placed at 3’ thick.
84. We have included a clay cap over the entire spoil disposal area. All clay cap material will be from the on-site excavated material at the tank and pump station site. No purchase or import above what is excavated from the tanks is included.
85. Traffic control has been included for the spoil disposal area for 6 months.
86. No gravel surfacing has been included.

87. No new asphalt paving has been included.
88. All replaced asphalt patching has been included per Google Earth. We will match existing.
89. No new concrete flatwork has been included.
90. All replaced concrete flatwork has been included per Google Earth. We will match existing.
91. No temporary chain link site security fencing has been included.
92. No new fencing has been included.
93. No new landscaping/landscape irrigation has been included.
94. No replaced landscaping/landscape irrigation has been included.
95. We have included final seeding with Type 1 Native Prairie for the entire spoil disposal area.
96. No temporary irrigation for seeded areas has been included.
97. We have included 12 months of maintenance for the seeding.
98. Anything not specified above has been excluded.

DIV 3 - CONCRETE

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

99. Assumed that all structures with water stop embedded in the concrete will need to be leak tested.
100. Assumed that all exposed concrete will need to be rubbed finished.
101. Assumed all equipment pads placed on top of slab on grade will need to have the reinforcement drilled and epoxied into slab, for the Pump Station.
102. Assumed all structural concrete on this project will need to be placed via pump truck.
103. Assumed a combined six (6) mobilizations will be needed to handle drilled piers for the manholes, vaults, generator pad, two tanks, and pump station.
104. Tank design is to be completed by SM&RC Structural Engineers Inc.
105. Geotechnical Engineering inspection for drilled piers/caissons is included in division 3 estimate.

DIV 4 - MASONRY

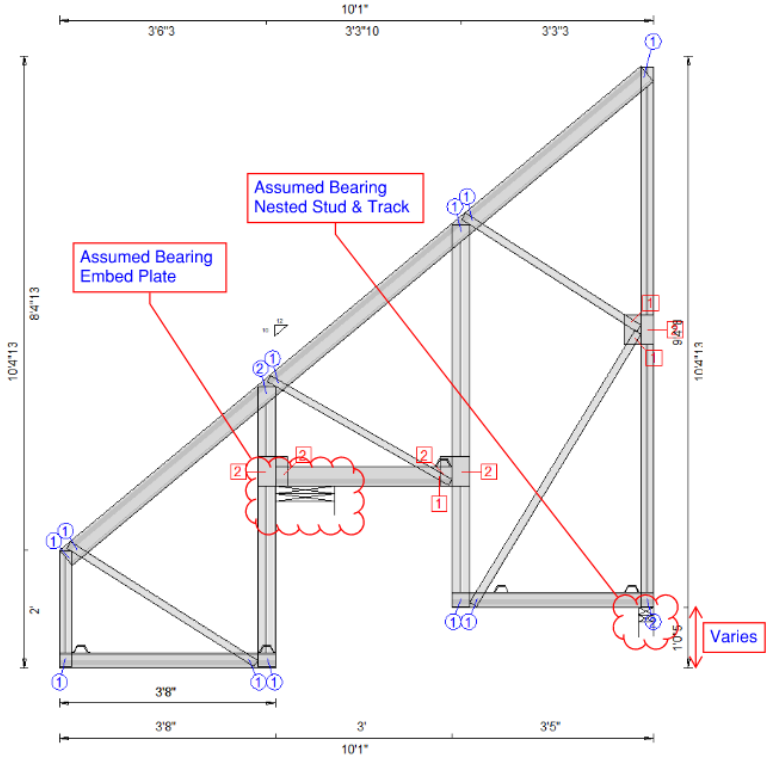
Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

106. Assumed CMU and Veneer for new Pump Station building, per plans and specifications.

DIV 5 – MISCELLANEOUS METALS / STRUCTURAL STEEL / ALUMINUM / DECKING AND FAB

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

107. Assumed 11 bollards around PW-01 per plans and specifications.
108. Assumed Aluminum and FRP support beams at each of the Manholes for grating support, as specified on plan sheets and specifications.
109. Assumed ladders in Manholes as Aluminum and FRP, as specified on plans and specifications.
110. Pricing of trusses provided by manufacturer based on design below.



111. Assumed embed plates at curb and top of wall (blue lines) – PL ½" x 8"x8" with two ½" studs per embed.
112. Assumed FRP ladders for interior of storage tanks, per plans and specifications.

113. Assumed two FRP 8x4x3/8" support beams per 8'x8' sump around pipe penetration.

DIV 6 – WOODS AND PLASTICS

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

114. Per plans and specifications.

DIV 7 – THERMAL AND MOISTURE PROTECTION

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

115. TPO roofing membrane system per plans and specifications.
116. Standing seam roofing per specifications, at new Pump Station front over hang.

DIV 8 – DOORS AND WINDOWS

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

117. Assumed Doors & Windows per schedule shown on sheet 1A-600.
118. Assumed no doors to be fire rated.
119. Windows priced as aluminum framed per plans and specifications.

Div 9 - Finishes

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

120. CMU to receive anti-graffiti coatings, as well as fluid applied air barrier.
121. Assumed tanks will not receive drain board and damp-proofing per tank detail 2 on sheet 0C-501.
122. Assumed all exposed steel, both inside and outside of Pump Station, to be coated as specified per plans and specifications.

123. Assumed process pipe and mechanical equipment to be painted and labeled per plans and specifications.
124. Assumed stain, to be applied to exposed walls and roof of both storage tanks per plans and specifications.
125. Assumed interior protective coatings for Overflow Manhole PW-04, per plans and specifications.

DIV 10 - SPECIALTIES

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

126. Door signage per specifications.
127. All fire extinguishers to be wall mounted to signs above.

YARD PIPE

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

128. YP materials as indicated on drawings and specs. They are as follows:
    128.1. PVC C900 used for all buried water lines, per spec for “33 11 00, Pressure Pipe”.
    128.2. DIP MJ fittings used. They are to be fusion bonded epoxy lined and fusion bonded epoxy coated, per the specification 33 11 00-5.
    128.3. All fittings restrained and joints restrained with bell harnesses.
    128.4. SDR35 pipe used at buried Sanitary line, per spec for “33 11 50, Gravity Pipe”.
    128.5. For underslab pipe at tanks, DIP pipe used, with MJ fittings and restrained joints with same F.B. epoxy coating and lining.
129. Buried line marker posts (fiberglass type) were assumed and included.
130. An allowance for Cathodic Protection was included, even though nothing was specifically shown.
131. Double-Wrapped Poly Wrap included at the DIP fittings for the buried pipe. Nut protection caps included as well for the buried hardware at fittings.
132. Flexible Bolted Sleeve Couplings (Dbl) included where indicated.
133. Flexible Coupling Flextend Force Balanced Double Ball included where indicated in the drawings.

134. Dewatering included only handling precipitation/nuisance water. Assumed not a considerable effort will be required.
135. Rock excavation included. Kumar Geotech Report dated August 2023 and revised March 2024. Bore information used to identify the strata and Agtek software was used to compute the approximate volumes encountered. Additional effort was included in the estimate to account for rock excavation and benching along deep trenches.
136. At tie-ins to existing water lines West of the new Pump Station, Isolation Valves used at each side of the tie-in Tee.
137. Concrete thrust blocks placed at bends in buried pipe.
138. Assumed that underslab pipe is to be concrete encased, but the costs are included with the Division 03 concrete estimate.
139. CLSM Flow Fill assumed at buried Utility crossings, where pipes intersect at close proximity.
140. CLSM Bedding used at buried pipes deeper than 20'.
141. Assumed that no washdown water lines need to be included at each tank.
142. Assumed that Garney will include and install the underslab piping at the tanks with the D115 type tanks.
143. Assumed import fill required for backfilling all pipe trenches.
144. Haul off of trench spoils included with Division 02.

DIV 11 - EQUIPMENT

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

145. Estimate includes three (3) EA Aurora 411 10x12x15C Split Case Pumps for the Potable Water Pump Station. No escalation is included.
146. Estimate includes two (2) EA PAX PWM400 Series Mixers, one (1) unit for each tank. Standard warranty is five years. No escalation is included.
147. Estimate includes one (1) EA Weil sump pump for the Potable Water Pump Station.
148. Estimate includes One (1) EA 3 Ton Under Running Single Girder Bridge Crane per plans and specs, include eight clarifications provided during bid time.
149. Sample pumps are not shown and are not included.

EXPOSED PROCESS PIPE

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

150. Used Ductile Iron Pipe for all Potable water Piping.
151. Flange insulating kits are used at first flange inside of Potable Tanks.
152. Sample stations at tanks excluded from estimate, no detail provided.
153. No Washdown piping included in tanks.
154. Tank Overflow piping included in Yard Pipe Estimate.

DIV 15 – HVAC & PLUMBING

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

155. Per plans and specs.

DIV 16 - ELECTRICAL

Scope of work per plans and specifications with the following exceptions, clarifications and assumptions:

156. Commodity Materials are based on Current COMEX Pricing Levels; Escalation has not been included.
157. All Primary Power Cabling, Terminations, Pole Risers, and Transformers are to be provided by the Utility Provider.
158. Includes an allowance for temporary power to construction trailers, temporary construction power and lighting.
159. Assumed load bank at 50% of generator KW.
160. Generator is provided by Cummins. **Standard color housing and 68 dBa at 23'.**
161. Division 28 Access Control and Intrusion Detection is included as shown on the drawing.
162. Video Surveillance – none shown none provided.
163. Fire alarm - none shown none provided.
164. **Emergency Fire Department Communications System is excluded.**
165. Radio path study is included.
166. Assumed radio antennas can be mounted on the exterior of the pump station and do not require any additional support structures.
167. Conduit and hardware provided based on Area Classification Schedule.
168. Generator Leadtime 46-48 weeks.

CONSULTING AGREEMENT BY BETWEEN THE CITY AND COUNTY OF BROOMFIELD AND BURNS & MCDONNELL ENGINEERING CO., INC. FOR ENGINEERING SERVICES DURING CONSTRUCTION FOR THE BROOMFIELD TANKS PROJECT EARLY WORK PACKAGE

1. PARTIES. The parties to this Agreement are The City and County of Broomfield, a Colorado municipal corporation and county, (the "City") and Burns & McDonnell Engineering Co., Inc., a Missouri corporation (the "Consultant"), collectively, the "Parties," or individually, a "Party."

2. RECITALS. The Recitals to this Agreement are incorporated herein by this reference as though fully set forth in the body of this Agreement.

2.1 The City desires to obtain Engineering Services During Construction (ESDC) in connection with a project called the Broomfield Tanks Project (the "Project").

2.2 The Consultant provides professional services and is qualified to perform services required by the City for the Project.

3. TERMS AND CONDITIONS. in consideration of the mutual covenants and promises of the Parties contained herein, and other valuable consideration, the receipt and adequacy of which are hereby acknowledged, the Parties agree as follows:

3.1 Obligations of the Consultant.

(a) General. The Consultant shall consult with and advise the City as the City requires in Exhibit A or elsewhere in this Agreement during the term of this Agreement. The Consultant shall act at the direction of the City employee assigned by the City to the Project as Project Manager. The Consultant shall communicate with the City about the Project only through the Project Manager.

(b) Basic Services. The Consultant shall perform the Basic Services described in Exhibit A and elsewhere in this Agreement.

(c) Extra Services. Upon the express, written consent of the City, the Consultant shall perform Extra Services. The Consultant shall charge the City for such Extra Services, if any, in accordance with such terms as the City may agree to in writing.

(d) Documents. All drawings, computer programs, computer input and output, analyses, plans, photographic images, tests, maps, surveys, electronic files, and written material of any kind required to be generated by the Agreement for the performance of this Agreement or required to be developed by the Consultant specifically for the Project are and shall remain the sole and exclusive property of the City. All such documents and electronic files prepared by Consultant pursuant to this Agreement are instruments of service in respect of the Services specified herein. Such documents and electronic files are not intended or represented to be suitable for reuse by the City or others in extensions of the project beyond that contemplated in the Agreement. Any reuse, extension, or completion by the City or others will be at the City's sole risk and without liability or legal exposure to Consultant. The Consultant shall not provide copies of any such material to any other party without the prior written consent of the City. Rights to Consultant's intellectual property developed, utilized or modified in the performance of the Services, but not created as a specific requirement of this Agreement, shall remain the property of Consultant. Consultant grants to the City a royalty-free, irrevocable, worldwide, nonexclusive, perpetual license to use

such intellectual property to use in connection with the associated with the Project and related facilities. Consultant grants to the City a royalty-free, irrevocable, worldwide, nonexclusive, perpetual license, to use, disclose, reproduce, sublicense, modify, or prepare derivative works from such intellectual property as needed to maintain, modify or improve the facilities associated with the Project. Such use, reproduction, or modification by the City or others will be at the City's sole risk and without liability or legal exposure to Consultant.

(e) Authorization to Proceed. No work on the Project shall be performed by the Consultant until written Authorization to Proceed has been issued by the City. If the Consultant proceeds with any work prior to receipt of said Authorization, the City is not responsible for payment for such work.

(f) Completion Date. The Consultant shall complete the services of this Agreement within 1460 days following the date of the authorization to Proceed.

3.2 Obligations of the City.

(a) General. The City shall coordinate reviews, approvals, and authorizations of all stages of work. All approvals and authorizations shall be in writing.

(b) Changes in Work. Any changes with regard to the Consultant's cost, time requirements of performance, or scope of the work must be in writing and approved by the Parties hereto prior to any work or services being performed in contemplation of said change.

(c) *Materials and Services to be Furnished by the City.* The City agrees to furnish the Consultant any material in the possession of the City to the extent that such material, in the opinion of the Project Manager, is readily available and will assist the Consultant in performing the work. The Consultant agrees to request such material in advance so as not to jeopardize the work schedule or meeting arrangements. The City shall not unreasonably withhold such material.

3.3 Commencement and Completion.

(a) The Consultant shall commence work on the first working day following receipt of a written Authorization to Proceed issued by the City, or such later date as indicated in the Authorization to Proceed.

(b) Except as may be agreed upon in writing by the City and the Consultant, the Consultant shall follow the time schedule shown in Exhibit A.

(c) If due to Acts of God, public emergency, changes in scope, or acts of a public enemy, it becomes apparent that this Agreement cannot be fully completed within the agreed time, the Consultant shall so notify the City in writing at least thirty days prior to any scheduled completion date, in order that the Consultant and the City may review the work accomplished to date and determine whether to amend this Agreement to provide additional time for completion.

3.4 Payments to Consultant.

(a) Aggregate Limit. Unless extra services are authorized in writing, the amount paid by the City to the Consultant under this Agreement will not exceed the amount shown in subparagraph (b) below. The Consultant will complete the Work for the amount shown.

(b) Billing. The Consultant shall bill the City monthly for work done in accordance with the terms and conditions of this Agreement, using the pay request form provided by the City. The total amount shall not exceed **$700,000** for ESDC during the Early Work Package, including reimbursables in accordance with the rates set forth in Exhibit A.

(c) Payment by City. The City will pay each bill in full within 30 days of receipt of payment request and supporting documentation. Consultant shall furnish such additional documentation as the City shall reasonably require. Incorrect payments to the Consultant due to omission, error, fraud, or defalcation may be recovered from the Consultant by deduction for subsequent payments due to the Consultant under this Agreement or other contracts between the City and the Consultant.

(d) Inspection of Records. The Consultant will permit the authorized agents and employees of the City at reasonable hours, to inspect, review, and audit all records of the Consultant related to this project and the work to be performed hereunder. The Consultant, its employees, subcontractors, and agents shall maintain all books, documents, papers, and accounting records related hereto, and all information regarding costs incurred herein, at their offices during the contract period and for three years thereafter. The audit rights of the City that are granted by this Agreement are not applicable to firm-fixed price or lump sum authorizations and are not applicable to any fixed labor rates or fixed expense charges, of any other type of contract whether compensation is based on time and material, rate schedule, guaranteed-maximum-price, or otherwise.

3.5 Termination.

(a) For Cause. This Agreement may be terminated by either party for a material breach of this Agreement by the other party not caused by any action or omission of the terminating party by giving the other party written notice in advance of the termination date. The termination notice shall specify in reasonable detail each such material breach and shall provide each party ten (1O) days to cure the breach (or if such breach cannot be cured within ten (1O) days, then the breaching party shall begin to cure such breach within three (3) days and continue to diligently pursue such cure until cured. If such breach is not reasonably subject to cure, such notice of termination shall be immediately affected upon receipt of the written notice. If this Agreement is so terminated by the Consultant, the Consultant will be paid for all services rendered up to the date of the termination. If this Agreement is so terminated by the City, the Consultant shall promptly deliver to the City all Documents as defined in Section 3.2(d) that are generated in the performance of this Agreement up to and including the date of termination. Termination pursuant to this subsection shall not prevent either party from exercising any other legal remedies which may be available to it.

(b) Without Cause. In addition to the foregoing, this Agreement may be terminated by the City for its convenience and without cause of any nature by giving the Consultant written notice at least seven days in advance of the termination date. In the event of such termination, the Consultant will be paid for all services rendered to the date of termination, and upon such payment, all obligations of the City to Consultant under this Agreement will cease. Furthermore, in the event of such termination, the Consultant shall promptly deliver to the City all Documents as defined in Section 3.2(d) that are generated in the performance of this Agreement up to and including the date of termination. Termination pursuant to this

subsection shall not prevent either party from exercising any other legal remedies which may be available to it.

3.6 Suspension.

Without terminating this Agreement or breaching its obligations hereunder, the City may, at its pleasure, suspend the services of the Consultant hereunder. Such suspension may be accomplished by giving the Consultant written notice one day in advance of the suspension date. Upon receipt of such notice, the Consultant shall cease its work in as efficient a manner as possible so as to keep his total charges to the City for services under the Agreement to the minimum.

3.7 Laws to be Observed.

The Consultant shall be cognizant of applicable federal and state laws and local ordinances and regulations in performance of its services that relate to Consultant's services performed hereunder, and shall observe and comply with such applicable existing laws, ordinances, and regulations.

3.8 Permits and Licenses.

The Consultant shall procure all permits and licenses required by Exhibit A, and pay all related charges, fees and taxes and give all related notices necessary and incidental to such permits and licenses.

3.9 Patented Devices, Materials, and Processes.

The Consultant shall hold and save harmless the City from any and all claims for infringement, to the extent caused by reason of the Consultant's (or its subconsultant's use of any tier or their respective employees) misappropriation or misuse of any patented design, device, material, process, any trademark, or copyright and shall indemnify the City for any costs, attorney's fees, expenses and damages which it might be obligated to pay by reason of such infringement, at any time during the prosecution or after completion of the work.

3.10 Liability and Indemnification.

(a) Professional Liability. The Consultant shall exercise in its performance of the Basic Services and Extra Services, if any, the standard of care normally exercised by locally recognized consulting organizations engaged in performing comparable services. Subject to the terms of this Agreement, Consultant shall reimburse the City promptly for the cost to repair and replace any damage to the Project to the extent caused by the negligent act, error or omission of Consultant.

(b) Indemnification. The Consultant shall indemnify and hold harmless the City and its agents and employees from and against damages, losses, and expenses, including, but not limited to, reasonable attorneys' fees, arising out of or resulting from the performance of the Basic Services or Extra Services, provided that any such claim, damage, loss or expense (1) is attributable to bodily injury, sickness, disease, or death or injury to or destruction of tangible property (other than the Project itself), including the loss of use resulting therefrom, and (2) is caused by any negligent act or error or omission of the Consultant, any subcontractor of the Consultant, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable. Such obligation shall not be construed to negate, abridge, or otherwise reduce any other right or obligation of indemnity which would otherwise exist as to

any party or person described in this paragraph 3.11 (b). Further, this indemnification is intended to comply with and be subject to Section 13-50.5-102 (8),C.R.S. as amended from time to time.

(c) *No Limitation on Claims.* In any and all claims against the City or against any of its agents or employees by any employee of the Consultant, any subcontractor of the Consultant, anyone directly or indirectly employed by any of them, or anyone for whose acts any of them may be liable, the indemnification obligation under subparagraph 3.11 (b) shall not be limited in any way by any limitation on the amount or type of damages, compensation, or benefits payable by or for the Consultant or any subcontractor under Workers' Compensation Act of Colorado or other employee benefit legislation.

(d) NEITHER CONSULTANT NOR THE CITY SHALL BE LIABLE TO THE OTHER FOR ANY CONSEQUENTIAL LOSSES OR DAMAGES, WHETHER ARISING IN CONTRACT, WARRANTY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY OR OTHERWISE, INCLUDING BUT NOT LIMITED TO LOSSES OF USE, ANTICIPATED PROFITS, BUSINESS, REPUTATION OR FINANCING.

3.11 Insurance.

(a) Purchase and Maintain Insurance. Consultant shall purchase and maintain insurance of the kind, in the amounts, and subject to the conditions specified herein in the Exhibit B. However, insurance requirements contained in this Agreement shall not be deemed to limit or define obligations of the Consultant as provided elsewhere in this agreement, and the Consultant should rely on its experience to obtain additional insurance coverage needed for the City and the Consultant in its performance hereunder.

(b) Coverage. Said insurance shall be maintained in full force and effect during the term of this Agreement and shall protect the Consultant, its employees, subcontractors, agents and representatives, and the City from claims for damages for personal injury and wrongful death and for damages to property arising in any manner from acts or omissions of the Consultant, its employees, agents or representatives, in the performance of the services covered herein.

(c) Valuable Papers. Furthermore, the Consultant shall carry valuable papers insurance in an amount sufficient for the restoration of any plans, drawings, field notes or other similar data related to the services covered by this Agreement in the event of their loss or destruction until such time as the final submission by the Consultant has been made and accepted by the City.

(d) Certificates. Certificates showing the Consultant is carrying the above-described insurance shall be furnished to the City within fifteen calendar days after the date on which this Agreement is made. Other than Workman's Compensation and Professional Liability, such certificates shall provide that the City is included as an additional insured and that the insuring company will provide thirty-day written notice prior to any alteration or cancellation of the above-described insurance.

3.12 NOTICE AND AUTHORIZED REPRESENTATIVES.
Any notice required or permitted by this Agreement shall be in writing and shall be sufficiently given for all purposes if sent by email to the authorized representative identified below. Such notice shall be deemed to have been given when the email was sent and received. The City may change its representative at any time by notice to the Consultant. The Consultant shall not replace the Consultant Representative unless: (a) the City requests a replacement, or (b) the Consultant terminates the employment of the Consultant Representative and provides a satisfactory substitute. The City must approve a substitute Consultant

Representative, and, if no substitute is acceptable, the City may terminate this Agreement. The Parties each designate an authorized representative as follows:

(a) The City designates CIP Construction Superintendent as the authorized representative of the City under this Agreement. Email address is ralford@broomfield.org.

(b) Consultant designates Nikole Rachelson as the authorized representative of the Consultant under this Agreement. Email address is nkrachelson@burnsmcd.com .

If the Consultant is alleging that the City is in breach of this Agreement or has violated any term of this Agreement, Legal Notice shall be made by making the notice above with a copy to citycountyattorney@broomfield.org.

4.0 ASSIGNMENT. This Agreement shall not be assigned by a Party without the prior written consent of the other Party.

5.0 EXHIBITS. All exhibits referred to in this Agreement are by reference incorporated herein for all purposes.

6.0 DELAYS. Any delays in or failure of performance by any Party of its obligations under this Agreement shall be excused if such delays or failure are a result of acts of God, fires, floods, strikes, labor disputes, accidents, regulations or orders of civil or military authorities, shortages of labor or materials, or other causes, similar or dissimilar, which are beyond the control of such Party.

7.0 PARAGRAPH CAPTIONS. The captions of the paragraphs are set forth only for the convenience and reference of the Parties and are not intended in any way to define, limit, or describe the scope or intent of this Agreement.

8.0 ADDITIONAL DOCUMENTS OR ACTION. The Parties agree to execute any additional documents or take any additional action that is necessary to carry out this Agreement.

9.0 INTEGRATION AND AMENDMENT. This Agreement represents the entire agreement between the Parties and there are no oral or collateral agreements or understandings. This Agreement may be amended only by an instrument in writing signed by the Parties. If any other provision of this Agreement is held invalid or unenforceable, no other provision shall be affected by such holding, and all of the remaining provisions of this Agreement shall continue in full force and effect.

10.0 DEFAULT. Time is of the essence. If any payment or any other condition, obligation, or duty is not timely made, tendered, or performed by either Party, then this Agreement, at the option of the Party who is not in default, may be terminated by the non-defaulting Party, in which case, the non-defaulting Party may recover such damages as may be proper. If the non-defaulting Party elects to treat this Agreement as being in full force and effect, the non-defaulting Party shall have the right to an action for damages.

11.0 WAIVER OF BREACH. A waiver by any Party to this Agreement of the breach of any term or provision of this Agreement shall not operate or be construed as a waiver of any subsequent breach by either Party.

12.0 GOVERNING LAW. This Agreement shall be governed by the laws of the State of Colorado. Any claims or litigation arising under this Agreement will be brought by the Parties solely in the District Court, Broomfield County, Colorado.

13.0 BINDING EFFECT. This Agreement shall inure to the benefit of and be binding upon the Parties and their respective legal representatives, successors, heirs, and assigns, provided that nothing in this paragraph shall be construed to permit the assignment of this Agreement except as otherwise expressly authorized herein.

14.0 EXECUTION IN COUNTERPARTS; ELECTRONIC SIGANTURES. This Agreement may be executed in several counterparts, each of which shall be deemed an original and all of which shall constitute but one and the same instrument. The Parties approve the use of electronic signatures for execution of this Agreement. All documents must be properly notarized, if applicable.

15.0 INDEPENDENT CONTRACTOR. **The Consultant is an independent contractor as described in section 8-40-202(2), C.R.S., and is not entitled to workers' compensation benefits and, further, is obligated to pay federal and state income tax on monies earned pursuant to this Agreement.**

16.0 NO THIRD-PARTY BENEFICIARIES. This Agreement is intended to describe the rights and responsibilities only as to the Parties hereto. This Agreement is not intended and shall not be deemed to confer any rights on any person or entity not named as a Party hereto.

17.0 FINANCIAL OBLIGATIONS OF THE CITY. All financial obligations of the City under this Agreement are subject to appropriation, budgeting, and availability of funds to discharge such obligations. Nothing in this Agreement shall be deemed to pledge the City's credit or faith, directly or indirectly, to the Consultant. If funds for this Agreement are not appropriated and budgeted in any year subsequent to the fiscal year of execution of this Agreement as determined by the City, this Agreement may be terminated by the City upon written notice to the Consultant. The City's fiscal year is currently the calendar year.

18.0 NO PRESUMPTION. The Parties to this Agreement and their attorneys have had a full opportunity to review and participate in the drafting of the final form of this Agreement. Accordingly, this Agreement shall be construed without regard to any presumption or other rule of construction against the Party causing the Agreement to be drafted.

19.0 SEVERABILITY. If any provision of this agreement as applied to either Party or to any circumstance shall be adjudged by a court to be void or unenforceable, the same shall in no way affect any other provision of this Agreement, the application of any such provision in any other circumstances or the validity, or enforceability of the Agreement as a whole.

20.0 EXECUTION REQUIRED. This Agreement shall not be binding upon any Party hereto unless and until the Parties have executed this Agreement.

21.0 MINOR CHANGES. The Parties executing this Agreement are authorized to make nonsubstantive corrections to this Agreement and attached exhibits, if any, as they consider necessary.

22.0 DAYS. If the day for any performance or event provided for herein is a Saturday, a Sunday, a day on which national banks are not open for the regular transactions of business, or a legal holiday pursuant to section 24-11-101(1), C.R.S., such day shall be extended until the next day on which such banks and state offices are open for the transaction of business.

23.0 GOOD FAITH OF PARTIES. In the performance of this Agreement or in considering any requested approval, acceptance, or extension of time, the Parties agree that each will act in good faith and will not act unreasonably,

arbitrarily, capriciously, or unreasonably withhold, condition, or delay any approval, acceptance, or extension of time required or requested pursuant to this Agreement.

24.0 PARTIES NOT PARTNERS. Notwithstanding any language in this Agreement or any other agreement, representation, or warranty to the contrary, the Parties shall not be deemed to be partners or joint venturers, and neither Party shall be responsible for any debt or liability of the other Party.

25.0 OFFICIALS NOT TO BENEFIT. No elected or employed member of City government shall directly or indirectly be paid or receive any share or part of this Agreement or any benefit that may arise therefrom. The Contractor warrants that it has not retained any entity or person, other than a bona fide employee working solely for the Consultant, to solicit or secure this Agreement.

[*The remainder of this page is intentionally left blank.*]

IN WITNESS WHEREOF, this Agreement is executed by the Parties hereto in their respective names as of _____, 2025.

THE CITY AND COUNTY OF BROOMFIELD,
a Colorado municipal corporation and county

_____
Mayor

ATTEST:

_____
Office of the City and County Clerk

APPROVED AS TO FORM:

_____
City and County Attorney

Burns & McDonnell, Inc. a Missouri corporation

Daniel P. Korinek

By: Daniel P. Korinek

Title: Senior V.P. President

EXHIBIT A
Scope of Services and Fees

SCOPE OF SERVICES:

The Broomfield Tanks and Pump Station Construction Phase Services include Engineering support during construction for the following work:

- Construction of two (2) new 3 MG Type DIIS tendon prestressed, partially-buried storage tanks
- Construction of one (1) new 17 MGD pump station, PRVs, tank fill valves, recommended surge mitigation components, and associated yard piping connections
- Associated site improvements to accommodate the new storage tanks and pump station
- State Revolving Fund (SRF) Funding Allowance that includes the following:
  - Update design drawings/specifications as needed to reflect SRF design requirements
  - Conduct Environmental Assessments and Permitting required for SRF
  - Additional Construction support assuming a schedule extension of 6 months to accommodate SRF requirements

Task Series 400: Construction Phase Engineering Services:

The Scope of Services described herein represents the Consultant's professional engineering activities necessary for engineering services during construction and post-construction activities. Consultant's resident project representative (RPR) services will in no way relieve construction contractors of their obligations for complete compliance with the drawings and specifications. Consultant shall not make exhaustive or continuous on-site assessments to check the quality or quantity of such work. Consultant shall not be responsible for the means, methods, techniques, sequences, or procedures of construction contractors, or for their safety precautions and programs incident to their work. Consultant shall not be responsible for the failure of construction contractors to perform the work in accordance with the Contract Documents.

Insofar as job site safety is concerned, Consultant is only responsible for its employees' activities on the job site, and this shall not be construed to relieve City or any construction contractors from their responsibilities for maintaining a safe job site. Neither the professional activities of Consultant, nor presence of Consultant or its employees and subcontractors shall be construed to imply Consultant has any responsibility for methods of work performance, superintendence, sequencing of construction, or safety in, on or about the job site. City agrees that the construction contractors are solely responsible for job site safety, and this intent shall be made evident in City's agreement with all construction contractors. City and Consultant shall be made additional insureds under the construction contractors' general liability insurance policy.

Consultant will not be a party to any construction contract and all authority and responsibility to stop work belongs to the City. Consultant shall not be liable for the results of any interpretations or decisions rendered by it in good faith when acting as an arbitrator or interpreter of the Contract Documents; provided, however, that all interpretations and decisions of Consultant shall be consistent with the intent of, and reasonably inferable from, the Contract Documents and shall be in writing or in the form of drawings.

By recommending any payment to others, Consultant will not thereby be deemed to have represented that continuous or exhaustive examinations have been made by Consultant to check the quality or quantity of the work or to review the means, methods, sequences, techniques or procedures of construction or safety precautions or programs incident thereto or that Consultant has made an examination to ascertain how or for what purposes any person(s) has used the moneys paid on account, or that title to any of work, materials or equipment has passed to the City free and clear of any lien, claims, security interests or encumbrances, or that others have completed their work exactly in accordance with the Contract Documents. Notwithstanding the foregoing, it is agreed that, by

recommending any payment to others, Consultant does thereby represent that, based on Consultant's evaluation of the work and the data comprising the Contractor's Application for Payment, that, to the best of Consultant's knowledge, information and belief, the work has progressed to the point indicated, the quality of the work is in accordance with the Contract Documents, that the Contractor is entitled to payment in the amount certified, and that Consultant knows of no legitimate reason that such payment or any part thereof may or should be withheld.

Consultant has based the scope of services level of effort on a construction duration of 730 days, with support for pre-construction activities starting 3 months prior for an additional 92 days. If more time is required, an equitable adjustment will be made to the Consultant's contract by means of an amendment.

Task 401 – General Management of Construction Contract:

Consultant shall provide for general management of the construction contract. The project manager will review project status and align resources. Consultant shall maintain, at Consultant's office, orderly files for correspondence, reports of job conferences, Shop Drawings and Samples, reproductions of original Contract Documents including Requests for Information, Construction Change Directives, Addenda, Change Orders, Field Orders, additional Drawings issued subsequent to the execution of the Contract, clarifications and interpretations of the Contract Documents, progress reports, Shop Drawing submittals and other project related documents.

Task 402 – Pre-Construction Conference:

Consultant will conduct a preconstruction conference. This meeting will be held at the City's offices with a virtual option by Microsoft Teams.

Task 403 – Progress Meetings:

Consultant will conduct construction progress meetings. These meetings will be held at the City's offices with a virtual option by Microsoft Teams. This task assumes bi-weekly onsite meetings for 2 months prior to construction beginning and weekly onsite meetings for the construction duration of 24 months. Consultant will take and distribute meeting minutes. Meetings will be attended by the Project Manager and/or Process Engineer, with discipline engineers attending as needed. Hours for the field engineer to attend are included in Task 408, Construction Observation and Field Engineer.

Task 404 – RFI Review and Response:

Consultant will review and respond to RFIs in writing and prepare and issue supplemental drawings and specifications as necessary in response to RFIs. Consultant will maintain a record of RFIs, responses provided to the Contractor, and documentation of each RFI's resolution. This task includes written responses to 130 RFI's with a review, determination, and response time of approximately 4 hour(s) per RFI.

Task 405 – Submittal and Resubmittal Reviews:

Consultant will review submittals for the project and provide a response and status for each submittal. Consultant will maintain a record of submittals, responses provided to the Contractor, and documentation of each submittal. This task includes written responses to 220 submittals with a review, determination, and response time of approximately 3 hour(s) per submittal. This task also includes that each submittal will have 1 resubmittal(s) with a review, determination, and response time of approximately 1.5 hour(s) per resubmittal.

Task 406 – Change Orders/Work Change Directives/Field Orders:

Consultant will review and comment on prospective change orders. Consultant will evaluate and make recommendations to City on change orders. Consultant will provide Work Change Directives and Field

Orders as needed. Consultant will track changes and obtain City approval prior to returning direction to the Contractor. This task assumes 10 change orders at an average review and response time of 10 hour per order, 10 Work Change Directives at an average review and response time of 10 hour per directive, and 20 Field Orders at an average review and response time of 10 hours per order.

Task 407 – Periodic Site Visits by Engineer:

This task includes one (1) site visit every other week for one (1) engineer (discipline, process, pipeline, or project manager). Each site visit is assumed to be four (4) hours in duration, including travel.

Task 408 – Construction Observation and Field Engineer:

Consultant will provide a field engineer to observe and record the construction progress and quality of the work as is reasonably necessary at various stages of construction to determine if the work is proceeding in general accordance with the design documents. The field engineer will be on site for 24 months of the construction period. This task includes hours for the field engineer to be on-site for 9 hours a day, 3 days a week for 100% of the project, or 2,808 hours. If more observation time is required, an equitable adjustment will be made to the Consultant's contract by means of an amendment. The field engineer will:

- Provide observation of construction progress and of the quality of the work as is reasonably necessary at various stages of construction to determine if the work is proceeding in general accordance with the design documents.
- Review delivered and on-site materials for general conformance with the design documents and approved submittals.
- Prepare and submit weekly construction observation reports to the City.
- Provide construction photos of construction activities.
- Attend weekly progress meetings.
- Observe that tests, equipment, and systems start-ups and operating and maintenance training are conducted in the presence of appropriate personnel.
- Participate with Contractor and City regarding start-up, testing, and commissioning. The Contractor will be responsible for start-up, testing, and commissioning.
- Report to process engineer and/or project manager, opinions and suggestions based on observations regarding defects or deficiencies in the work and compliance with drawings and specifications.
- Observe and document differing subsurface and physical conditions encountered.
- Review Contractor's construction schedule for conformance with milestones, and other project requirements.
- Review monthly pay applications with City and provide approval/suggested modifications after review.
- Observe onsite quality assurance testing and maintain copies of testing results on site.
- Review as-built construction mark-ups on a weekly basis to observe if contractor is documenting field changes to the work in a common set of drawings/specifications.
- Conduct special inspections of the following:
    - Concrete Construction
        - Mix Design
        - Reinforcement
        - Formwork
        - Curing
        - Anchors Cast in Concrete
        - Anchors Post Installed in Concrete
    - Masonry Construction
        - Reinforcing
        - Size
        - Placement
        - Conditions
    - Structural Steel
        - Material Verification - Structural Steel

- Material Verification - High-Strength Bolts
- Material Verification - Cold-Formed Steel Deck
- Steel Frame Joint Details
- High-Strength Bolting
- Open Web Joists
    - End Connections and Bridging

- The following special inspections will be provided by the City or Contractor and are not the responsibility of Consultant:
    - Material Testing
        - Steel
            - Skidmore testing of bolts.
        - Concrete
            - Fabricate specimens for strength, perform slump, air content and temperature.
        - Soils
            - Subgrade Preparation
            - Deep Foundation Inspections
        - Masonry
            - Verification of f'm
            - Verification of grout and mortar properties
    - Structural steel welding

Post-Construction Engineering:

Task 409 – Support for Pipe Flushing Activities:

This task includes support for pipe flushing activities, including two (2) site visits by the pipeline engineer during flushing activities, and office engineering support to assist in planning prior to and provide guidance to the City and Contractor during pipe flushing activities.

Task 410 –Start-Up:

Start-up shall be performed by the City and Contractor with Consultant, as needed, for operating recommendations. The City's Operation Staff shall oversee operations once water is introduced into the system. The Contractor shall complete instrumentation and control construction (installation and adjustment) including all items that require water to be present.

Task 411 – Pre-Start-Up Workshop:

Consultant will conduct a pre-start-up planning workshop with the City and Contractor prior to introducing water into the system.

Task 412 – Arch Flash Study:

Consultant will perform a short circuit analysis to evaluate if the equipment is rated for maximum available fault current. Where possible, the arc flash hazard at the equipment will be reduced by adjusting the trip unit settings of the breakers while maintaining protective device coordination. Arc Flash labels conforming to NFPA 70E requirements will be provided for the electrical equipment based on the arc flash hazard analysis upon completion of electrical system studies. It is assumed the Contractor will print labels. Consultant will provide an Arc Flash Study report to summarize the results.

Consultant assumes that the contractor will provide assistance in data collection required and adjustment to circuit breaker settings as required.

Task 413 – Substantial Completion Inspection and Punchlist

Consultant will participate in the field walks of the site with the City and the Contractor. Consultant will generate a punchlist of incomplete and construction items to correct in the field and prepare the substantial completion letter with final completion requirements outlined. This task assumes eight (8) hours each for five (5) discipline engineers, the process engineer, and the project manager to perform the site walk. The task also includes hours for punch list preparation/tracking and certificates of substantial completion.

Task 414 – Final Completion Inspection and Punchlist

Once the Contractor has indicated that they have corrected the punchlist items, a final field visit will be conducted to confirm that the work is complete. Based on the findings, final punch list letters of completion will be prepared and submitted. The fee assumes two (2) discipline engineers, the project engineer, and the project manager will perform the final field visit and develop final completion letter.

Task 415 – CDPHE Certifications:

Consultant shall issue CDPHE Certification of completion per approved design and/or work through changes to assist City with final approval from CDPHE for construction.

Task 416 – Conforming to Construction Record Drawings:

Following the construction, and prior to recommendation of the final payment to the Contractor, the Contractor will be required to provide a complete set of red lined drawings indicating any changes that took place in the field during construction of the project.

Consultant will prepare conforming to construction drawings from the Contractor supplied redlines. A hard copy, pdf copy, point files and/or AutoCAD files of the information will be provided to the City.

Task 417 – Warranty Phase Services:

Consultant will conduct one (1) end of warranty walk with the City and Contractor at the end of the Contractor's warranty period. In addition to the warranty walk, Engineer will provide up to 40 hours of services for answering warranty-related questions.

Task 418 – Project Closeout:

This task includes provisions for the Consultant to close out project documentation. This task will be conducted in the office and will include final discussions with the Contractor, punch list items, final payment, and other documents required by the contract documents for final completion and final payment.

Add Alternate: Tasks 000, 001, and 002 - SRF Funding Support

These tasks include estimated time to provide support on the project if SRF funding is utilized. Support is assumed to include the following:

Update Design Drawings/Specifications to reflect SRF design/procurement requirements related to piping, valves, pumps, rebar, embedded items, access hatches, and electrical equipment.

Conduct required Environmental Assessments and provide permitting related communication & documentation, including cultural & historic resources for State Historic Preservation Office (SHPO) reviews, wetland & endangered species assessments, and accommodating public comment periods/responses.

Provide additional construction phase engineering support assuming a schedule extension of 6 months.

BURNS MCDONNELL

City and County of Broomfield

Broomfield Tanks and Pump Station
Construction Phase Services

Task Series 400	Construction Phase Engineering	Project Manager	Process Engineer	Pipeline Engineer	Structural Engineer	Electrical and I&C Engineer	Mechanical Engineer	CAD	Architectural Engineer	Field Engineer	Project Assistant	QA/QC	Environmental Permitting
		Nicole Rasmussen	Julie Davis Katelin Schluerman	Amelia Dishon	Sherri Dalglish Megan Neid	Mark Haycock John Hayes	David Olsen	Josh Lee Clare Herm	Jennifer Dow Ryan Lurz	Ben Hendricks	Ashley Clawson Amelia Rendon	Kristin Weiss Angie Wheeler	Jennifer Bell Angie Wheeler
Task 401	Overall Management of Construction Contract	384									416		
Task 402	Pre-Construction Conference	8	8										
Task 403	Progress Meetings	324	432	40	40	40	0	24	0				
Task 404	RF Review & Notice of Intent	144	144	30	30	140	8	24	0				
Task 405	Submittal and Non-Conformance Review	92	296	96	184	296	40	92	80				
Task 406	Change Order/Work Change Directive/Field Orders	80	160	40	24	80		16					
Task 407	Periodic Site Visit by Engineer	40	80	8	40	32		12					
Task 408	Construction Observation and Field Engineer									2808			
Task 409	Support for Hydrostatic Activities	24	24	8		40		24					
Task 410	Start Up	48	112										
Task 411	Pre-Start-Up Workshop	8	0			0							
Task 412	As-Built Stage	16	16			128							
Task 413	Substantial Completion Inspection and Punchlist	16	16		8	8	8	8	8				
Task 414	Final Completion Inspection and Punchlist	16	16		8	8							
Task 415	CDPHE Certification	12	24										
Task 416	Conformance to Construction Record Drawings	12	64	8	20	40	8	24	8			80	
Task 417	Warranty Phase Services	22	30										
Task 418	Project Closeout	40	40										
Task Subtotal		1296	1458	368	372	768	72	172	128	2808	416	80	0
Project Total		**1430**	**1796**	**408**	**498**	**948**	**92**	**196**	**160**	**3510**	**456**	**80**	**280**
Add Alternates													
Task 600	SRF Funding Support - Updates to Design Documents/Specs	24	64	24	24	64	8		16			280	
Task 601	SRF Funding Support - Environmental & Permitting	60	120	32	48	64	16	24	24		40		
Task 602	SRF Funding Support - Additional Construction Support	130	162	32	76	96	12	28	24	352	40	280	
Task Subtotal		**214**	**366**	**100**	**136**	**160**	**36**	**52**	**64**	**352**	**80**	**280**	
Optional Service Total		**234**	**356**	**109**	**126**	**160**	**20**	**24**	**36**	**702**	**40**	**0**	**280**

Total Hours	Total Cost	Expenses	Subtotal
780	$ 222,892	$ 9,040	$ 230,40
16	$ 4,672	$ 187	$ 4,85
340	$ 226,200	$ 17,610	$ 203,80
308	$ 143,781	$ 7,658	$ 149,44
396	$ 767,744	$ 10,033	$ 777,77
400	$ 129,960	$ 4,398	$ 114,30
212	$ 58,376	$ 5,819	$ 64,19
2808	$ 884,015	$ 53,114	$ 938,12
128	$ 51,136	$ 1,498	$ 52,63
208	$ 55,184	$ 2,707	$ 57,89
24	$ 6,005	$ 272	$ 6,27
212	$ 58,852	$ 4,744	$ 63,59
72	$ 30,196	$ 1,342	$ 31,53
48	$ 13,104	$ 844	$ 13,94
96	$ 15,104	$ 448	$ 15,55
256	$ 97,151	$ 2,686	$ 99,83
48	$ 14,870	$ 504	$ 15,37
56	$ 15,637	$ 621	$ 16,25
7796	$ 2,537,571	$ 121,340	$ 2,378,46
9354	**$ 2,674,900**	**$ 150,981**	**$ 3,025,88**

Total Hours	Total Cost	Expenses	Subtotal
2520	$ 727,560	$ 29,977	$ 757,53
600	$ 147,648	$ 5,614	$ 153,26
1340	$ 356,372	$ 25,837	$ 382,21
2988	**$ 617,583**	**$ 25,641**	**$ 642,22**
2068	**$ 617,583**	**$ 29,641**	**$ 647,22**

Schedule of Hourly Professional Service Billing Rates

Position Classification	Classification Level	Hourly Billing Rate
General Office *	5	$78.00
Technician *	6	$99.00
Assistant *	7	$120.00
	8	$165.00
	9	$195.00
Staff *	10	$222.00
	11	$243.00
Senior	12	$275.00
	13	$297.00
Associate	14	$306.00
	15	$308.00
	16	$310.00
	17	$313.00

NOTES:

1. Position classifications listed above refer to the firm's internal classification system for employee compensation. For example, "Associate", "Senior", etc., refer to such positions as "Associate Engineer", "Senior Architect", etc.

2. For any nonexempt personnel in positions marked with an asterisk (*), overtime will be billed at 1.5 times the hourly labor billing rates shown.

3. For outside expenses incurred by Burns & McDonnell, such as authorized travel and subsistence, and for services rendered by others such as subcontractors, the client shall pay the cost to Burns & McDonnell plus 10%.

4. Monthly invoices will be submitted for payment covering services and expenses during the preceding month. Invoices are due upon receipt. A late payment charge of 1.5% per month will be added to all amounts not paid within 30 days of the invoice date.

5. The services of contract/agency and/or any personnel of a Burns & McDonnell parent, subsidiary, affiliate, or related or associated entity shall be billed to Owner according to the rate sheet as if such personnel is a direct employee of Burns & McDonnell.

6. The rates shown above are effective for services through December 31, 2025, and are subject to revision thereafter. The composition or build-up of the rates shown above are not subject to audit, inspection, or review.

Form BMR25-6A

EXHIBIT B
INSURANCE REQUIREMENTS

CITY and COUNTY of BROOMFIELD INSURANCE REQUIREMENTS - Including Professional Liability

1. All insurers must be licensed or approved to do business within the State of Colorado.
2. Contractor/Vendor's insurance carriers should have an A.M. Best Company rating of at least A- VII.
3. Additional Insured - City and County of Broomfield, its officers, board members, agents, employees and volunteers acting within the scope of their duties for the City and County of Broomfield shall be named as Additional Insured on all Commercial General Liability, and Automobile Liability Insurance policies (construction contracts require Additional Insured coverage for completed operations).
4. Primacy of Coverage – Coverage required of Contractors and Subcontractors shall be primary and non-contributory to any insurance carried by the City and County of Broomfield
5. All subcontractors must meet the same insurance requirements for the Contract or Purchase Order unless Risk Management has approved a deviation.
6. Subrogation Waiver – All insurance policies required under this Contract maintained by Contractor or its Subcontractors shall waive all rights of recovery against City and County of Broomfield, its officers, board members, agents, employees and volunteers acting within the scope of their duties for the City and County of Broomfield.
7. Cancellation – The above insurance policies shall include provisions preventing cancellation or non-renewal without at least 30 days prior notice to Contractor/Vendor and Contractor/ Vendor shall forward such notice to within seven days of receipt of such notice.
8. Certificates – Contractor and all Subcontractors shall provide certificates showing insurance coverage required hereunder to the City and County of Broomfield within 5 days of:
    a. the effective date of the Contract
    b. the expiration date of any coverage
    c. a request by the City and County of Broomfield
9. City and County of Broomfield in no way warrants that the limits required herein are sufficient to protect the Contractor/Vendor from liabilities that may arise out of the performance of the work under this Contract by the Contractor, its agents, representative, employees or subcontractors. The Contractor is not relieved of any liability or other obligations assumed or pursuant to the Contract by reason of its failure to obtain or maintain insurance in sufficient amounts, duration or type.
10. All parties understand and agree that the City and County of Broomfield is relying on, and does not waive or intend to waive by any provision of this Contract, the monetary limitations, immunities, protections or any other rights provided by the Colorado Governmental Immunity Act.
11. The City and County of Broomfield reserves the right to negotiate additional specific insurance requirements at the time of the Contract.

Vendor/Contractor/Subcontractor shall obtain and maintain, at its own expense and for the duration of the contract including any warranty periods under which the Contract are satisfied, the following:

Insurance Requirements - Including Professional Liability		
	COVERAGES AND LIMITS OF INSURANCE	**Required**
1.	**Commercial General Liability** Commercial General Liability insurance covering all operations by or on behalf of the contractor/vendor on an occurrence basis against claims for bodily injury, property damage (including loss of use), advertising liability, products and completed operations, and contractual liability. **Note: For contracts involving vendor/contractor contact with minors or at-risk adults, Sexual Abuse and Misconduct Coverage should be included in the coverage requirements.**	• $1,000,000 Each occurrence • $2,000,000 General Aggregate (Per Project) • $2,000,000 Products/Completed Operations Aggregate (for construction projects, this coverage should be maintained for a minimum of 3 years from the end of the project)
2.	**Automobile Liability** Automobile Liability Insurance covering any auto (including owned, hired and non-owned autos).	• $1,000,000 combined single limit • If hazardous materials are transported, an MCS 90 form shall be included on the policy
3.	**Workers' Compensation** Workers' Compensation Insurance as required by State statute, covering all Vendors/Contractors employees acting within the course and scope of their employment. This requirement shall not apply if exempt under Colorado Workers' Compensation Act, AND when providing the sole proprietor waiver form.	Employer's Liability with Limits: • $100,000 Each Accident • $100,000 Each Employee by Disease • $500,000 Disease Aggregate
4.	**Professional Liability** Contractor will purchase and maintain professional liability insurance covering any damages caused by an error, omission or negligent professional act to include the following: Coverages: • Limited Contractual Liability • If coverage is Claims Made, a retroactive date prior to the inception of the work • If coverage is Claims Made, similar coverage must be maintained for three years following the completion of the work or an extended reporting period of 36 months must be purchased	Limit: • $1,000,000 Per Claim/Aggregate
Additional Insured - The following shall be named an Additional Insured: The City and County of Broomfield, its officers, board members, agents, employees and volunteers acting within the scope of their duties for the City and County of Broomfield shall be named as Additional Insured on all Commercial General Liability, Umbrella Liability and Automobile Liability Insurance policies (construction contracts require Additional Insured coverage for completed operations). A Waiver of Subrogation is provided in favor of the Additional Insureds as respects to all policies. **Certificate Holder is:** City and County of Broomfield One DesCombes Drive Broomfield, CO 80020-2495 certificates@broomfield.org		

Any deviations below the standards given above must be approved by the City and County of Broomfield's Risk Management office. Please direct any questions to RiskManagement@broomfield.org

City and County of Broomfield

City Council Regular Meeting

H. Public Hearing - Ordinance Second Reading - Water and Sewer License Purchase and Refund Requirements and Timing

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7H.

Presented By
Katie Allen

Community Goals
☑ Financial Sustainability and Resilience

Overview

View Correspondence
View Presentation

Proposed Ordinance 2287 contains updates to the Broomfield Municipal Code (BMC) regarding the purchase of water and sewer licenses. The proposed changes are being considered to prohibit advance purchases of water and sewer licenses. The draft ordinance will require that water and sewer licenses be purchased concurrently with the issuance of a building permit or irrigation tap request. The ordinance is necessary to accurately model the revenues and expenditures of the water and sewer enterprise funds and plan for rate adjustments accordingly.

Attachments

Memo - Water and Sewer License Timing second reading
Ordinance No 2287 - Water and Sewer license timing

Water and Sewer License Amendments, Ordinance 2287 - Second Reading
Prepared By: Katie Allen, Director of Community Development

Summary

View Correspondence
View Presentation

Proposed Ordinance 2287 contains updates to the Broomfield Municipal Code (BMC) regarding the purchase of water and sewer licenses. The proposed changes are being considered to prohibit advance purchases of water and sewer licenses. The ordinance, if adopted, will require that water and sewer licenses be purchased concurrently with the issuance of a building permit or irrigation tap request. The ordinance is necessary to accurately model the revenues and expenditures of the water and sewer enterprise funds and plan for rate adjustments accordingly.

Proposed Ordinance 2287 also clarifies and updates the application process for water and sewer licenses and provides a process for water and sewer license refunds. Refunds may be given if the project and associated building permit have been canceled within 12 months of purchase, or if a multi-tenant shell building overpurchased licenses because the future tenants were uncertain at the time of application. In the case of tenant finishes of shell buildings, the refund request must be made within 24 months of the date of purchase of the license.

Financial Considerations

Currently, developers may purchase water and sewer licenses before obtaining a building permit as a way to hedge against future water or sewer license fee increases, which can negatively impact the water and sewer enterprise fund revenue. By prohibiting the advance purchase of licenses, proposed Ordinance 2287 may increase revenues in the enterprise funds and will help accurately model revenues to better plan for necessary rate adjustments.

Prior Council or Other Entity Actions

These matters as set forth in the Broomfield Municipal Code have not been modified since 1984.

October 14, 2025 - Council approved Ordinance No. 2287 on first reading.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions/Recommendations

If Council desires to make changes to the Broomfield Municipal Code related to the purchase of water and sewer licenses, the appropriate motion is…

That Ordinance No. 2287 be adopted on second and final reading and ordered published by title.

Alternatives

Make no changes to the Broomfield Municipal Code.

Make changes to the Broomfield Municipal Code as directed by City Council.

Ordinance No. 2287

Proposed Ordinance No. 2287 amends Chapter 13-02 Water Licenses and Chapter 13-08 Sewer Licenses of the Broomfield Municipal Code to revise the requirements for the purchase of water and sewer licenses. If approved on second reading, proposed Ordinance No. 2287 will be published by title, and will become effective 7 days after publication.

Bold type indicates new material to be added to the Broomfield Municipal Code
~~Strikethrough type~~ indicates deletions from the Broomfield Municipal Code

ORDINANCE NO. 2287

Amending Chapter 13-02 Water Licenses and Chapter 13-08 Sewer Licenses

Be it ordained by the City Council of the City and County of Broomfield, Colorado:

Section 1.

Chapter 13-02 - Water Licenses of the Broomfield Municipal Code is amended as follows:

Chapter 13-02 - Water Licenses

13-02-010 - Required.

It shall be unlawful to make a service connection to the city's water system without a water license therefore, except for temporary connections for construction purposes made with the permission of the director of **water utilities** ~~public works~~ and in accordance with chapter 13-16 of this title.

. . .
13-02-030 - Application.

Applications for water licenses may be made **when applying for a building permit or a stand-alone irrigation water tap** to the **water utilities** ~~public works~~ department on forms provided by that department by any person owning property within the city or by his or her agent. Applications ~~must be accompanied by the license fee and~~ must contain the following:

(A) A description of the lot, tract, or parcel owned and to be served, including a legal description, a street address, or such other description as may be required by the **water utilities** ~~public works~~ department.

(B) The size of the water tap and water meter requested.

(C) A description of the purposes for which the water is to be used**, including business types, the square footage for each business type, and the number and types of residential units**.

(D) **A water budget for landscape irrigation as described in BMC 17-70-060.**

(E) ~~(D)~~ The name, address, and signature of the applicant.

(F) Other information required by the **water utilities** ~~public works~~ department to assist in administering this chapter.

The number of three-quarter-inch tap equivalents required for the expected annual total water use will be calculated by the water utilities department based on the description of water uses and building types provided in the application. Additional tap equivalents may

be required if previously purchased tap equivalents do not provide the expected annual total water use as calculated by the water utilities department.

13-02-040 - Issuance.

The department of **water utilities** ~~public works~~ shall issue a water license **at the time of building permit issuance or when a stand-alone irrigation tap permit is approved** if the application complies with section 13-02-030 above. If the application does not comply with section 13-02-030 above, the department of **water utilities** ~~public works~~ shall deny the application.

13-02-050 - Required for building permit.

No building permit for a structure which will require a new water tap or connections shall be issued **without an accompanying** ~~unless the applicant has a~~ valid water license.

. . .

13-02-100 - ~~Definitions.~~ **Refunds.**

Except as provided in B.M.C. 13-02-080 (Prior Provisions), the Department of Water Utilities will refund water license fees previously paid in connection with the issuance of a service license under the following conditions:

(A) For projects that are withdrawn and are not constructed:
- **(1) The request for the refund must be made in writing by the license holder and received by the city within 12 months of the date of purchase of the license from the permit holder. No refunds will be made thereafter.**
- **(2) Any building or tap permits relating to the services must also be (i) withdrawn concurrently, and (ii) either the city will confirm no work was completed under the permit issued, or all the permitted work has been removed and returned to its previous condition, in order to receive such a refund.**
- **(3) Any costs incurred by the city in connection with cancelling the license and disconnecting the service will be deducted from the refund amount as well as a $250 administration fee for such refund.**

(B) For refunds relating to shell building developments where future tenants are uncertain at the time of application:
- **(1) In the event the initial purchase of the water licenses is inaccurate for the actual tenants of the shell building, the license holder may request a refund on the following conditions:**
  - **(i) The refund request must be made in writing by the license holder and received by the City within 24 months of the date of purchase of the license.**
  - **(ii) Any building or tap permits relating to the tenant finish services must also be (a) withdrawn or revised concurrently consistent with the request for the refund, as applicable, and (b) the city will confirm additional water licenses are not needed for the current and proposed uses within the building at the time in order to receive such a refund. The license holder will be required to submit documentation consistent with BMC 13-02-030 to aid the city in**

determining the revised water usage for the building and potential refund amount.

(iii) Any costs incurred by the city in connection with cancelling the license and disconnecting the service will be deducted from the refund amount, if applicable, as well as a $250 administration fee for such refund.

13-020-110 Definitions.

As used in this chapter, unless the context clearly indicates otherwise, the following terms shall have the meanings indicated:

(A) Three-quarter-inch equivalent tap. The basic unit of comparison based on demand on the water system. Demand is compared to the demand characteristics of three-quarter-inch connections serving single-family detached housing. Equivalence is determined on a case-by-case basis by the public works department, except for the following:
  (1) Connections serving duplexes shall be equivalent to one three-quarter-inch equivalent tap per unit.
  (2) Connections serving mobile homes shall be equivalent to 80% of a three-quarter-inch equivalent tap per unit.
  (3) Connections serving townhouses or other single-family attached and detached housing with no individual outside irrigation shall be equivalent to 60% of a three-quarter-inch equivalent tap per unit.
  (4) Connections serving apartments or apartment-style condominium units with no individual outside irrigation shall be equivalent to 40% of a three-quarter-inch equivalent tap per unit.
  (5) Accessory dwelling units (ADUs) consistent with section 17-32-160 shall be tied into the existing water connection for the principal structure on a residential property and as such shall not require a separate water tap or additional water license.

(B) City water system. The water reservoir, plant, lines, pumps, facilities, assets, and appurtenances controlled by the city.

(C) Tap. A physical connection to a distribution main.

(D) Stub-in. A tap made to allow streets to be paved before a service connection is made. A stub-in line ordinarily extends only to just beyond the curb line. A stub-in does not provide service.

(E) Service connection. A tap and appurtenances capable of effecting water service to a water meter.

Section 2.

Chapter 13-08 - Sewer Licenses of the Broomfield Municipal Code is amended as follows:

. . .

13-08-030 - Application.

Applications for sewer licenses may be made to the **community development** ~~public works~~ department on forms provided by that department by any person owning property within the

city or by his or her agent. Applications must be accompanied by the license fee and must contain the following:

(A) A description of the lot, tract, or parcel owned and to be served, including a legal description, a street address, or such other description as may be required by the public works department.

(B) The size of the sewer tap requested.

(C) A description of the purposes for which the sewer is to be used.

(D) The name, address, and signature of the applicant.

(E) Other information required by the **community development** ~~public works~~ department to assist in administering this chapter.

The number of equivalent sewer taps required will be determined by the community development department based on the description and information provided in the application. Additional equivalent sewer taps may be required if previously purchased licenses are not sufficient for the property as calculated by the community development department.

13-08-040 - Issuance.

The Department of **Community Development** ~~public work~~ shall issue a sewer license **at the time of building permit issuance** if the application complies with section 13-08-030 above. If the application does not comply with section 13-08-030 above, the Department of **Community Development** ~~public works~~ shall deny the application.

13-08-050 - Required for building permit.

No building permit for a structure which will require a new sewer tap or connection shall be issued **without an accompanying valid sewer license** ~~unless the application has a valid sewer license~~.

. . .

13-08-090 - ~~Definitions.~~ **Refunds.**

The Department of Community Development will refund sewer license fees previously paid in connection with the issuance of a service license under the following conditions:

(C) For projects that are withdrawn and are not constructed:

(1) The request for the refund must be made in writing by the license holder and received by the city within 12 months of the date of purchase of the license from the permit holder. No refunds will be made thereafter.

(2) Any building or tap permits relating to the services must also be (i) withdrawn concurrently, and (ii) either the city will confirm no work was completed under the permit issued, or all the permitted work has been removed and returned to its previous condition, in order to receive such a refund.

(3) Any costs incurred by the city in connection with cancelling the license and disconnecting the service will be deducted from the refund amount as well as a $250 administration fee for such refund.

(D) For refunds relating to shell building developments where future tenants are uncertain at the time of application:

(1) In the event the initial purchase of the sewer licenses are incorrect, the license holder may request a refund on the following conditions:

(i) The refund request must be made in writing by the license holder and received by the City within 24 months of the date of purchase of the license.

(ii) Any building or tap permits relating to the tenant finish services must also be (a) withdrawn or revised concurrently consistent with the request for the refund, as applicable, and (b) the city will confirm additional sewer licenses are not needed for the current and proposed uses within the building at the time in order to receive such a refund. The license holder will be required to submit such other information consistent with BMC 13-08-030 to aid the city in determining the revised sewer usage for the building and potential refund amount.

(A) Any costs incurred by the city in connection with cancelling the license and disconnecting the service will be deducted from the refund amount, if applicable, as well as a $250 administration fee for such refund.

13-080-100 Definitions.

As used in this chapter, unless the context clearly indicates otherwise, the following terms shall have the meanings indicated:

(A) Equivalent sewer tap. The basic unit of comparison based on demand on the sewer system. Demand is compared to the demand characteristics of sewer connections serving single-family detached housing. Nonresidential equivalence is determined on a case-by-case basis by the public works department and is based on 320 gallons of average daily flow per equivalent sewer tap. All residential uses, including single-family detached, attached, mobile home, condominiums, townhouses, apartments, and motels or hotel rooms with kitchen facilities, shall have one equivalent sewer tap per dwelling unit. Accessory dwelling units (ADUs) consistent with section 17-32-160 shall be tied into the existing sewer connection for the principal structure on a residential property and as such shall not require a separate sewer tap or additional sewer license.

(B) City sewer system. The wastewater plant, lines, pumps, facilities, assets, and appurtenances controlled by the city.

(C) Tap. A physical connection to a collection main.

(D) Service connection. A tap and appurtenances capable of effecting sewer service.

Section 3.

This ordinance is effective seven days after publication following final passage.

Introduced and approved after first reading on October 14, 2025, and ordered published in full.

Introduced a second time and approved on October 28, 2025, and ordered published.

The City and County of Broomfield, Colorado

_____
Mayor

Attest:

_____
Office of the City and County Clerk

Approved as to form:

NCR

_____
City and County Attorney

City and County of Broomfield

City Council Regular Meeting

I. Resolution - Broomfield Business Center (BBC) Metropolitan District Service Plan Amendment

Meeting	Agenda Group
Tuesday, October 28, 2025, 6:00 PM	Action Items Item: 7I.

Presented By
Maddie Guzman

Community Goals

Overview

View Correspondence
View Presentation

Resolution 2025-148 approving an Amendment to the First Amended and Restated Service Plan for BBC Metropolitan District. BBC Metropolitan District is seeking an amendment to the First Amended and Restated Service Plan to authorize the District to own, operate and maintain streets and street improvements. The District does not currently have this power under the approved 2012 Service Plan. There are no proposed changes to the District's debt authority or mill levy cap.

Attachments

Memo - Approving an Amendment to the First Amended and Restated Service Plan for BBC Metropolitan District.pdf

Resolution No. 2025-148 Approving an Amendment to the First Amended and Restated Service Plan for BBC Metropolitan District .pdf

BBCMD - Amendment to Service Plan FINAL - 10-28-2025.pdf

Memo - Approving an Amendment to the First Amended and Restated Service Plan for BBC Metropolitan District
Prepared By: Karl Frundt, Senior Attorney; Jeff Romine, Economist; Maddie Guzman, Analyst.

Summary

View Correspondence
View Presentation

BBC Metropolitan District is seeking an amendment to the First Amended and Restated Service Plan to authorize the District to own, operate and maintain streets and street improvements. The District does not currently have this power under the approved 2012 Service Plan. There are no proposed changes to the District's debt authority or mill levy cap.

Currently, Del Corso Way and Via Lata Drive are privately owned and maintained. If the requested Service Plan amendment is approved, the ownership and maintenance of the portions of Del Corso Way and Via Lata Drive located within the District would transfer from the developer to the District.

The District has sufficient financial capacity to assume these street maintenance obligations. Transferring ownership and maintenance responsibility from the private developer to the District will ensure that Del Corso Way and Via Lata Drive are managed consistently with other public infrastructure assets within the District, providing uniformity in maintenance standards, long-term capital planning, and operational oversight. This transfer also eliminates the uncertainty associated with private ownership and ensures perpetual maintenance funding through the District's established financial mechanisms. Additionally, public ownership by the District provides greater transparency and accountability to residents, as the streets will be maintained using the same processes and standards that govern the District's other infrastructure assets.

BBC Metropolitan District is generally located south and east of the Northwest Parkway on the north end of Via Varra. The land in the BBC Metro District has primarily been developed as residential, and includes the Vive on Via Varra, Northwest Apartments, and Caliber at Flatirons residential properties. A map of the BBC Metro District boundaries is included for reference. The Overlook and Parkway Circle neighborhoods are to the south.

BBC Metropolitan District was originally formed in 2002 as the BBC/Overlook Metropolitan District. On March 15, 2012 the BBC/Overlook Metropolitan District was renamed following a court order to the BBC Metropolitan District.

Financial Considerations

The proposed Service Plan Amendment sought by the BBC Metropolitan District does not have a financial impact on the City and County of Broomfield.

Prior Council or Other Entity Actions

September 24, 2002 the City Council approved Resolution No. 2002-202 approving the Service Plan for BBC/Overlook Metropolitan District.

May 13, 2008 the City Council approved Resolution No. 2008-89 approving the First Modification of the Service Plan for BBC/Overlook Metropolitan District.

April 24, 2012 the City Council approved Resolution No. 2012-88 approving the First Amended and Restated Service Plan for the BBC Metropolitan District.

Boards and Commissions Prior Actions and Recommendations

N/A

Proposed Actions / Recommendations

If Council desires to approve the proposed amendment to the BBC Metropolitan Service Plan, the appropriate motion is...

That Resolution 2025- 148 be adopted.

Alternatives

Council could choose not to approve the proposed amendment to the BBC Metropolitan Service Plan and the portions of Corso Way and Via Lata Drive within the District would remain in private ownership.

RESOLUTION NO. 2025-148

A resolution approving an Amendment to the First Amended and Restated Service Plan for BBC Metropolitan District

Recitals.

Whereas, pursuant to the provisions of Part 2 of Article 1 of Title 32, C.R.S., as amended, (the "Act"), no special district shall be organized if its boundaries are wholly within the boundaries of a municipality, except upon adoption of a resolution of approval by the governing body of the municipality.

Whereas, the City Council on September 24, 2002, pursuant to the Act, held a public hearing and adopted Resolution No. 2002-202, that determined that the requirement of the filing of the Service Plan (the "Original Service Plan") for BBC/Overlook Metropolitan District, and the organization of the BBC/Overlook Metropolitan District had been fulfilled.

Whereas, the City Council on May 13, 2008, held a public hearing and adopted Resolution No. 2008-89, approving the First Modification to the Original Service Plane Plan for BBC/Overlook Metropolitan District.

Whereas, on March 15, 2012 the BBC/Overlook Metropolitan District was renamed the BBC Metropolitan District (the "District") by court order.

Whereas, the City Council on April 24, 2012, held a public hearing and adopted Resolution No. 2012-88, approving the First Amended and Restated Service Plan for BBC Metropolitan District (the "Amended and Restated Service Plan").

Whereas, on June 17, 2025, the District submitted a proposed Amendment to the Amended and Restated Service Plan for City Council's review and consideration (the "Amendment").

Whereas, the Amendment is a material modification of the Amended and Restated Service Plan and will authorize the District to own, operate, and maintain streets within the District.

Whereas, the City Council completed a public hearing on October 28, 2025, regarding the Amendment.

Whereas, the Act requires that any material modification of a service plan must be approved by resolution of the governing body of the municipality within which the District lies.

Whereas, the District's boundaries are wholly within the boundaries of the City and County of Broomfield.

Now, therefore, be it resolved by the City Council of the City and County of Broomfield,

Colorado:

Section 1.

City Council determines that all of the requirements of the Act, relating to the filing of the Amendment to the Amended and Restated Service Plan have been fulfilled and the Amendment is hereby approved.

Section 2.

City Council determines that the District has complied with the notification requirements regarding the public hearing on the Amendment

Section 3.

In accordance with the requirements C.R.S. 32-1-203(2), City Council finds that:

a. There is sufficient existing and projected need for organized service in the area to be served by the District.
b. The existing service area to be serviced by the District is inadequate for present and projected needs.
c. The District is capable of providing economical and sufficient service to the area within the proposed boundaries.
d. The area included within the District has, or will have, the financial ability to discharge the proposed indebtedness on a reasonable basis.

Section 4.

In accordance with C.R.S. 32-1-203(2.5), City Council also finds that:

a. The service standards of the District are compatible with the service standards of the City.
b. The modifications to the District's First Amended and Restated Service Plan incorporated into the Amendment will be in the best interests of the area proposed to be served.

Section 5.

City Council's findings are based solely upon the evidence in the Amendment as presented at the public hearing and the City shall never be liable for any of the District's debt obligations.

Section 6.

This resolution is effective upon its approval by the City Council.

Approved on October 28, 2025.

The City and County of Broomfield, Colorado

_____

Mayor

Attest:

_____

Office of the City and County Clerk

Approved as to form:

NCR

_____

City and County Attorney

AMENDMENT TO THE

FIRST AMENDED AND RESTATED SERVICE PLAN

FOR

BBC METROPOLITAN DISTRICT

(City and County of Broomfield, Colorado)

Approved: October 28, 2025

Prepared by:

Erb Law, LLC
8480 E. Orchard Road, Suite 3650
Greenwood Village, CO 80111

Service Plan Approved: September 10, 2002
First Modification to Service Plan Approved: May 13, 2008
First Amended and Restated Service Plan Approved: April 24, 2012

I. PURPOSE AND INTENT

BBC Metropolitan District (the "**District**") was organized and operates pursuant to its service plan as amended and restated by the City Council of the City and County of Broomfield, Colorado ("**Broomfield**") on April 24, 2012 ("**Service Plan**"), to provide for the design, acquisition, construction, installation, and financing of certain water, sanitation, street, safety protection, parks and recreation, transportation, television relay and translator, mosquito control, and limited fire protection improvements and services within and without the District boundaries.

Section (V)(A)(3) of the Service Plan states that the District was intended to design, acquire, construct, finance, complete and install the street improvements within the District, and the intent was for Broomfield to acquire, own and maintain the street improvements within the District upon completion.

The intent of this Amendment is to give the District the additional power to own, operate and maintain streets and street improvements, namely those streets within and without the District that Broomfield does not own, operate or maintain. The statutory authority for metropolitan districts to provide such services is set forth in Section 32-1-1004(2), C.R.S.

II. AMENDMENT

1. Section (V)(A)(3) of the Service Plan is hereby deleted in its entirety and amended to read as follows:

> Streets. The District shall have the power to provide for the design, acquisition, construction, financing, completion, installation, and operation and maintenance of street improvements, including curbs, gutters, culverts, and other drainage facilities, acceleration and deceleration lanes, sidewalks, bike paths and pedestrian ways, median islands, paving, lighting, parking lots, signage and monuments, grading, landscaping and irrigation, and snow removal, together with all necessary, incidental, and appurtenant facilities, land and easements, within and without the boundaries of the District. This includes the power to own any street or streets within and without the District's boundary.

2. Except as set forth in this Amendment, all provisions of the Service Plan remain unchanged and in full force and effect.