



## Request for Comments

Case Name: Arvada Tennyson North Trunk Sewer Improvements Project  
Case Number: RCU2024-00012

June 13, 2024

The Adams County Planning Commission is requesting comments on the following application: **An Intergovernmental Agreement (IGA) in lieu of an Ares and Activities of State Interest Permit is being pursued by the City of Arvada with Adams County for a Sewer Improvements Project.** This request is located along Tennyson Street between I-76 & W. 61st Place.

Applicant Information: CITY OF ARVADA  
KRIS GARDNER  
8101 RALSTON RD  
ARVADA, CO 80001

Please forward any written comments on this application to the Community and Economic Development Department at 4430 South Adams County Parkway, Suite W2000A, Brighton, CO 80601, or call (720) 523-6800 by July 4, 2024, in order that your comments may be taken into consideration in the review of this case. If you would like your comments included verbatim please send your response by way of e-mail to [GJBarnes@adcogov.org](mailto:GJBarnes@adcogov.org).

Once comments have been received and the staff report written, the staff report and notice of public hearing dates may be forwarded to you upon request. The full text of the proposed request and additional colored maps can be obtained by contacting this office or by accessing the Adams County web site at [www.adcogov.org/current-land-use-cases](http://www.adcogov.org/current-land-use-cases). Thank you for your review of this case.

Greg Barnes  
Principal Planner

BOARD OF COUNTY COMMISSIONERS

Eva J. Henry  
DISTRICT 1

Charles "Chaz" Tedesco  
DISTRICT 2

Emma Pinter  
DISTRICT 3

Steve O'Dorisio  
DISTRICT 4

Lynn Baca  
DISTRICT 5



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## **Appendix A**

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Design Drawings

Alternate Design Drawings

Design Specifications

Stormwater Management Plan

## **Design Drawings**

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# CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS



## OWNER/CONSULTANTS

CITY OF ARVADA PUBLIC WORKS  
8101 RALSTON RD  
ARVADA, CO 80002

KRIS GARDNER  
KGARDNER@ARVADA.ORG  
720-898-7647

KENNEDY/JENKS CONSULTANTS  
165 S UNION BLVD SUITE 570  
LAKEWOOD, CO 80228

JERRY PENA  
JERRYPENA@KENNEDYJENKS.COM  
303-229-1750

LITHOS ENGINEERING  
2750 S WADSWORTH BLVD SUITE D-200  
DENVER, CO 80227

JAMES CARROLL  
JAMES@LITHOSENS.COM  
303-625-9502

UNDERGROUND CONSULTING SOLUTIONS  
5778 KELLY AVE  
LITTLETON, CO 80125

KEN GOFF  
UCS@DONTDIGWITHOUTUCS  
303-904-7422

## REGULATORY AGENCIES

REGIONAL TRANSPORTATION DISTRICT - DENVER  
1660 BLAKE ST  
DENVER, CO 80202

NIKITA ZANICHKOWSKY  
NIKITA.ZANICHKOWSKY@RTD-DENVER.COM  
303-299-2420

BNSF RAILWAY - DENVER  
585 W 53RD PL  
DENVER, CO 80216

ALLAN BREDEN  
ALLAN.BREDED@BNS.COM  
720-415-8398

UNION PACIFIC RAILROAD CO  
1180 W 52ND AVE  
DENVER, CO 80221

JUSTIN SORIANO  
JASORIAN@UP.COM  
402-544-5433

MANHART DITCH COMPANY  
6575 WEST 88TH AVE  
WESTMINSTER, CO 80031

BOB KRUGMIRE  
WESTY.DITCHES.2019@GMAIL.COM  
303-658-2181

ADAMS COUNTY PUBLIC WORKS  
4955 E 74TH AVE  
COMMERCE CITY, CO 80022

MARK MCDONALD  
MMCDONALD@ADCOGOV.ORG  
720-523-6809

DENVER WATER  
1600 W 12TH AVE  
DENVER, CO 80204

DENVER WATER LOCATING DEPT.  
DWLOCATE@DENVERWATER.ORG  
303-628-6666

METRO WATER RECOVERY  
6450 YORK ST  
DENVER, CO 80229

KELSEY GEDGE  
KGEDGE@METROWATERRECOVERY.COM  
303-286-3357

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414 NICOLLET MALL  
MINNEAPOLIS, MN 55401

DANIEL NIVAL  
DANIEL.NIVAL@XCELENERGY.COM  
303-619-3805

COLORADO DEPARTMENT OF TRANSPORTATION  
2829 W. HOWARD PL, 2551  
DENVER, CO 80204

TANISHA ALFORD  
TANISHA.ALFORD@STATE.CO.US  
303-880-3693

MILE HIGH FLOOD DISTRICT  
12575 W BAYAUD AVE  
LAKEWOOD, CO 80228

DAN HILL  
DHILL@MHFD.ORG  
303-455-6277

CITY OF WESTMINSTER PARKS AND RECREATION  
4800 W 92ND AVE  
WESTMINSTER, CO 80031

TOMÁS HERRERA-MISHLER  
PRL@CITYOFWESTMINSTER.US  
303-658-2192

HYLAND HILLS PARK & RECREATION DISTRICT  
8801 N PECOS ST  
FEDERAL HEIGHTS, CO 80260

STEVE HEGER  
SHEGER@HYLANDHILLS.ORG  
303-650-7590

CRESTVIEW WATER AND SANITATION DISTRICT  
7145 MARIPOSA ST #7200  
DENVER, CO 80221

MITCHELL TERRY  
MANAGER@CRESTVIEWWATER.COM  
303-429-1881

BERKELEY WATER AND SANITATION DISTRICT

CONTACT DENVER WATER



**LOCATION MAP**  
SCALE: NTS



**VICINITY MAP**  
SCALE: NTS

## DRAWING INDEX

SHEET NO	DRAWING NO	SHEET TITLE
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### GENERAL:

1	G-001	COVER, LOCATION AND VICINITY MAPS, AND DRAWING INDEX
2	G-002	GENERAL NOTES AND LEGEND
3	G-003	GENERAL PROCESS SYMBOLS
4	G-004	SURVEY CONTROL DIAGRAM

### CIVIL:

5	C-001	CIVIL NOTES AND ABBREVIATIONS
6	C-002	CIVIL LEGEND
7	C-003	CIVIL DETAILS
8	C-004	TUNNELING DETAILS - I
9	C-005	TUNNELING DETAILS - II
10	C-006	TUNNELING DETAILS - III
11	C-350	PLAN AND PROFILE STA 1+00 TO 6+00
12	C-351	PLAN AND PROFILE STA 6+00 TO 11+00
13	C-352	PLAN AND PROFILE STA 11+00 TO 16+00
14	C-353	PLAN AND PROFILE STA 16+00 TO 20+50
15	C-354	PLAN AND PROFILE STA 20+50 TO 25+50
16	C-355	PLAN AND PROFILE STA 25+50 TO 30+50
17	C-356	PLAN AND PROFILE STA 30+50 TO 35+50
18	C-357	PLAN AND PROFILE STA 35+50 TO 37+00
19	C-450	SITE RESTORATION STA 1+00 TO 11+00
20	C-451	SITE RESTORATION STA 11+00 TO 20+50
21	C-452	SITE RESTORATION STA 20+50 TO 30+50
22	C-453	SITE RESTORATION STA 30+50 TO 37+00

### STRUCTURAL:

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24	S-002	STRUCTURAL PLANS
25	S-003	STRUCTURAL SECTIONS
26	S-004	STRUCTURAL DETAILS - I
27	S-005	STRUCTURAL DETAILS - II

### MECHANICAL:

28	M-001	METERING VAULT PLAN
29	M-002	METERING VAULT SECTIONS AND DETAILS

## DRAWING INDEX - CONTINUED

SHEET NO	DRAWING NO	SHEET TITLE
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### ELECTRICAL:

30	E-001	ELECTRICAL ABBREVIATIONS AND NOTES
31	E-002	ELECTRICAL LEGEND - I
32	E-003	ELECTRICAL LEGEND - II
33	E-004	ELECTRICAL TYPICAL DETAILS - I
34	E-005	ELECTRICAL TYPICAL DETAILS - II
35	E-006	ELECTRICAL TYPICAL DETAILS - III
36	DE-010	OVERALL DEMOLITION SITE PLAN
37	E-010	ELECTRICAL OVERALL SITE PLAN
38	E-011	ELECTRICAL METER VAULT DETAILS
39	E-020	ELECTRICAL ONE LINE DIAGRAM AND SCHEDULES
40	E-030	ELECTRICAL CONDUIT AND CABLE SCHEDULE
41	E-040	ELECTRICAL CONDUIT ROUTING BLOCK DIAGRAM

### INSTRUMENTATION:

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43	I-002	INSTRUMENTATION STANDARD DETAILS
44	I-010	NETWORK DIAGRAM
45	I-011	PARSHALL FLUME PROCESS AND INSTRUMENTATION DIAGRAM

### EROSION CONTROL:

46	EC-601	EROSION CONTROL NOTES
47	EC-602	EROSION CONTROL DETAILS - I
48	EC-603	EROSION CONTROL DETAILS - II
49	EC-650	GRADING, EROSION, AND SEDIMENT CONTROL STA 1+00 TO 11+00
50	EC-651	GRADING, EROSION, AND SEDIMENT CONTROL STA 11+00 TO 20+50
51	EC-652	GRADING, EROSION, AND SEDIMENT CONTROL STA 20+50 TO 30+50
52	EC-653	GRADING, EROSION, AND SEDIMENT CONTROL STA 30+50 TO 37+00

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

**JAN 2024 - INTERIM 100%**

**NOT FOR CONSTRUCTION**  
THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

## SCALES

0 1" = 1" = 25mm  
0 25mm  
IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

## DESIGNED

TS

## DRAWN

WAS

## CHECKED

LS



**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**



**COVER, LOCATION AND VICINITY MAPS,  
AND DRAWING INDEX**

## SCALE

NTS

JOB NO 2246059\*00

DATE JAN 2024

SHEET 1 OF 52

G-001

Plot Date: 1/23/2024 9:23 AM

User: BRYANT BEHNKE

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### NOTES

#### GENERAL

1. THIS PROJECT IS WITHIN CITY OF ARVADA AND ADAMS COUNTY RIGHT OF WAY. CONTRACTOR SHALL CONFORM TO CITY OF ARVADA AND ADAMS COUNTY PERMITS AND REQUIREMENTS.
2. ALL WORK SHALL BE PERFORMED IN ACCORDANCE WITH CITY OF ARVADA STANDARDS, ADAMS COUNTY STANDARDS, AND APPLICABLE AWWA STANDARDS.
3. PRE-EXISTING SITE CONDITION PHOTOS SHALL BE PROVIDED BY THE CONTRACTOR AND SHALL SHOW EXISTING CONDITIONS OF ALL CONCRETE, ASPHALT, LANDSCAPED AREAS, ETC. SURROUNDING THE CONSTRUCTION AREAS. PHOTOS SHALL BE SUBMITTED TO THE OWNER PRIOR TO BREAKING GROUND. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT EXISTING IMPROVEMENTS WHICH ARE TO REMAIN IN PLACE FROM DAMAGE. ALL IMPROVEMENTS DAMAGED BY THE CONTRACTOR'S OPERATIONS SHALL BE EXPEDITIOUSLY REPAIRED OR RECONSTRUCTED AT THE CONTRACTOR'S EXPENSE WITHOUT ADDITIONAL COMPENSATION.
4. CONTRACTOR SHALL RESTORE ALL SURVEY MONUMENTS THAT ARE DAMAGED OR DESTROYED DURING CONSTRUCTION.
5. OBSERVATIONS OF WORK IN PROGRESS DURING SITE VISITS SHALL NOT ALTER THE REQUIREMENTS OF THE CONTRACT DOCUMENTS.

#### UTILITIES

1. LOCATIONS OF UNDERGROUND UTILITIES SHOWN ON THE DRAWINGS WERE OBTAINED FROM AVAILABLE RECORDS AND ARE SHOWN IN THEIR APPROXIMATE LOCATION. THERE IS NO GUARANTEE THAT ALL EXISTING PIPELINES AND OBSTRUCTIONS ARE SHOWN OR THAT LOCATIONS INDICATED ARE ACCURATE. PRIOR TO THE START OF CONSTRUCTION, THE CONTRACTOR SHALL POTHOLE TO DETERMINE ACTUAL LOCATION AND ELEVATION OF ALL EXISTING UTILITIES IN AND AROUND THE AREAS OF NEW CONSTRUCTION.
2. THE CONTRACTOR SHALL TAKE ALL PRECAUTIONARY MEASURES NECESSARY TO PROTECT ALL REMAINING EXISTING UTILITIES WHETHER SHOWN OR NOT SHOWN.
3. PRIOR TO ANY CONNECTION TO AN EXISTING UTILITY, THE CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER.
4. PRIOR TO ANY EXCAVATION IN THE VICINITY OF ANY EXISTING UNDERGROUND FACILITIES, INCLUDING ALL WATER, SEWER, STORM DRAIN, GAS, PETROLEUM PRODUCTS, OR OTHER PIPELINES; ALL BURIED ELECTRIC POWER, COMMUNICATIONS, OR TELEVISION CABLES; ALL TRAFFIC SIGNAL AND STREET LIGHTING FACILITIES; AND ALL ROADWAY, STATE HIGHWAY, AND RAILROAD RIGHTS-OF-WAY, THE CONTRACTOR SHALL NOTIFY THE RESPECTIVE AUTHORITIES REPRESENTING THE OWNERS OR AGENCIES RESPONSIBLE FOR SUCH FACILITIES TO FACILITATE A TIMELY MANNER OF WORK SO THAT A REPRESENTATIVE OF SAID OWNERS OR AGENCIES CAN BE PRESENT DURING SUCH WORK IF THEY SO DESIRE. IN THE CASE OF THE UNDERGROUND UTILITY SERVICE ALERT CENTER, THIS NOTICE WILL GIVE THEM TIME TO MARK THE LOCATION OF THE UTILITIES. THE CONTRACTOR SHALL ALSO NOTIFY UNDERGROUND SERVICES ALERT (USA) AT (811) IN ACCORDANCE WITH THE SPECIFICATIONS TO FACILITATE A TIMELY MANNER OF WORK, PRIOR TO SUCH EXCAVATION.

#### SUE QUALITY LEVEL

1. EXISTING SUBSURFACE UTILITIES SHOWN ON THESE PLANS ARE LOCATED TO ASCE 38 QUALITY LEVEL B STANDARDS, UNLESS NOTED OTHERWISE.
2. SUBSURFACE, GAS, ELECTRIC, WATER, STORM SEWER, AND FIBER OPTIC MAINLINE CROSSINGS OF THE PROPOSED SANITARY PIPE WERE LOCATED TO ASCE QUALITY LEVEL A STANDARDS. SANITARY SEWER LINE DEPTHS ARE DERIVED FROM SURVEYED INVERT INFORMATION PROVIDED BY THE OWNER SHOWING A LINEAR PIPE SLOPE FROM INVERT TO INVERT. POT HOLE INFORMATION FOR EXISTING UTILITIES AND CROSSINGS IS PROVIDED ON SHEET C-357. ALL OTHER EXISTING SUBSURFACE UTILITIES SHOWN ON THESE PLANS ARE LOCATED TO ASCE 38 QUALITY LEVEL B STANDARDS. INDIVIDUAL SERVICE LINES FOR SUBSURFACE UTILITIES ARE LOCATED TO QUALITY LEVEL B, EXCEPT THOSE SERVICES AS IDENTIFIED ON SHEET C-357.
3. ALL SANITARY AND STORM INFORMATION FOR INSTANCES NOT CROSSING THE PROPOSED SANITARY PIPE IS QUALITY LEVEL C.
4. THE CONTRACTOR SHALL REQUEST LOCATE INFORMATION FOR THE PROJECT PRIOR TO ANY EXCAVATION. KENNEDY/JENKS DOES NOT GUARANTEE THE LOCATIONS OF THE UTILITIES SHOWN OR THAT THE UTILITIES SHOWN INCLUDE ALL UTILITIES IN THE AREA. RELIANCE UPON THESE DATA DOES NOT RELIEVE THE CONTRACTOR FROM FOLLOWING ALL THE APPLICABLE UTILITY DAMAGE PREVENTION STATUTES, POLICIES, AND/OR PROCEDURES DURING EXCAVATION. IT IS IMPORTANT THAT THE CONTRACTOR INVESTIGATES AND UNDERSTANDS THE SCOPE OF WORK BETWEEN THE PROJECT OWNER AND THEIR ENGINEER REGARDING THE SCOPE AND LIMITS OF THE UTILITY INVESTIGATIONS LEADING TO THESE UTILITY DEPICTIONS. CONTRACTOR SHALL MEET ALL REQUIREMENTS OF COLORADO SENATE BILL 18-167 AS PART OF THIS PROJECT.

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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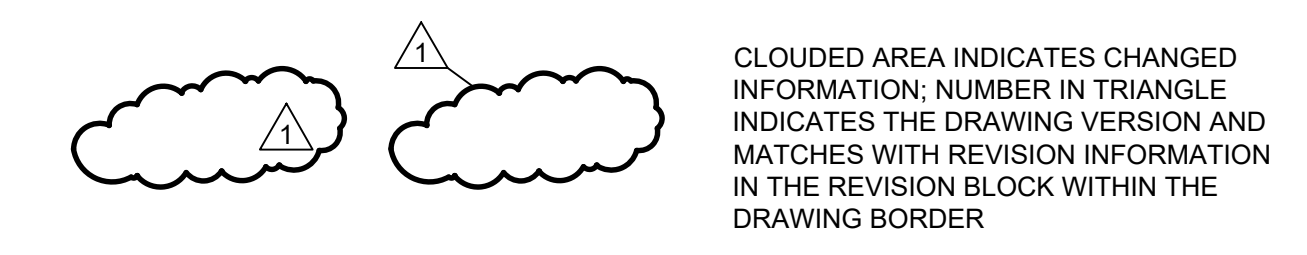
### NOTES (CONTINUED)

**QUALITY LEVEL - A:**  
(3D INFORMATION) USE OF APPROPRIATE NONDESTRUCTIVE DIGGING EQUIPMENT AT DISCREET, CRITICAL POINTS TO DETERMINE THE PRECISE HORIZONTAL AND VERTICAL POSITION OF UNDERGROUND UTILITIES, AS WELL AS THE TYPE, SIZE, CONDITION, MATERIAL, AND OTHER CHARACTERISTICS. QLA IS THE HIGHEST QUALITY LEVEL PRESENTLY AVAILABLE.

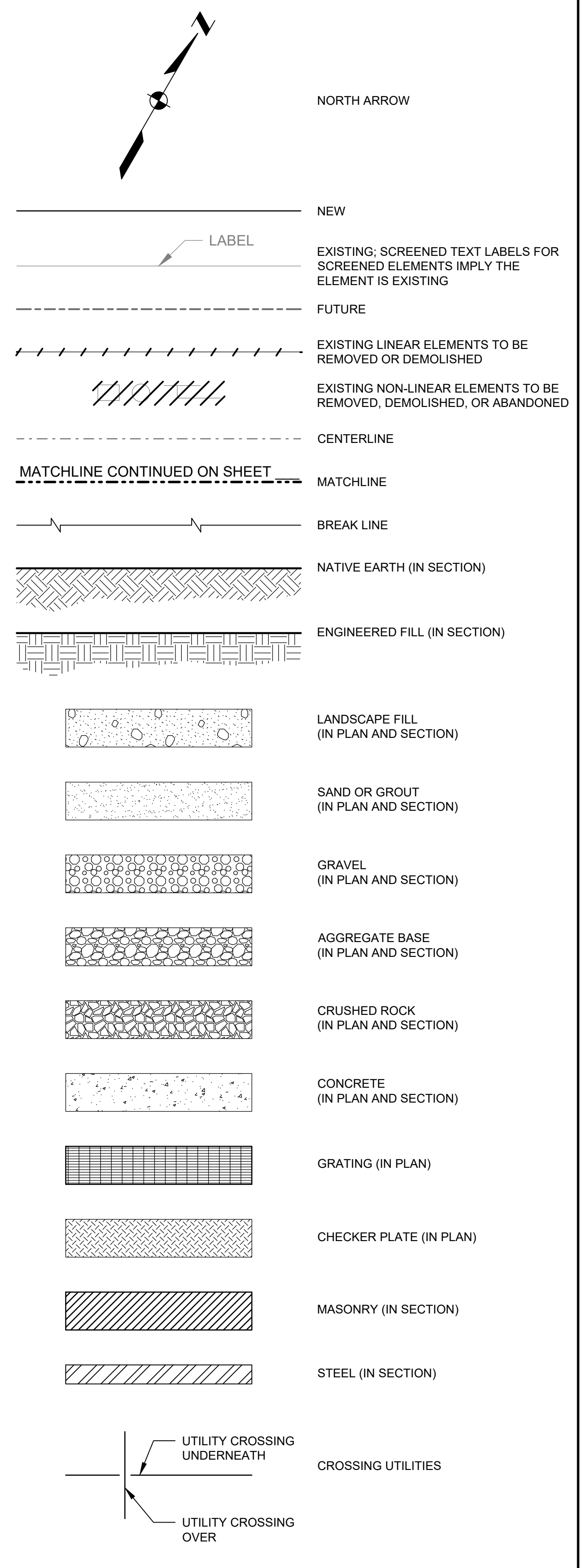
**QUALITY LEVEL - B:**  
(2D INFORMATION) USE OF APPROPRIATE GEOPHYSICAL METHODS TO DETERMINE THE EXISTENCE AND HORIZONTAL POSITION OF VIRTUALLY ALL SUBSURFACE UTILITIES.  
1) UTILITY QUALITY LEVEL B (QLB) IS VALUE ASSIGNED TO A UTILITY SEGMENT OR SUBSURFACE UTILITY FEATURE WHOSE EXISTENCE AND POSITION ARE BASED UPON GEOPHYSICAL METHODS COMBINED WITH PROFESSIONAL JUDGEMENT AND WHOSE LOCATION IS TIED TO THE PROJECT SURVEY DATUM. QLB IS MORE UNCERTAIN THAN QLA, AND LESS UNCERTAIN THAN QLC OR QLD.  
2) APPROXIMATE HORIZONTAL LOCATION OF UTILITY.

**QUALITY LEVEL - C:**  
SURVEYING VISIBLE ABOVE GROUND UTILITY FACILITIES.

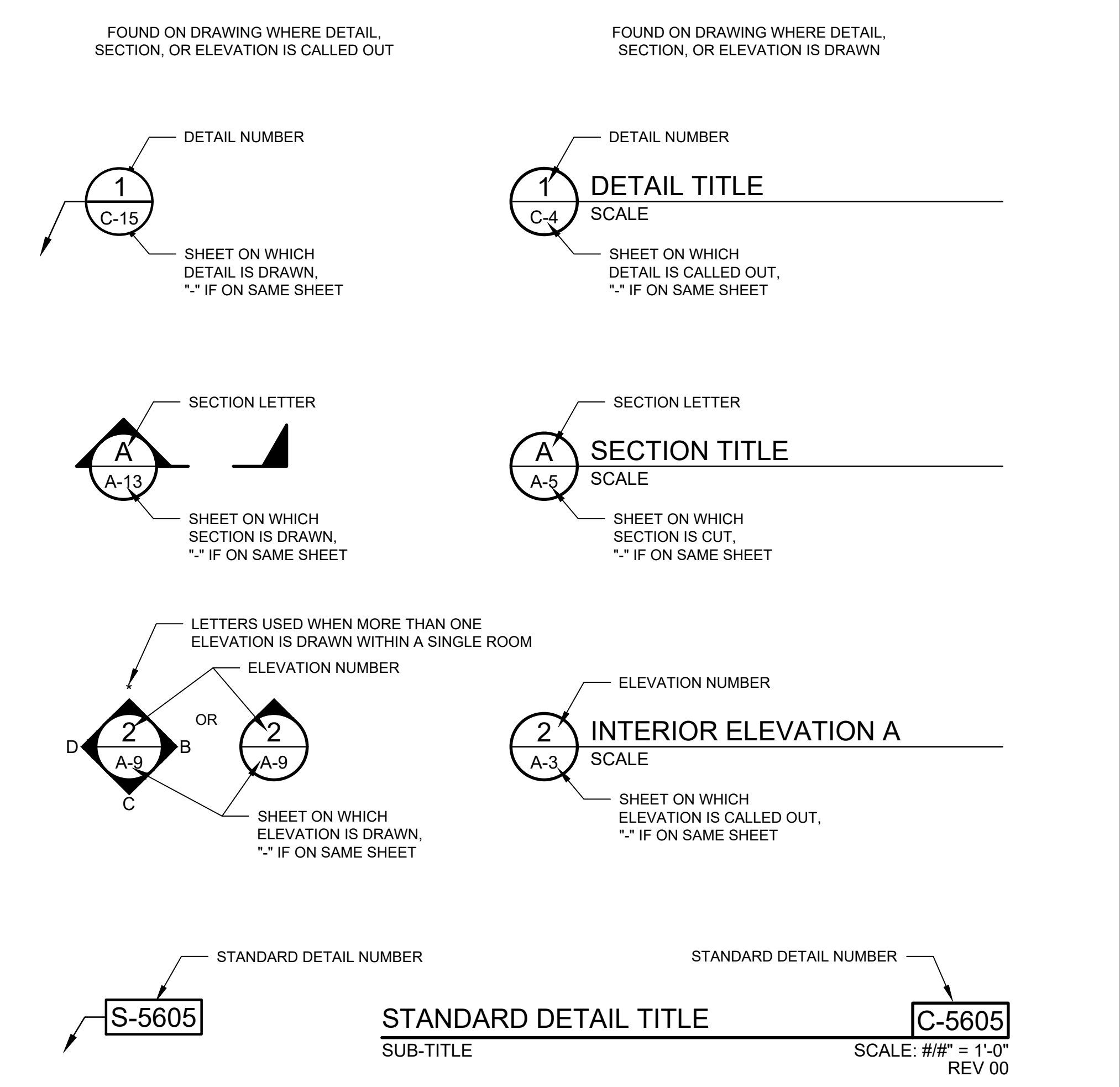
### REVISION SYMBOLS



### SYMBOLLOGY



### CROSS-REFERENCING SYMBOLS



DESIGNED	TS
DRAWN	WAS
CHECKED	LS

**CITY OF ARVADA**

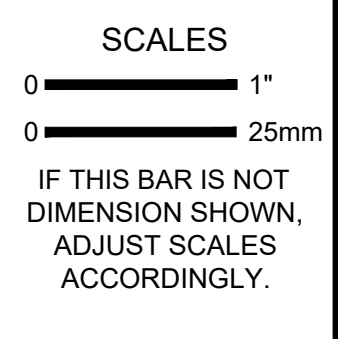
**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**GENERAL NOTES AND LEGEND**

SCALE	NTS
JOB NO	2246059*00
DATE	JAN 2024
SHEET	2 OF 52

**G-002**

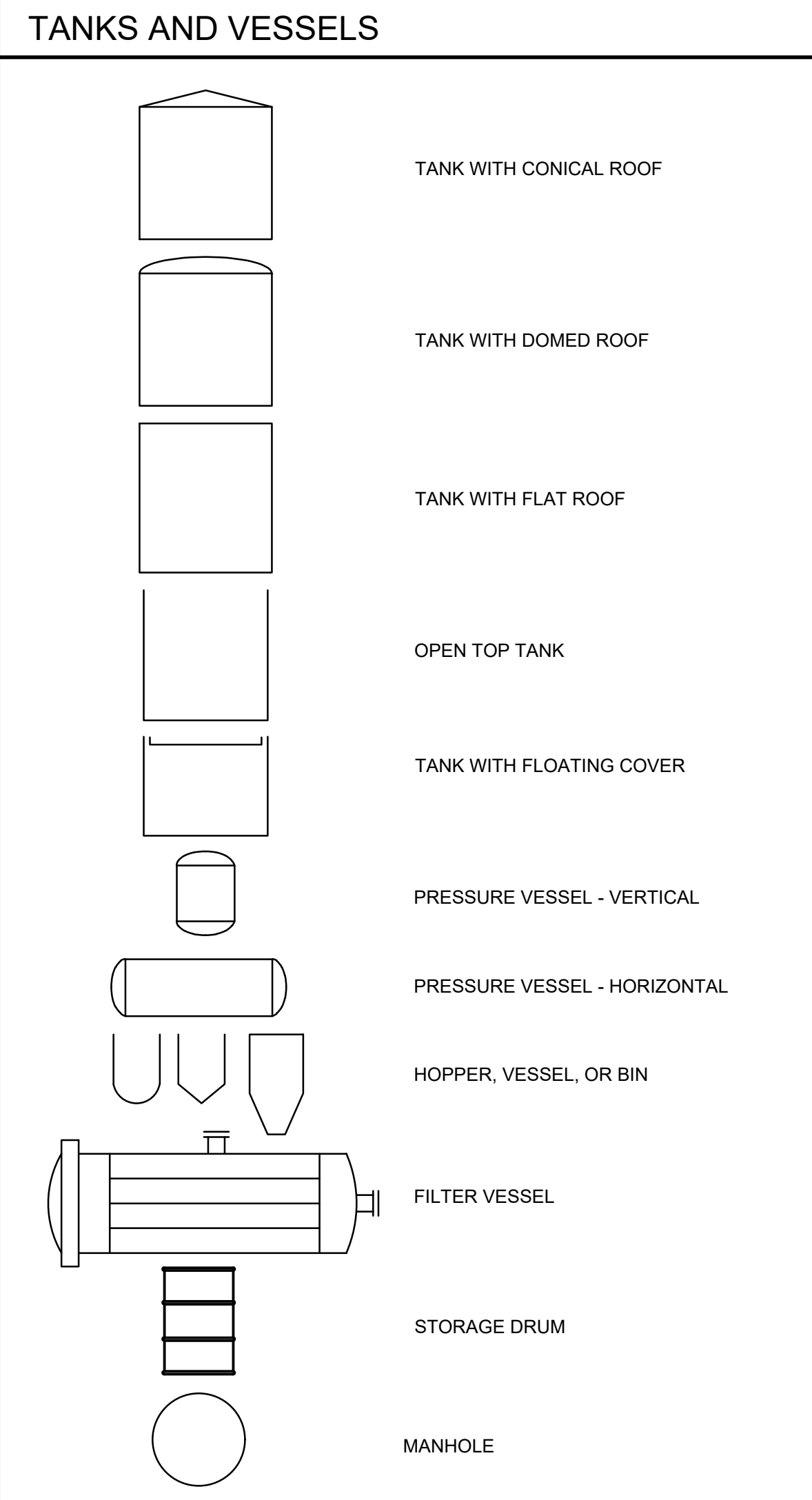
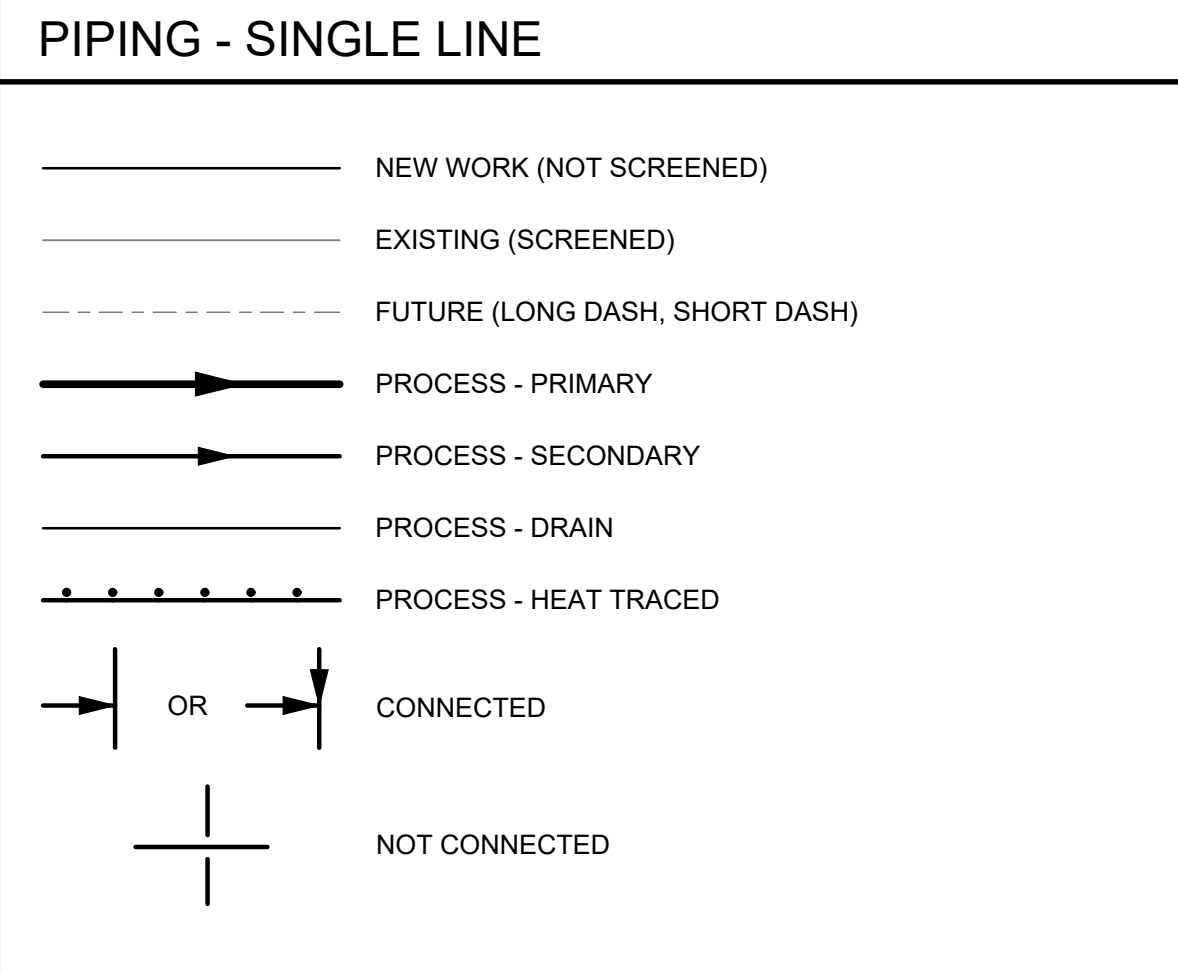




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User: BRYANT BEHNKE

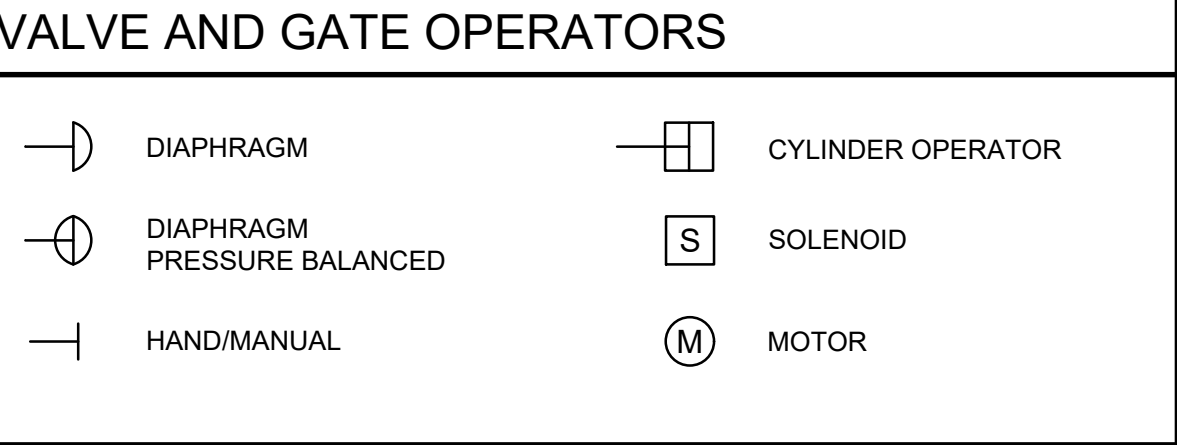
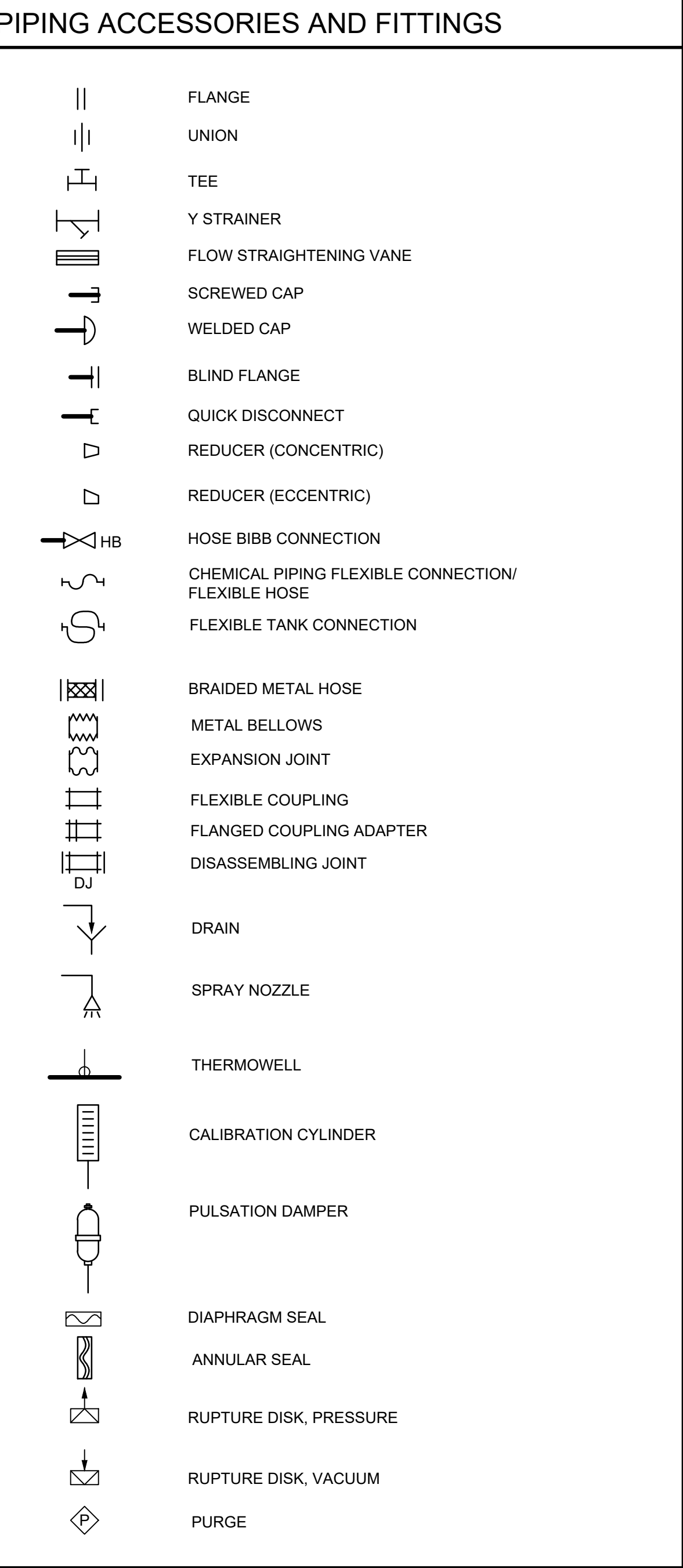
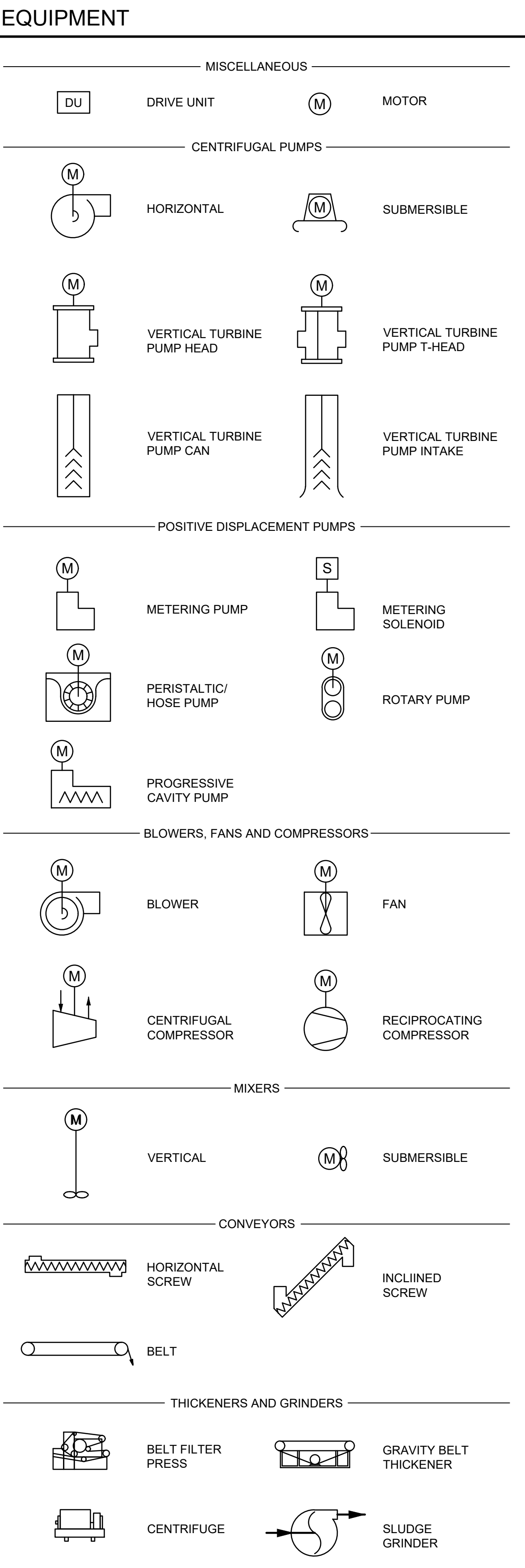
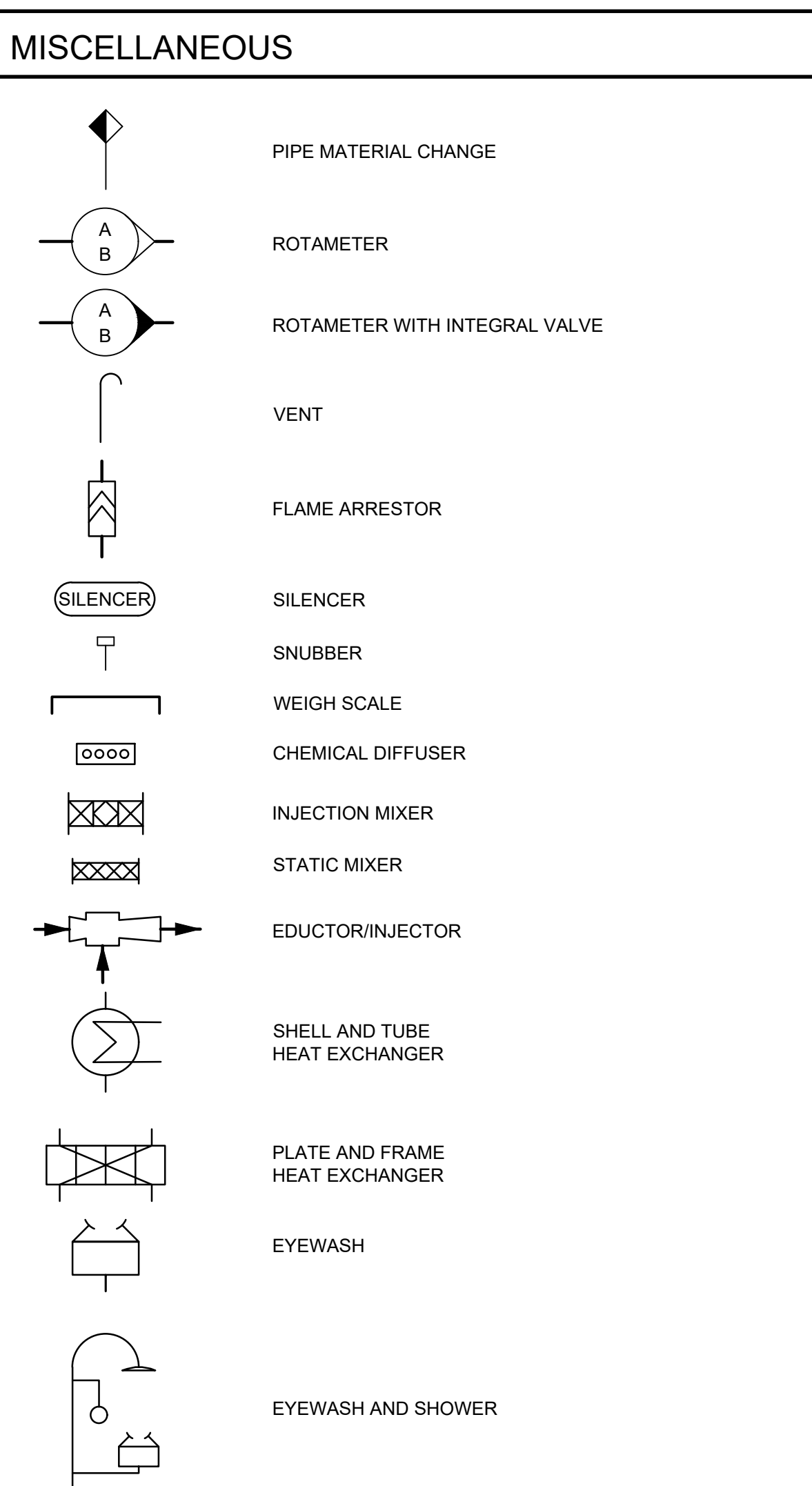
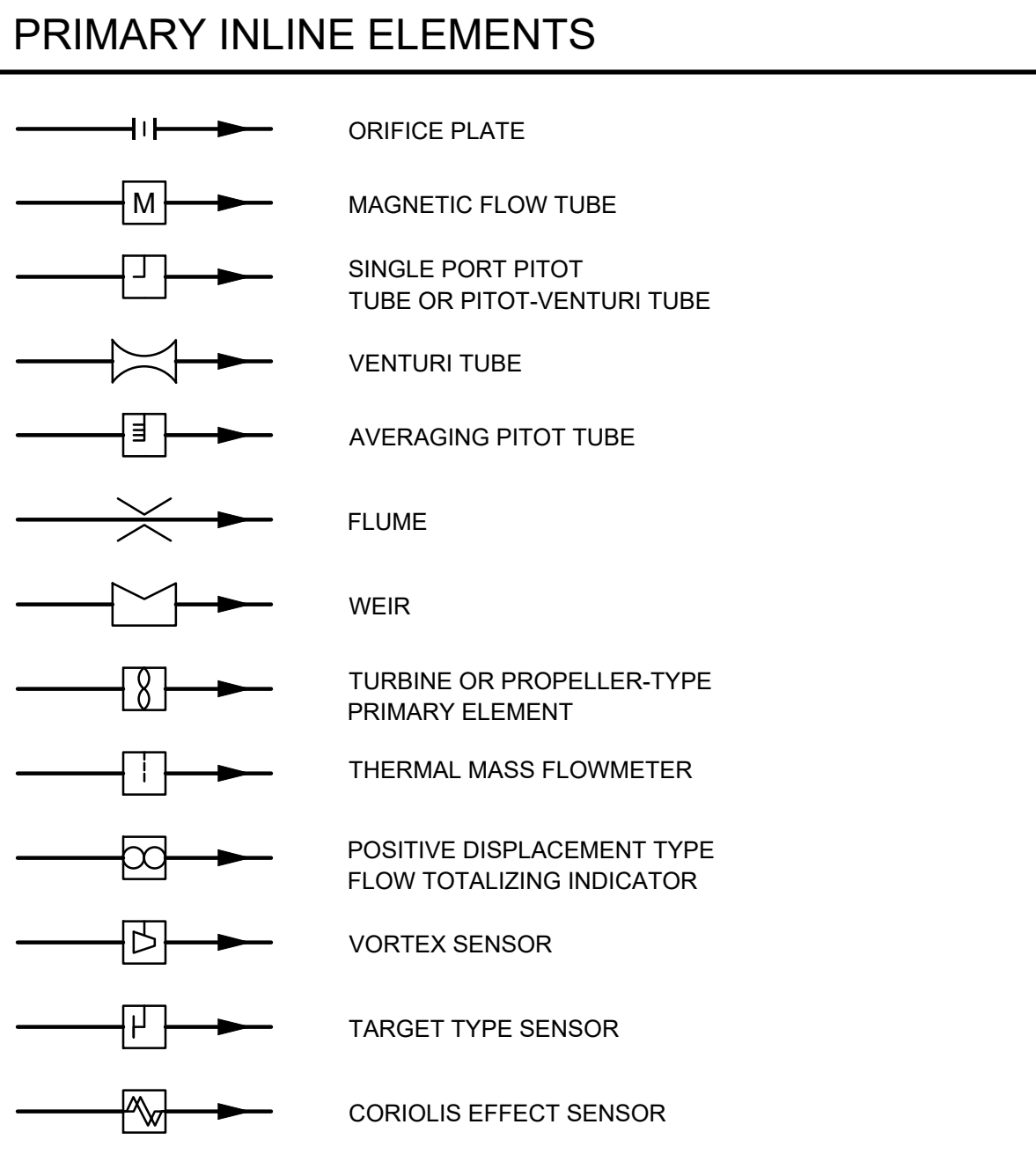
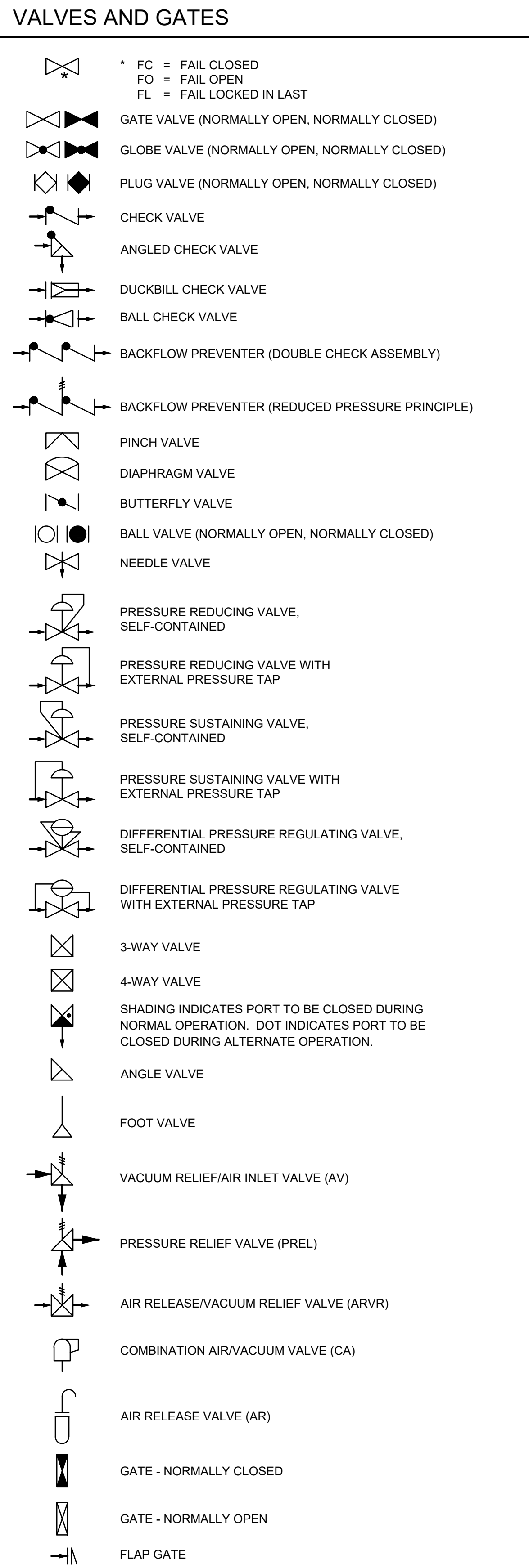
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**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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### NOTES

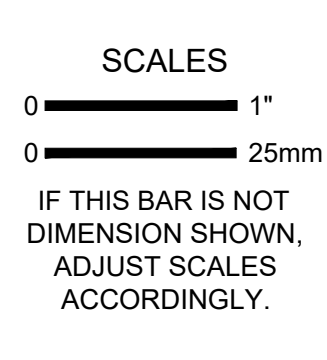
- SEE THE PRECEDING DRAWING FOR EQUIPMENT DESIGNATIONS AND PROCESS IDENTIFICATION CODES.
- THIS IS A GENERALIZED LEGEND SHEET. SEE ALSO ISA S5.1, S5.3 AND S7.3.

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NO	REVISION	DATE	BY



DESIGNED	TS
DRAWN	CLL
CHECKED	LS

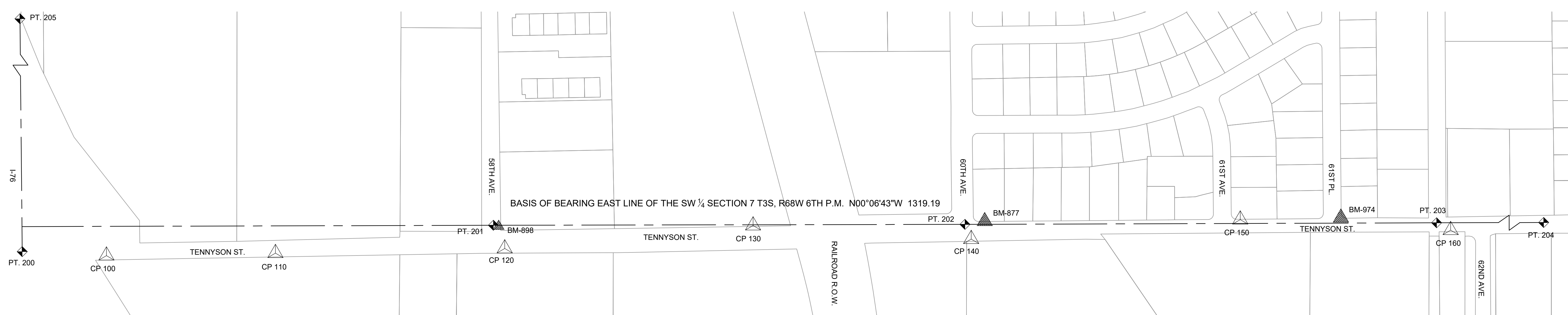
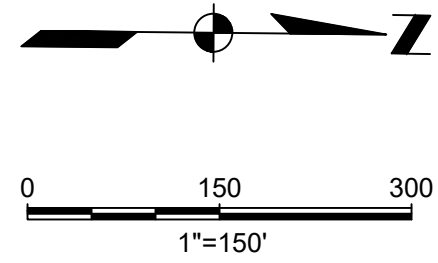
**CITY OF ARVADA**  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**GENERAL PROCESS SYMBOLS**

SCALE	NTS
JOB NO	2246059*00
DATE	JAN 2024
SHEET	3 OF 52
	G-003



# NORTH TRUNK SEWER IMPROVEMENTS TENNYSON STREET SURVEY CONTROL DIAGRAM 61ST PL. TO HIGHWAY 76



PROJECT BENCHMARK INFORMATION

PT#	COLORADO CENTRAL STATE PLANE NAD83 COORDINATES		ELEVATION NAVD88	PROJECT COORDINATES		ELEVATION CITY OF ARVADA	DESCRIPTION
	NORTHING	EASTING		NORTHING	EASTING		
BM-877	1718690.601	3128077.474	5248.35	719098.501	128819.867	5245.90	2" BRASS CAP TBC 4.4' NORTH OF 5' TYPE R INLET AT THE NRP OF THE NW CORNER 60TH AVE. & TENNYSON ST.

PROJECT COORDINATE TABLE

PT#	COLORADO CENTRAL STATE PLANE NAD83 COORDINATES		ELEVATION NAVD88	PROJECT COORDINATES		ELEVATION CITY OF ARVADA	DESCRIPTION OF MONUMENT
	NORTHING	EASTING		NORTHING	EASTING		
100	1716235.485	3128174.019	5242.33	716642.802	128916.435	5239.93	SET 18" #5 REBAR WITH A 2 1/2" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 100, 10' BELOW GRAVEL SHOULDER SURFACE
110	1716707.689	3128166.503	5242.42	717115.118	128908.916	5240.07	SET 18" #5 REBAR WITH A 2 1/2" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 110, FLUSH WITH GROUND
120	1717348.954	3128153.540	5243.76	717756.535	128895.951	5241.40	SET 18" #5 REBAR WITH A 2 1/2" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 120, FLUSH WITH GROUND
130	1718043.519	3128089.233	5246.66	718451.266	128831.628	5244.10	SET 18" #5 REBAR WITH A 2 1/2" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 130, FLUSH WITH GROUND
140	1718653.577	3128127.307	5248.86	719061.468	128869.711	5246.50	SET 18" #5 REBAR WITH A 2 1/2" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 140, FLUSH WITH GROUND
150	1719406.089	3128072.783	5269.56	719814.159	128815.174	5267.09	FOUND CHISELED TRIANGLE WITH PUNCH MARK ON 5' TYPE R INLET AT NW CORNER 61ST AVE. & TENNYSON ST.
160	1719994.598	3128102.218	5278.84	720402.808	128844.617	5276.41	SET 18" #5 REBAR WITH A 2 1/2" ALUM. CAP STAMPED: CITY OF ARVADA, DO NOT DISTURB 160, FLUSH WITH GROUND
200	1715999.301	3128162.299		716406.563	128904.713		70" W.C. EAST OF THE S 1/4 SEC. 7 FOUND A 3 1/4" CAP IN RANGE BOX ILLEGIBLE
201	1717317.224	3128088.588		717724.799	128830.985		C-S 1/8 SEC. 7 FOUND A 2 1/2" ALUM. CAP IN RANGE BOX STAMPED: S 7 C-S 1/8 2005 LS 16837
202	1718636.102	3128086.014		719043.989	128828.409		C 1/4 SEC. 7 3 1/4" ALUM. CAP ON 2" STEEL PIPE IN RANGE BOX STAMPED: ERNEST KNIGHT LS 7276 T3S, R68W S7 C 1/4 1988 ADAMS COUNTY
203	1719955.381	3128081.771		720363.582	128824.166		C-N 1/8 SEC. 7 3 1/4" ALUM. CAP ON #6 REBAR IN RANGE BOX STAMPED: GREENHORNE & OMARA N 1/8 S7 1986 PLS 20696
204	1721275.134	3128077.632		721683.648 C.O.A. CALC.	128820.025 C.O.A. CALC.		N 1/4 SEC. 7 1" AXLE 1.2' BELOW ASPHALT SURFACE IN RANGE BOX @ 64TH & TENNYSON ST.
205	1715973.927	3125529.897		716381.183 C.O.A. CALC.	126271.685 C.O.A. CALC.		SW CORNER SEC. 7 3 1/4" ALUM. CAP IN CONCRETE ON BRIDGE IN RANGE BOX STAMPED: LANE ENG. SRV INC T3S R69W R68W 13-7 2006 LS 16837 @ 56TH & SHERIDAN BLVD.

**GENERAL NOTES:**

1. THIS PROJECT CONTROL DIAGRAM IS FOR THE EXCLUSIVE USE OF THE CITY OF ARVADA, FOR THE DESIGN AND CONSTRUCTION OF THE TENNYSON AND 58TH NORTH TRUNK SEWER PROJECT. IT IS NOT A MONUMENTED LAND SURVEY OR LAND SURVEY PLAT. IT IS INTENDED ONLY TO DEPICT THE CONTROL INFORMATION AND MONUMENTATION SHOWN HEREON, AND IS SUBJECT TO CHANGE. CONTACT THE CITY OF ARVADA FOR THE MOST RECENT DIAGRAM.
2. PUBLISHED UNITS FOR COORDINATES AND ELEVATIONS ARE IN US SURVEY FEET.
3. SURVEY CONTROL DIAGRAM WAS PROVIDED BY THE CITY OF ARVADA DATED SEPTEMBER 22ND, 2022.
4. DESIGN SURVEY WAS PERFORMED BY THE CITY OF ARVADA DATED AUGUST 21ST, 2023.
5. CONTRACTOR SHALL PROTECT IN PLACE THE ALIQUOT SECTION CORNER MONUMENTS WITHIN THE AREA OF WORK. IF MONUMENTS ARE TO BE DISTURBED DURING CONSTRUCTION, THEY SHALL BE REFERENCED IN PLACE PRIOR TO DISTURBANCE AND REESTABLISHED IN PLACE AFTER CONSTRUCTION COMMENCES BY A PLS REGISTERED IN THE STATE OF COLORADO.

**BASIS OF BEARINGS:**

ASSUMES THE LINE BETWEEN POINT 201 AND POINT 202 BEARS N 00° 06' 43" W A DISTANCE OF 1313.19 FEET. POINT 201 IS THE S 1/8 AT 58TH AND TENNYSON ST. AND 202 IS THE C 1/4 AT 60TH AND TENNYSON

**BASIS OF ELEVATIONS:**

THE VERTICAL CONTROL IS BASED ON EXCLUSIVE CITY OF ARVADA DATUM AND IS NOT RELATED TO NGVD29 OR NAVD88. A LEVEL LOOP WAS RAN THROUGH EACH CONTROL POINT FROM BM-877 USING A LEICA DNA 10 (DIGITAL LEVEL) FROM BENCHMARK #877 WHICH IS A 2" BRASS CAP AT TBC 4.4' NORTH OF 5' TYPE R INLET AT THE NRP OF THE NW CORNER OF 60TH AND TENNYSON ST.

**COORDINATE DATUM:**

STATE PLANE COORDINATES ARE COLORADO CENTRAL ZONE (0502) NAD83 GEOID 18 BASED ON FAST STATIC GPS SURVEY. PROJECT COORDINATES ARE MODIFIED COLORADO STATE PLANE CENTRAL ZONE COORDINATES. PROJECT COORDINATES ARE DERIVED FROM STATE PLANE COORDINATES USING THE FOLLOWING FORMULAS.

PROJECT NORTHING = (STATE PLANE NORTHING \* 1.000237332) - 1000000.00  
PROJECT EASTING = (STATE PLANE EASTING \* 1.000237332) - 3000000.00

**CONVERSION OF PROJECT COORDINATES TO COLORADO STATE PLANE CENTRAL ZONE:**

ADD 1,000,000 FEET TO THE PROJECT NORTHING AND 3,000,000 FEET TO PROJECT EASTING AND MULTIPLY EACH BY THE COMBINED SCALE FACTOR OF 0.999762724.

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

**LEGEND:**

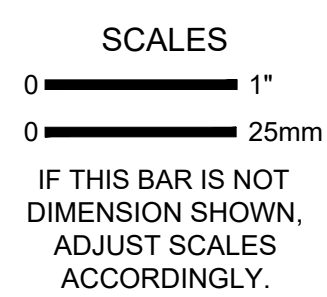
- = SECTION, QUARTER & SIXTEENTH CORNERS
- = CONTROL POINT SET BY THE CITY OF ARVADA
- = CITY OF ARVADA BENCHMARK

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

JAN 2024 - INTERIM 100%

NOT FOR CONSTRUCTION  
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NO	REVISION	DATE	BY



DESIGNED  
TS  
DRAWN  
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CHECKED  
LS

NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

SURVEY CONTROL DIAGRAM

SCALE  
1" = 150'  
JOB NO  
2246059\*00  
DATE  
JAN 2024  
SHEET 4 OF 52  
G-004

p:\k\ce-pw\Documents\Clients\Arvada, City of CO\Projects\North Trunk Sewer Improvements\_2246059\0010-Design\10.06-Drawings\General\2246059\_00-G-005



Plot Date: 1/23/2024 9:23 AM

User: BRYANT BEHNKE

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CIVIL NOTES

- GENERAL
1. OBTAIN PERMITS NECESSARY TO COMPLETE FEATURES WITHIN EASEMENTS, DEDICATIONS, AND PUBLIC RIGHT-OF-WAY.
2. COORDINATES ARE PROVIDED AS FOLLOWS UNLESS OTHERWISE NOTED ON DRAWINGS:
2.1. FACE OF WALL
2.2. FACE OF CURB
2.3. CORNER OF EQUIPMENT PADS AND VAULTS
3. ORIENT SURFACE FEATURES PARALLEL TO CURB/GUTTER OR WALLS UNLESS OTHERWISE NOTED.
4. PROTECT ALL SURVEY MONUMENTS.
5. SHOULD THE CONTRACTOR DISCOVER ANY DISCREPANCIES BETWEEN THE CONDITIONS EXISTING IN THE FIELD AND THE INFORMATION SHOWN ON THESE DRAWINGS, CONTRACTOR SHALL NOTIFY THE OWNER AND ENGINEER PRIOR TO PROCEEDING WITH CONSTRUCTION.
6. THE CONTRACTOR SHALL MAINTAIN A COPY OF AN APPROVED SET OF PLANS ON THE CONSTRUCTION SITE AT ALL TIMES.
7. "LIMITS OF EXCAVATION" INDICATES THE MINIMUM MATERIAL REMOVAL REQUIRED DUE TO GEOTECHNICAL RECOMMENDATIONS AND THE NATURE OF THE WORK. TAKE CARE NOT TO EXCAVATE BEYOND THE LIMITS INDICATED IN THE CONTRACT DOCUMENTS.
8. "LIMITS OF WORK" INDICATES THE TOTAL AREA OF DISTURBANCE DUE TO THE NATURE AND SCOPE OF THE WORK. THE TERM MAY ALSO BE USED TO INDICATE AREAS WHERE ACCESS IS LIMITED OR RESTRICTED.
9. PROVIDE TEMPORARY TRAFFIC SIGNAGE IN ACCORDANCE WITH STATE AND LOCAL AGENCIES DURING THE COURSE OF CONSTRUCTION.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ALL TRAFFIC CONTROL WITHIN THE PUBLIC RIGHT OF WAY IN ACCORDANCE WITH LOCAL ORDINANCES. NO WORK SHALL COMMENCE UNTIL ALL REQUIRED TRAFFIC CONTROL MEASURES ARE IN PLACE.
11. FOR WORK ASSOCIATED WITH METRO WATER RECOVERY: METRO MAY REQUIRE PRE- AND POST-VIDEO INSPECTIONS OF THE EXISTING METRO TRANSMISSION MAINLINE DURING CONSTRUCTION TO ENSURE NO DAMAGE IS DONE TO THE EXISTING SANITARY LINE. COORDINATE WITH THE METRO FIELD INSPECTOR FOR REQUIREMENTS.
a. NOTIFY TYLER HOPKINS 2-WEEKS PRIOR TO CONSTRUCTION STARTING AT THOPKINS@METROWATERRECOVERY.COM AND (225) 202-7163.
b. NOTIFY AND INVITE METRO TO THE PRECONSTRUCTION MEETING AT THOPKINS@METROWATERRECOVERY.COM AND (225) 202-7163.
12. ALL PROPOSED WORK FROM SSMH 4-8 SOUTH TO THE SOUTHERN MOST EXTENTS OF CONSTRUCTION LIMITS ARE LOCATED WITHIN THE 100-YEAR FLOODPLAIN AND/OR FLOODWAY. THE CONTRACTOR IS RESPONSIBLE FOR COORDINATING ALL NECESSARY PERMITS FOR WORK WITHIN THE ADAMS COUNTY AND CITY OF ARVADA RIGHT OF WAY INCLUDING ANY NECESSARY PERMITS REQUIRED RELATED TO WORK WITHIN THE FLOODPLAIN AND/OR FLOODWAY.

- GRADING
1. ADJUST VALVE BOXES, PULL BOXES, VAULTS, AND MAINTENANCE HOLES TO FINISHED GRADES AND SLOPES SHOWN ON CIVIL GRADING DRAWINGS UNLESS OTHERWISE SHOWN OR SPECIFIED. MAINTENANCE HOLES IN OPEN FIELDS SHALL BE SET ONE FOOT ABOVE GRADE. APPROXIMATE RIM ELEVATIONS ARE SHOWN ON DRAWINGS.
2. GRADES SHOWN ARE TO TOP OF THE FINISHED SURFACE UNLESS OTHERWISE NOTED.

- DEMOLITION
1. DEMOLITION EXTENTS INDICATED IN DRAWINGS ARE THE MINIMUM REQUIRED TO COMPLETE THE WORK. CONTRACTOR SHALL DETERMINE FULL DEMOLITION EXTENTS DURING FIELD RECONNAISSANCE PRIOR TO CONSTRUCTION.
2. PROVIDE COORDINATES OF ABANDONED UTILITIES IN THE RECORD DRAWINGS.
3. EXISTING METERING VAULT SHALL BE REMOVED. REMOVE VAULT BASE AS NEEDED TO PERFORM THE PIPELINE BEDDING, TRENCHING, AND BACKFILLING REQUIREMENTS OUTLINED IN THE PROJECT SPECIFICATIONS. BACKFILL REMAINING AREAS TO GRADE.

APPROVED
City of Arvada, Colorado
CITY ENGINEER DATE JOB NUMBER
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JAN 2024 - INTERIM 100%
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- PIPING
1. THESE NOTES ARE GENERIC IN NATURE. PROJECT SPECIFIC NOTES ON FOLLOWING DRAWINGS TAKE PRECEDENCE.
2. THE CONTRACTOR SHALL COMPLY WITH THE STATE DEPARTMENT OF HEALTH SERVICES CRITERIA FOR THE SEPARATION BETWEEN WATER MAINS, NON-POTABLE WATER UTILITIES, AND SEWER.
3. INSTALL WATER, STORM, AND SEWER PIPELINES WITH A MINIMUM OF 48 INCHES OF COVER, UNLESS OTHERWISE NOTED OR SHOWN ON THE DRAWINGS.
4. PRIOR TO SUBMITTAL OF PIPE SHOP DRAWINGS, VERIFY THE INVERT ELEVATIONS, ALIGNMENT, OUTSIDE DIAMETER, LOCATION, AND MATERIAL OF ALL EXISTING PIPELINES TO WHICH NEW PIPELINES WILL BE CONNECTED.
5. PIPE STATIONING REPRESENTS THE HORIZONTAL PROJECTION OF THE PIPE CENTERLINE BETWEEN MAINTENANCE HOLES, POINTS OF INFLECTION, AND/OR CENTER OF FITTINGS.
6. RESTRAIN ALL WATER PIPE AND FITTINGS AT UTILITY CROSSINGS PER CITY OF ARVADA LENGTH OF RESTRAINED PIPE DETAIL.
7. LOCATION OF EXISTING UTILITIES ARE APPROXIMATE. CONTRACTOR SHALL EXPOSE EXISTING PIPE(S) OR STRUCTURE(S) TO WHICH NEW PIPE(S) IS/ARE CONNECTING. VERIFY EXACT LOCATION, SIZE, MATERIALS, AND INVERT ELEVATIONS PRIOR TO SUBMITTING PIPE DRAWINGS.
8. PROTECT EXISTING UTILITIES UNLESS OTHERWISE NOTED.
9. USE CAUTION WHEN WORKING IN PROXIMITY TO GAS. NOTIFY UTILITY COMPANY WHEN WORKING WITHIN THE VICINITY, AND FOLLOW UTILITY SAFETY GUIDELINES AND OSHA REQUIREMENTS.
10. USE CAUTION WHEN WORKING IN PROXIMITY TO OVERHEAD ELECTRICAL LINES. FOLLOW ELECTRICAL UTILITY SAFETY GUIDELINES AND OSHA REQUIREMENTS.
11. CROSSING PIPELINES SHOWN IN PROFILE REPRESENT OUTSIDE DIAMETER UNLESS OTHERWISE NOTED.
12. ORIENT ECCENTRIC MAINTENANCE HOLE(S) SUCH THAT THE LID IS OUTSIDE OF WHEEL PATH.
13. COORDINATES LOCATING MAINTENANCE HOLES ARE TO THE CENTER OF THE STRUCTURE.
14. SIZE OF FITTING SHOWN ON THE DRAWINGS CORRESPONDS TO THE ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE NOTED. MATCH TYPE OF JOINT AND FITTING MATERIAL TO ADJACENT STRAIGHT RUN OF PIPE, UNLESS OTHERWISE NOTED.
15. NUMBER AND LOCATION OF UNIONS SHOWN ON DRAWINGS ARE APPROXIMATE. PROVIDE UNIONS AS NECESSARY TO FACILITATE CONVENIENT REMOVAL OF VALVES AND MECHANICAL EQUIPMENT.
16. COORDINATE AND PERFORM CONNECTIONS TO THE WORK OF OTHER CONTRACTORS, IF APPLICABLE.
17. MINIMUM HORIZONTAL CLEARANCE FOR UTILITIES IS 10 FEET FROM EDGE OF SANITARY SEWER PIPE. MINIMUM VERTICAL CLEARANCE FOR UTILITIES IS 18 INCHES FROM EDGE OF SANITARY SEWER PIPE. IF MINIMUM HORIZONTAL AND VERTICAL UTILITY CLEARANCES CANNOT BE MET DUE TO FIELD CONDITIONS, SANITARY PIPING DESIGN CONSISTS OF PRESSURE RATED MATERIALS WITH LEAK TIGHT JOINTS. CONTRACTOR SHALL WORK WITH UTILITY OWNERS TO ACCOMMODATE REQUIRED CLEARANCES WHEN POSSIBLE.
18. WHEN CROSSING UNDERNEATH POTABLE WATER WITH LESS THAN 18-INCHES OF CLEARANCE, THE CONTRACTOR SHALL NOTIFY THE ENGINEER. THE CONTRACTOR SHALL CROSS THE UTILITY WITH NO PIPE JOINTS WITHIN 9-FEET OF EITHER SIDE OF THE CROSSING.

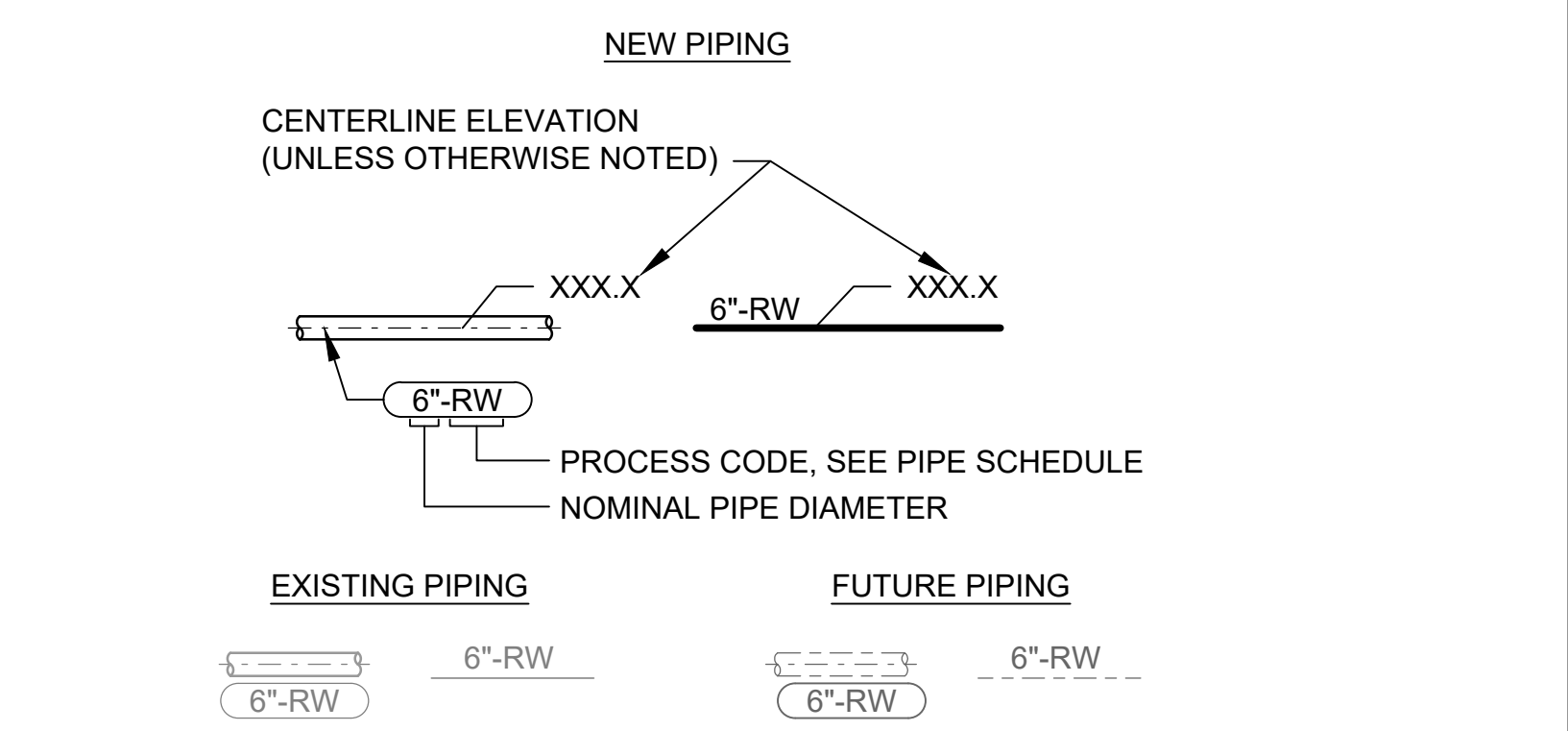
- WATER
1. WATER MAIN ABANDONMENT, CITY OF ARVADA: CITY OF ARVADA WATER MAINS TO BE ABANDONED MUST BE REMOVED AND DISPOSED OF OFF SITE.
2. MINIMUM BURY DEPTH FOR ALL WATERLINES IS 4-FEET DEEP TO TOP OF PIPE UNLESS OTHERWISE NOTED ON THE PLANS.
3. NEW WATER MAIN SHOULD BE TESTED IN SECTIONS AS TO MINIMIZE THE AMOUNT OF POTENTIAL DOWNTIME OF WATER SERVICE TO CUSTOMERS. CONTRACTOR SHALL NOTIFY CUSTOMER A MINIMUM 48 HOURS IN ADVANCE OF UPCOMING UTILITY DISRUPTIONS. FOR DOWNTIMES RESULTING IN 4 HOURS OR MORE, CONTRACTOR SHALL PROVIDE TEMPORARY WATER SERVICE TO CUSTOMERS.
4. CONTRACTOR SHALL COORDINATE WITH THE CITY OF ARVADA WATER DEPARTMENT BEFORE, AND DURING, THE WATERLINE REPLACEMENT WORK. COORDINATION WILL INCLUDE CONSTRUCTION SEQUENCING, WATER SERVICE DISRUPTIONS, INSTALLATION OF TEMPORARY BLOWOFFS, AND OPERATION OF EXISTING VALVES. CONTRACTOR IS NOT PERMITTED TO OPERATE EXISTING ARVADA WATER DEPARTMENT VALVES. VALVES WILL OPERATED BY ARVADA PERSONNEL ONLY.
5. A POTENTIAL WATERLINE CONSTRUCTION SEQUENCE IS PROVIDED ON SHEETS C-355 THROUGH C-357. THIS IS NOT A REQUIRED SEQUENCE AS THE CONTRACTOR IS RESPONSIBLE FOR DETERMINING THE MEANS AND METHODS OF WATERLINE CONSTRUCTION SEQUENCING IN THE FIELD TO MINIMIZE UTILITY DISRUPTIONS.
6. CITY RECORDS INDICATE AN ABANDONED 6" CI WATER LINE IS LOCATED IN THE VICINITY OF THE PROPOSED WATER MAIN ALONG TENNYSON STREET. CONTRACTOR SHALL REMOVE AND DISPOSE OF EXISTING WATER LINE IF ENCOUNTERED IN THE FIELD DURING CONSTRUCTION.
7. FOR WATERLINE RAISINGS AND LOWERINGS, CONTRACTOR SHALL WORK WITH THE UTILITY OWNER TO DETERMINE THE APPROPRIATE METHOD FOR MAINTAINING VERTICAL CLEARANCES AND ON WHETHER A PERMANENT BLOWOFF ASSEMBLY IS REQUIRED.

- SANITARY SEWER
1. ALL SANITARY SEWER SYSTEM PLANS AND CONSTRUCTION SHALL CONFORM TO THE CURRENT CITY OF ARVADA ENGINEERING STANDARDS AND SPECIFICATIONS AND SHALL BE SUBJECT TO CONSTRUCTION OBSERVATION BY CITY PERSONNEL OR REPRESENTATIVES. THE ENGINEER OR CONTRACTOR SHALL SCHEDULE A PRE-CONSTRUCTION MEETING WITH THE OWNER AT LEAST 48-HOURS PRIOR TO START OF CONSTRUCTION. NO CONSTRUCTION WILL BE PERMITTED UNTIL ALL EASEMENTS ARE SIGNED AND RECORDED, AS APPLICABLE, AND THE PRE-CONSTRUCTION MEETING HAS BEEN HELD.
2. PROBATIONARY ACCEPTANCE OF THE NEW SANITARY SEWER MAINS WILL NOT BE CONSIDERED UNTIL ALL REQUIREMENTS FOR ACCEPTANCE HAVE BEEN MET, INCLUDING:
a. SANITARY SEWER TRENCH COMPACTION TEST RESULTS
b. SANITARY SEWER PIPE LEAK TESTING RESULTS
c. CCTV FOOTAGE OF THE NEWLY INSTALLED PIPELINE
d. RECORD DRAWINGS
3. MAINTENANCE HOLE RIMS SHALL BE SET AT AN ELEVATION RELATIVE TO THE PAVEMENT, IN ACCORDANCE WITH THE APPROPRIATE CITY, COUNTY, OR STATE HIGHWAY DEPARTMENT STANDARDS. WHETHER OR NOT THE MAINTENANCE HOLE IS IN A PAVED OR UNPAVED AREA, A MINIMUM OF 4-INCHES OF CONCRETE RISER RINGS SHALL BE USED TO ADJUST RIM ELEVATIONS TO FINAL GRADE. THE MAXIMUM ACCEPTABLE VERTICAL ADJUSTMENT UTILIZING RISER RINGS IS 12-INCHES.
4. THE CONTRACTOR SHALL VERIFY EXISTING MAINTENANCE HOLE INVERTS AT PROPOSED POINTS OF CONNECTION, PRIOR TO CONSTRUCTION STAKING.
5. THE CONTRACTOR SHALL TAKE CARE TO PROPERLY SHAPE ALL MAINTENANCE HOLE INVERTS AND BENCHES IN ACCORDANCE WITH CITY ENGINEERING STANDARDS AND SPECIFICATIONS. MAINTENANCE HOLE INVERTS SHALL BE CONSTRUCTED WITH A SMOOTH TROWEL FINISH, AND BENCHES FINISHED WITH A LIGHT BROOM, NON-SKID FINISH.
6. THE OWNER, OWNER'S REPRESENTATIVE, AND/OR THE ENGINEER, IS NOT A GUARANTOR OF THE CONSTRUCTION CONTRACTORS' OBLIGATIONS AND PERFORMANCE OF CONTRACT.
7. OBSERVATIONS OF WORK IN PROGRESS AND ON-SITE VISITS ARE NOT TO BE CONSTRUED AS A GUARANTEE BY THE CITY OR ENGINEER OF THE CONTRACTORS' PERFORMANCE.
8. THE OWNER OR ENGINEER, IS NOT RESPONSIBLE FOR SAFETY IN, ON, OR ABOUT THE PROJECT SITE, NOR FOR COMPLIANCE BY THE APPROPRIATE PARTY OF ANY REGULATIONS RELATING THERETO.
9. THE OWNER OR ENGINEER, EXERCISES NO CONTROL OF THE SAFETY OR ADEQUACY OF ANY EQUIPMENT, BUILDING COMPONENTS, SCAFFOLDING, FORMS, OR ANY OTHER WORK AIDS USED IN OR ABOUT THE PROJECT, OR IN THE SUPERINTENDING OF THE SAME.
10. ALL NEW MAINS MUST BE JETTED PRIOR TO PROBATION AND AGAIN PRIOR TO FINAL CONVEYANCE AND ACCEPTANCE BY THE OWNER.
11. ALL NEW MAINS SHALL BE VIDEO-INSPECTED PRIOR TO PROBATION AND AGAIN PRIOR TO FINAL CONVEYANCE AND ACCEPTANCE BY THE OWNER.
12. THE INVERT ELEVATIONS OF ALL EXISTING PIPES WHERE CONNECTIONS ARE TO BE MADE MUST BE FIELD VERIFIED PRIOR TO CONSTRUCTION.
13. SANITARY SEWER ABANDONMENT, CITY OF ARVADA R/W: SANITARY SEWER MAINS MAY BE ABANDONED IN PLACE AND SHALL BE FILLED WITH CONCRETE OR FLOW FILL. WHERE A PIPE IS ABANDONED AT A MAINTENANCE HOLE, THE PIPE SHALL BE PLUGGED AT THE MAINTENANCE HOLE AND REMOVED FOR A MINIMUM OF 2-FEET. PRIOR TO FILLING WITH CONCRETE OR FLOW FILL, ANY PIPE TO BE ABANDONED IN PLACE SHALL BE FLUSHED WITH CLEAN WATER TO REMOVE DEBRIS. THE FLUSHING WATER SHALL BE PROPERLY CAPTURED AND TREATED AND NOT RELEASED TO THE STORM WATER SYSTEM OR NATURAL CHANNEL. FLUSHING WATER AND DEBRIS SHALL NOT BE DISCHARGED TO DOWNSTREAM SANITARY SEWER PIPING.
14. SANITARY SEWER ABANDONMENT, ADAMS COUNTY R/W: SANITARY SEWER MAINS TO BE ABANDONED WITHIN ADAMS COUNTY R/W MUST BE REMOVED AND DISPOSED OF OFF SITE.
15. MAINTENANCE HOLE ABANDONMENT: MAINTENANCE HOLES SHALL HAVE THE TOP CONE REMOVED AND THE REMAINING MAINTENANCE HOLE VOID SPACE SHALL BE FILLED WITH FLOWABLE FILL WITH COMPRESSIBLE STRENGTH OF LESS THAN 200 PSI SO THAT IT CAN BE EXCAVATED IN THE FUTURE AS NEEDED.
16. CONTRACTOR SHALL ROTATE ECCENTRIC MAINTENANCE HOLE RIMS AND COVERS TO AVOID DRAINAGE AREAS SUCH AS GUTTERS, SURFACE STORMWATER FLOWLINES, AND DRAINAGE PANS. ROTATE RIMS AND COVERS OUT OF THE LIKELY WHEEL PATH OF VEHICLES WITHIN THE RIGHT-OF-WAY. ROTATE RIMS AND COVERS SO THAT THEY ARE LOCATED OUTSIDE OF THE CURB AND SIDEWALK WHERE POSSIBLE.
17. ALL MAINTENANCE HOLE RIMS AND COVERS SOUTH OF AND INCLUDING SSMH 4-8 SHALL BE WATER TIGHT, SEE SECTION 02080 FOR REQUIREMENTS.
18. FOR CONNECTING PIPELINES LESS THAN OR EQUAL TO 30-INCHES IN DIAMETER, 5'-0" DIAMETER MAINTENANCE HOLES ARE REQUIRED. FOR CONNECTING PIPELINES GREATER THAN 30-INCHES IN DIAMETER, 6'-0" DIAMETER MAINTENANCE HOLES ARE REQUIRED.
19. 6'-0" DIAMETER MANHOLES SHALL BE INSTALLED WITH 30" RINGS AND COVERS. 5'-0" DIAMETER MANHOLES SHALL BE INSTALLED WITH 24" RINGS AND COVERS. SEE SECTION 02080 FOR DETAILS.
20. ALL MAINTENANCE HOLES SHALL INCLUDE EXTERNAL SEALING BANDS ON THE OUTSIDE OF THE STRUCTURE AT ALL JOINTS TO PREVENT GROUNDWATER INTRUSION. COAL TAR EPOXY COAT THE EXTERIOR OF THE MAINTENANCE HOLE. LINE THE INSIDE OF THE MAINTENANCE HOLE WITH AN H2S RESISTANT COATING. SEE SECTION 02080 FOR REQUIREMENTS.
21. ALL MAINTENANCE HOLES AND PIPING SOUTH OF THE METER VAULT SHALL BE DESIGNED AND CONSTRUCTED TO METRO WATER RECOVERY STANDARD DETAILS AND SPECIFICATIONS. THIS INCLUDES THE 30" BYPASS PIPING AROUND THE METER VAULT.
22. SANITARY SEWER OWNERSHIP TRANSITIONS FROM THE CITY OF ARVADA TO METRO DOWNSTREAM OF SSMH M-3. ALL SANITARY RELATED INFRASTRUCTURE DOWNSTREAM OF THIS LOCATION, INCLUDING BYPASS INFRASTRUCTURE AND ELECTRICAL INFRASTRUCTURE, WILL BECOME THE PROPERTY OF METRO ONCE CONSTRUCTION IS ACCEPTED BY METRO.

PIPE SCHEDULE

Table with 7 columns: LINE, SYSTEM, SIZE, SERVICE, FLOW, PIPE TYPE, SPECIFICATION. Rows include SS (Sanitary), SSFM (Sanitary Force Main), W (Water Main), W (Fire Hydrant Lateral), W (Water Service), and - (Casing Pipe).

PIPING DESIGNATIONS



ABBREVIATIONS

Table of abbreviations including FOOT, FEET, INCH, INCHES, POUND, NUMBER PERCENT, AND, AT, APPROXIMATELY, CENTERLINE, LESS THAN, EQUALS, GREATER THAN, GREATER THAN OR EQUAL TO, DEFLECTION, ANGLE, DEGREE(-S) (ANGULAR), AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS, ALUMINUM, APPROXIMATE(-LY), AMERICAN SOCIETY OF CIVIL ENGINEERS, AMERICAN SOCIETY FOR TESTING AND MATERIALS, AIR RELEASE/AIR VACUUM, BEST MANAGEMENT PRACTICE, CASING TEST STATION, CLOSED CIRCUIT TELEVISION, COLORADO DEPARTMENT OF TRANSPORTATION, COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT, CAST IRON, CAST IRON PIPE, CURED IN PLACE PIPE, CONTROL MEASURE, CURRENT SPAN TEST STATION, CORROSION TEST STATION, COPPER PIPE, CONCRETE WASHOUT AREA, DIAMETER, DUCTILE IRON PIPE, DID NOT FIND, EROSION CONTROL, EROSION AND SEDIMENT CONTROL PLAN, EASEMENT, ELECTROLYSIS TEST STATION, FIBER OPTIC CABLE, FOREIGN PIPELINE TEST STATION, FIBERGLASS REINFORCED PLASTIC FEET, GAS, HIGH DENSITY POLYETHYLENE, INSIDE DIAMETER, INSULATING JOINT TEST STATION, INVERT, LINEAR FEET, MAXIMUM, MINIMUM, MECHANICAL JOINT, MONITORING WELL, NORTH AMERICAN DATUM, NORTH AMERICAN VERTICAL DATUM, NATIONAL GEODETIC VERTICAL DATUM, OUTSIDE DIAMETER, OVERHEAD ELECTRICAL, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION, POLYETHYLENE, PROPERTY LINE, POTHOLE, POLYVINYL CHLORIDE, QUALITY LEVEL A, QUALITY LEVEL B, QUALITY LEVEL C, QUALITY LEVEL D, REMOVE AND REPLACE, RIGHT OF WAY, REINFORCED CONCRETE PIPE, STORM DRAIN, STORM DRAIN MAINTENANCE HOLE, SQUARE, SANITARY SEWER, STAINLESS STEEL, STABILIZED STAGING AREA, SANITARY SEWER MAINTENANCE HOLE STATION, SUBSURFACE UTILITY ENGINEERING, STEEL WELD, STORMWATER MANAGEMENT PLAN, TEST PIT, TYPICAL, VEHICLE TRACKING CONTROL.

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CITY OF ARVADA
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11
K Kennedy Jenks
SCALE NTS
JOB NO 2246059\*00
DATE JAN 2024
SHEET 5 OF 52
C-001



Plot Date: 1/23/2024 9:23 AM

User: BRYANT BEHNKE

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GEOTECHNICAL SYMBOLS	
	POT HOLE LOCATION
	TEST PIT LOCATION
	MONITORING WELL
	UTILITY MONITORING POINT

CORROSION CONTROL SYMBOLS	
	ELECTROLYSIS TEST STATION
	CATHODIC TEST STATION
	CORROSION TEST STATION
	CASING TEST STATION
	INSULATING JOINT TEST STATION
	FOREIGN PIPELINE TEST STATION
	CURRENT SPAN TEST STATION

TOPOGRAPHY AND MAPPING SYMBOLS	
	MAJOR CONTOURS
	MINOR CONTOURS
	TOP OF SLOPE
	TOE OF SLOPE
	PROPERTY LINE
	RIGHT-OF-WAY LINE
	GRADE BREAK
	RIDGE LINE
	EASEMENT LINE
	TEMPORARY EASEMENT LINE
	TRAIL OR DIRT ROAD
	FLOW LINE
	FLOOD HAZARD AREA
	EDGE OF WETLANDS
	RAILROAD
	SITE OR RETAINING WALL
	GUARDRAIL (PERMANENT)
	LIMITS OF GRADING
	LIMITS OF EXCAVATION
	BNSF RAILROAD MONITORING ARRAY
	UPRR RAILROAD MONITORING ARRAY
	RTD RAILROAD MONITORING ARRAY

EXISTING UTILITIES	
	NATURAL GAS
	WATER LINE
	STORM DRAIN
	SANITARY SEWER
	FIBER OPTIC CABLE
	POWER
	UNIDENTIFIED
	ABANDONED UTILITY

EXISTING FEATURES	
	VEGETATION
	TREE (SIZE AND TYPE)
	WELL
	POWER POLE
	GUY LINE AND ANCHOR
	MAILBOX
	TRAFFIC SIGNAL BOX OR POLE
	SIGN
	TELEPHONE BOX
	COMMUNICATION/CATV BOX
	HOSE BIBB
	HOSE RACK
	WATER BOX/METER
	BACKFLOW PREVENTER
	MAINTENANCE HOLE OR VAULT
	FIRE HYDRANT

PIPING AND UTILITIES	
	AV/AR VALVE (IN PLAN) LOCATE ON SIDE SHOWN
	AV/AR VALVE (IN PROFILE)
	BLOWOFF (IN PLAN) LOCATE ON SIDE SHOWN
	BLOWOFF (IN PROFILE)
	FIRE HYDRANT (IN PLAN)
	MAINTENANCE HOLE (IN PLAN)
	CLEANOUT TO GRADE (IN PLAN)
	GATE VALVE (IN PLAN)
	RESTRAINED COUPLING (IN PLAN)

ROADWORK AND PAVING	
NOTES: 1. PAVING PATTERNS MAY ONLY APPEAR IN PORTIONS OF PAVED AREAS TO DEFINE LIMITS OF PAVING. 2. SEE ALSO GENERAL LEGEND FOR ADDITIONAL PAVING PATTERNS.	
	ASPHALT (IN PLAN AND SECTION)
	CONCRETE CURB
	CONCRETE CURB AND GUTTER
	DRIVEWAY/ACCESS RAMP
	WELDED WIRE FABRIC (IN SECTION)

CONTROL SYMBOLS	
	BENCH MARK
	SITE COORDINATES (SEE TABLE ON DRAWINGS)
	SITE COORDINATES
	CONTROL POINT
	MONUMENT
	FINISHED ELEVATION/GRADE
	EXISTING ELEVATION/GRADE
	CURVE DATA (SEE TABLE ON DRAWINGS)

STRUCTURES	
	FENCE (CHAIN LINK)
	FENCE (WOOD)
	FENCE (SWING GATE)
	PROTECTIVE BARRIER
	PROTECTIVE BARRIER (REMOVABLE)
	STRUCTURE
	STRUCTURE (BELOW GRADE)

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER	DATE	JOB NUMBER
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**SCALES**

0 ——— 1"  
0 ——— 25mm

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CITY OF ARVADA  
**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

Kennedy Jenks

SCALE	NTS
JOB NO	2246059*00
DATE	JAN 2024
SHEET	6 OF 52
<b>CIVIL LEGEND</b>	
<b>C-002</b>	



Plot Date: 1/23/2024 9:24 AM

User: BRYANT BEHNKE

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**DENVER WATER**

DETAIL NO.	DENVER WATER DETAIL TITLE
33215	STORM AND SANITARY SEWER CROSSING
33216	OPEN CUT CROSSING OVER OR UNDER CONDUIT OR CONFLICTING UTILITY
33225	TRACER WIRE INSTALLATION FOR PVC WATER MAIN

**CITY OF ARVADA**

DETAIL NO.	CITY OF ARVADA DETAIL TITLE
400-1	TYPICAL TRENCH SECTION PIPE PROTECTION WATER MAINS
400-2	TYPICAL TRENCH SECTION FOR WATER MAIN PIPELINES IN UNSTABLE SUBGRADE
400-5	TRACER WIRE & TEST SITE DETAILS
400-6	VALVE BOX DETAIL
400-11	BLOWOFF INSTALLATION FOR 12" AND SMALLER PIPE
400-12	CROSSING STORM AND SANITARY SEWERS
400-13	OPEN CUT CROSSING BENEATH CONDUIT
400-21	LENGTH OF RESTRAINED PIPE
400-22	TIE ROD AND WASHER DETAILS
400-23	JOINT RESTRAINT DETAIL EYE BOLTS
400-24	MECHANICAL JOINT RESTRAINT DETAILS
400-25	FLANGE LUG DETAIL
400-29	FIELD INSTALLATION WAX TAP
400-34	WATER SERVICE, PROFILE 5/8" x 3/4", 3/4" AND 1"
400-52	VENT PIPE DETAIL
400-54	6" DIAMETER VENT PIPE SCREEN
400-56	VALVE BOX SUPPORT PLATE AND VALVE OPERATOR EXTENSION GUIDE
400-60	REFERENCE POST OR HYDRANT BOLLARD TYPICAL DETAIL
400-67	CATHODIC PROTECTION TEST STATION POTENTIAL WITH COPPER SULFATE REF. ELECTRODE - AT GRADE
400-69	FIRE LINE FOR 4" AND LARGER PIPE
500-1	PIPE BEDDING AND BACKFILL LIMITS SEWER MAINS
500-2	UNSTABLE SUBGRADE AND UNDERDRAIN BEDDING
500-3	TYPICAL MANHOLE
500-5	MANHOLE STEP
500-9	SANITARY MANHOLE FRAME AND LID DETAIL
600-1	STORM MANHOLE FRAME AND LID DETAIL
800-1	MOUNTABLE AND VERTICAL CURB AND GUTTER SECTIONS
800-3	VERTICAL CURB, GUTTER AND SIDEWALK SECTION AND CURB CUT SECTIONS
800-4	CROSSSPAN
800-5	TYPICAL CURB CUT
800-8	DRIVE CUT LOCATION & SPACING
800-9	JOINT DETAILS
800-10	CONCRETE REPLACEMENT DETAILS
900-1	TYPICAL T-TRENCH AND ASPHALT RESTORATION
900-3	T-TRENCH AND ASPHALT RESTORATION NOTES (Sheet 1 of 2)
900-4	T-TRENCH AND ASPHALT RESTORATION NOTES (Sheet 2 of 2)
900-5	TYPICAL TEST HOLE RESTORATION

**CDOT**

DETAIL NO.	CDOT DETAIL TITLE
M-203-2	DITCH TYPES
M-206-1	PIPE IN TRENCH
M-601-10	HEADWALL FOR PIPES
M-601-12	HEADWALL FOR PIPES OUTLET PAVING
M-601-13	WINGWALLS FOR PIPE OR BOX CULVERTS STANDARD SHEETS 1 THROUGH 2
M-603-1	METAL PIPE STANDARD SHEETS 1 THROUGH 4
M-603-2	REINFORCED CONCRETE PIPE
M-603-5	POLYVINYL CHLORIDE (PVC) PIPE (AASHTO M304)
M-603-10	CONCRETE AND METAL END SECTIONS
M-604-10	INLET, TYPE C
M-604-11	INLET, TYPE D
M-604-12	CURB INLET TYPE R STANDARD SHEETS 1 THROUGH 2
M-604-13	CONCRETE INLET TYPE 13
M-608-1	CURB RAMPS STANDARD SHEETS 1 THROUGH 10

**METRO WATER RECOVERY**

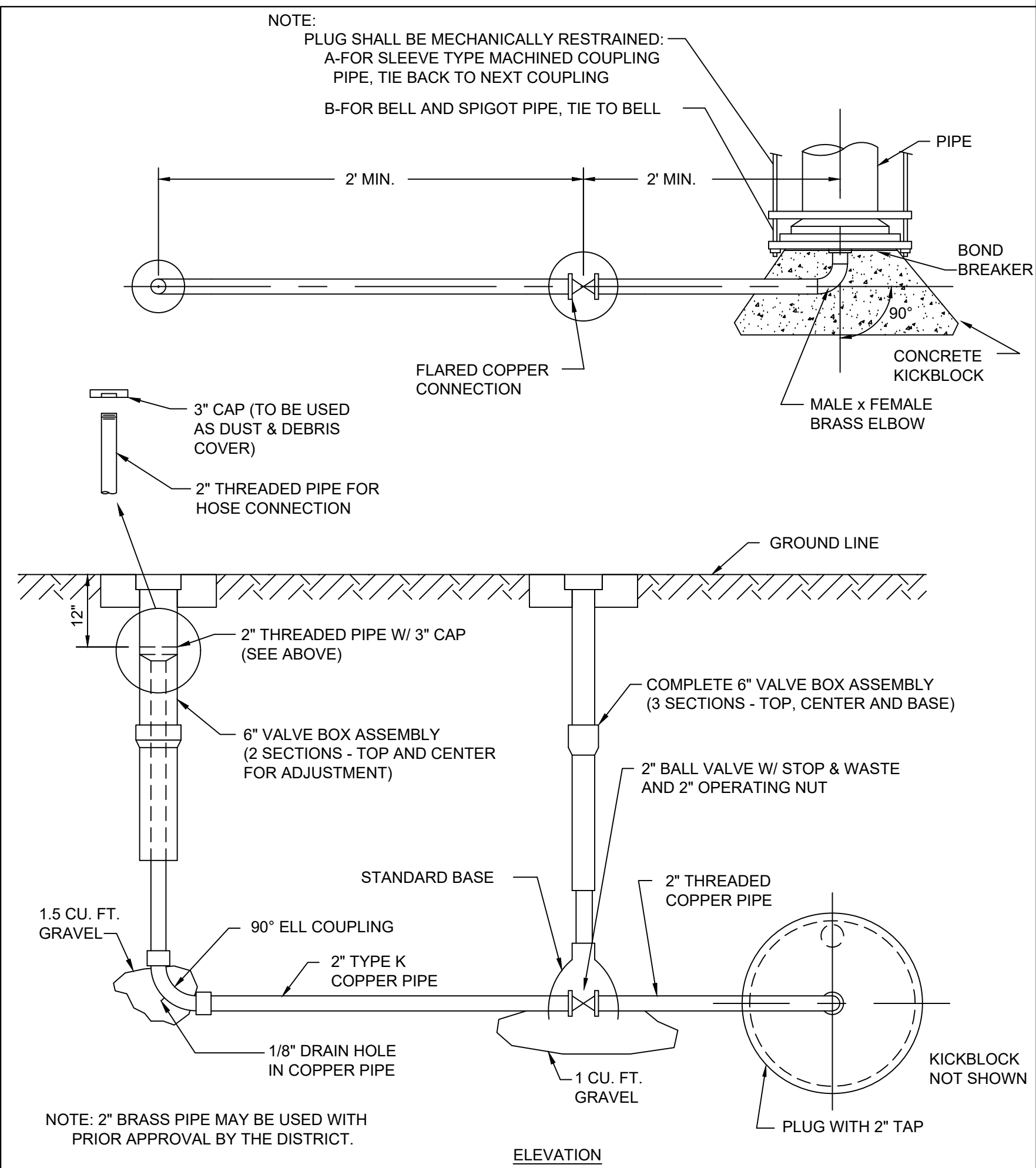
DETAIL NO.	METRO WATER RECOVERY DETAIL TITLE
33 05 61.2	STANDARD MANHOLE CAST IN PLACE BASE
33 05 61.4	MANHOLE FRAME AND COVER
33 05 61.5	MANHOLE STEPS

**ADAMS COUNTY**

DETAIL NO.	ADAMS COUNTY DETAIL TITLE
-	TRENCH PATCHING DETAIL
-	SURVEY MONUMENT W/ RANGE BOX
-	SURVEY MONUMENT W/O RANGE BOX
-	TYPICAL CROSSSPAN
-	ROAD - CURB, GUTTER AND WALK
-	STORM SEWER - TRACER WIRE SPECIFICATION
-	INLET BOX TYPES 13 AND 16
-	SIDEWALK CHASE DETAILS

**GENERAL SHEET NOTES**

1. REFERENCED CIVIL DETAILS ARE THE STANDARD SET OF DETAILS FROM EACH LISTED JURISDICTION AVAILABLE IN NOVEMBER 2023. IF STANDARD DETAILS ARE UPDATED BY A JURISDICTION BETWEEN FINAL DESIGN AND CONSTRUCTION, CONTRACTOR SHALL NOTIFY THE ENGINEER OF ANY DISCREPANCIES FOR FURTHER COORDINATION AS REQUIRED.
2. ADAMS COUNTY FOLLOWS CDOT STANDARD "PIPE IN TRENCH" DETAIL ON SHEET M-206-1 OF THE CDOT STANDARD PLANS. CONTRACTOR SHALL USE THE APPLICABLE TRENCHING AND BACKFILL DETAILS AS REQUIRED PER THE JURISDICTION WHERE THE WORK IS BEING PERFORMED.
3. FOR SITE RESTORATION, CONTRACTOR SHALL CONFIRM WITH THE AUTHORITY HAVING JURISDICTION THE PREFERRED REFERENCE DETAIL FOR COMPLETING THE WORK.



**2" BLOW-OFF ASSEMBLY FOR USE ON MAINS 12" & SMALLER**

DRAWING NO.: CPN-13W    DATE: 9/13    PAGE:

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Kennedy/Jenks Consultants  
Engineers & Scientists

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City of Arvada, Colorado

CITY ENGINEER    DATE    JOB NUMBER

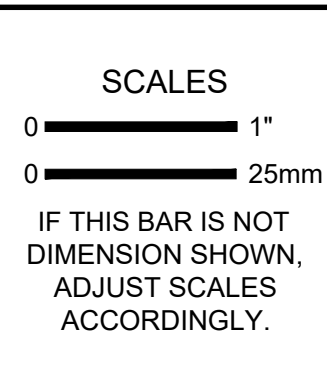
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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

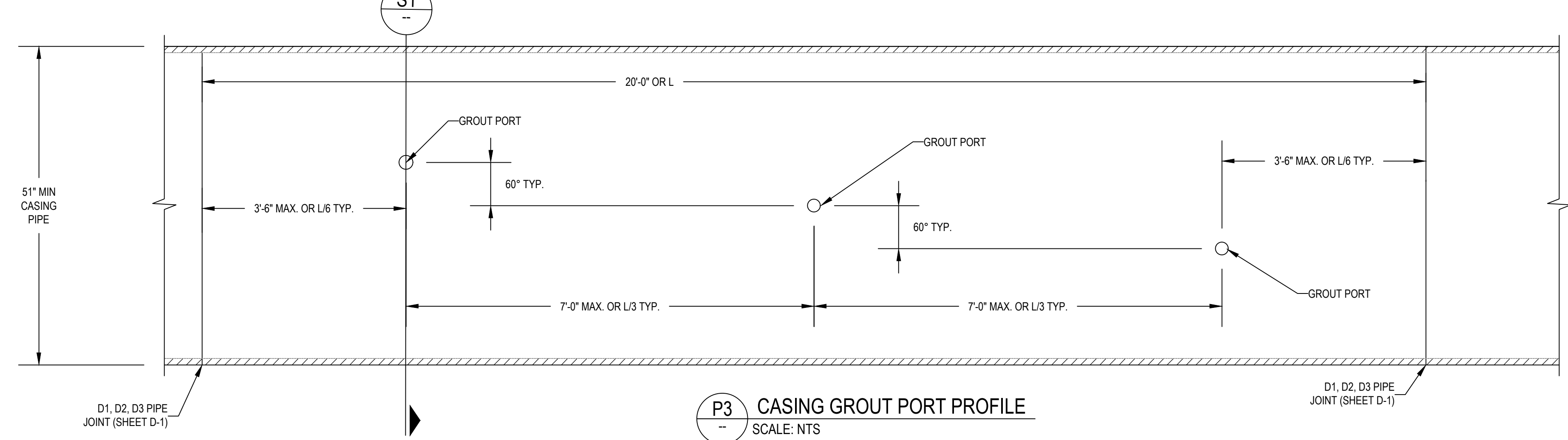
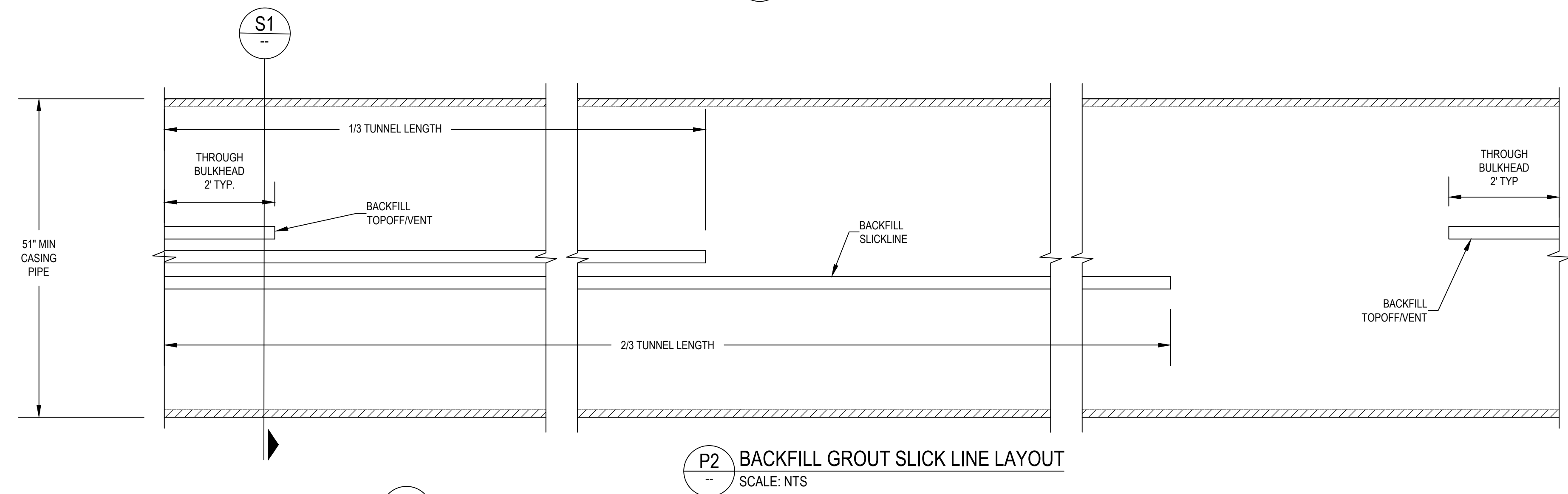
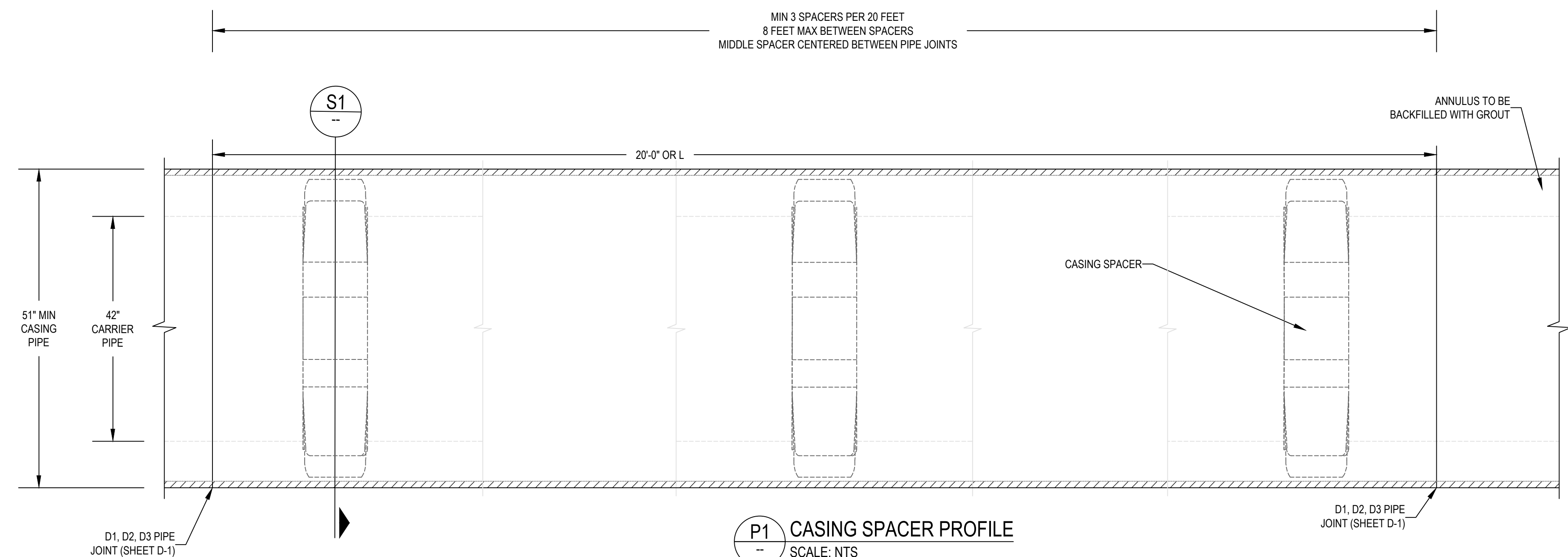
**CIVIL DETAILS**

SCALE	NTS
JOB NO	2246059*00
DATE	JAN 2024
SHEET	7 OF 52
<b>C-003</b>	

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City of Arvada, Colorado

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**SCALES**

0 — 1" = 1'

0 — 25mm = 1"

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED: JC

DRAWN: AM

CHECKED: RD

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**TUNNELING DETAILS - I**

SCALE: NTS

JOB NO: 2246059\*00

DATE: JAN 2024

SHEET 8 OF 52

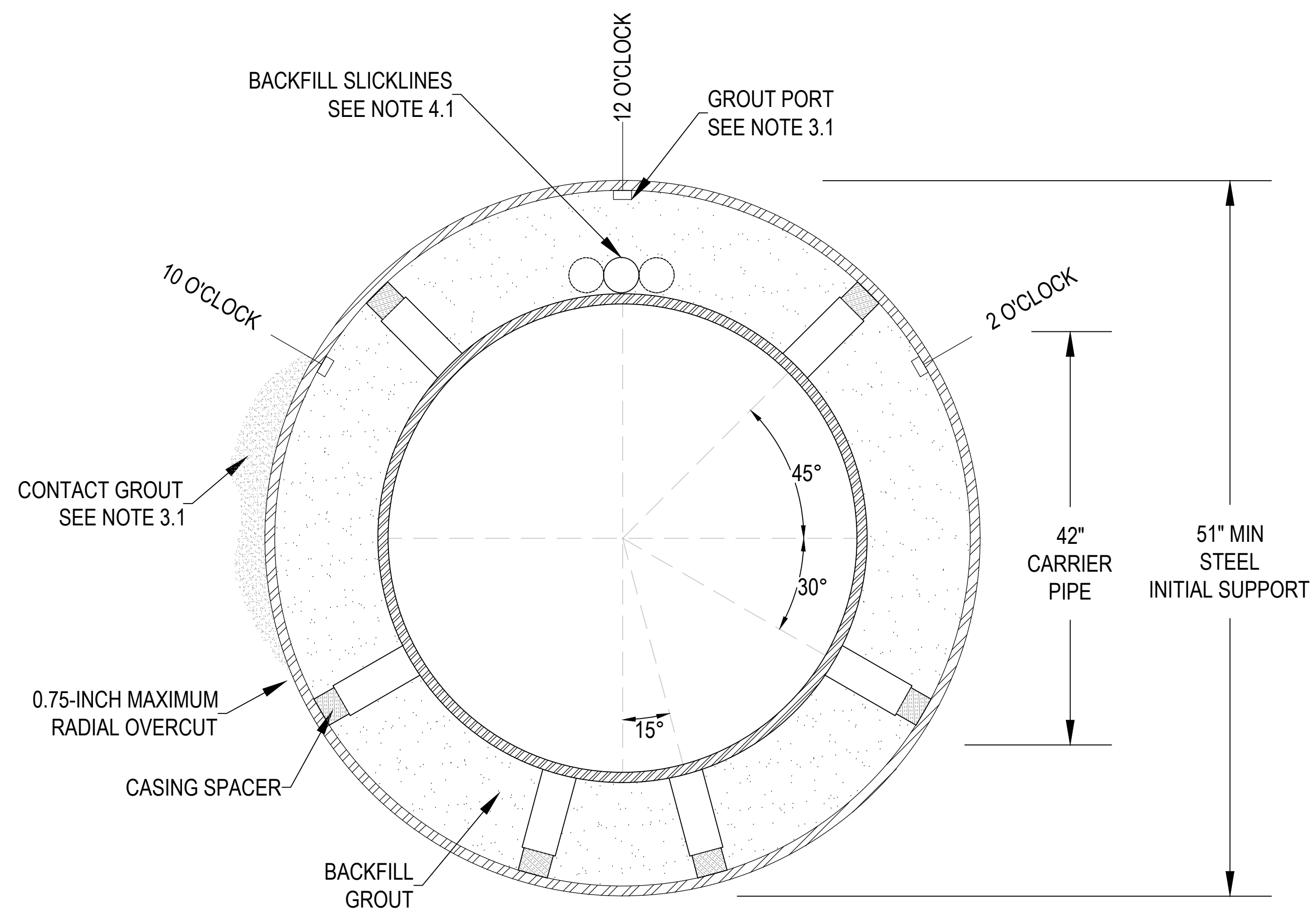
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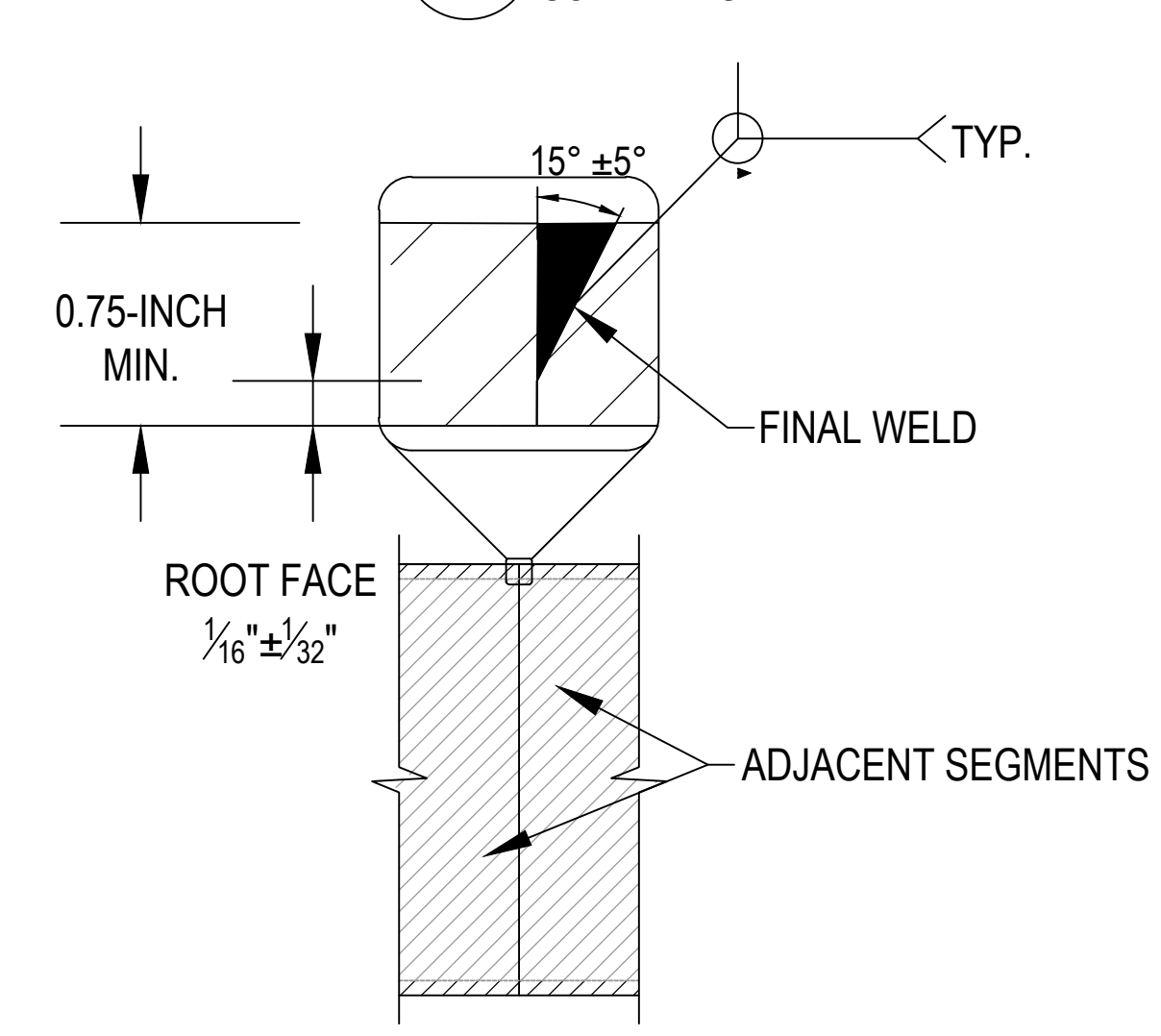
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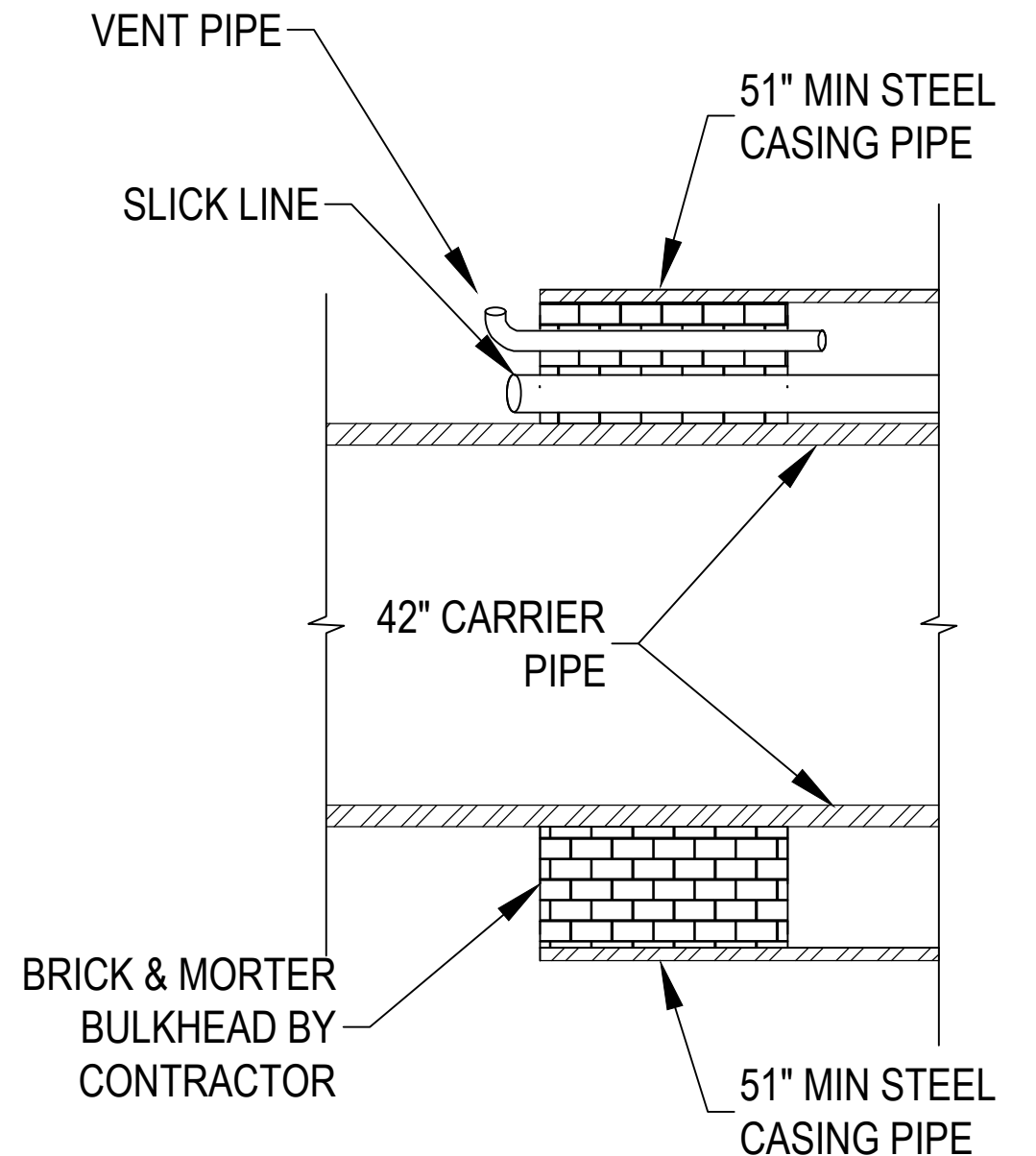
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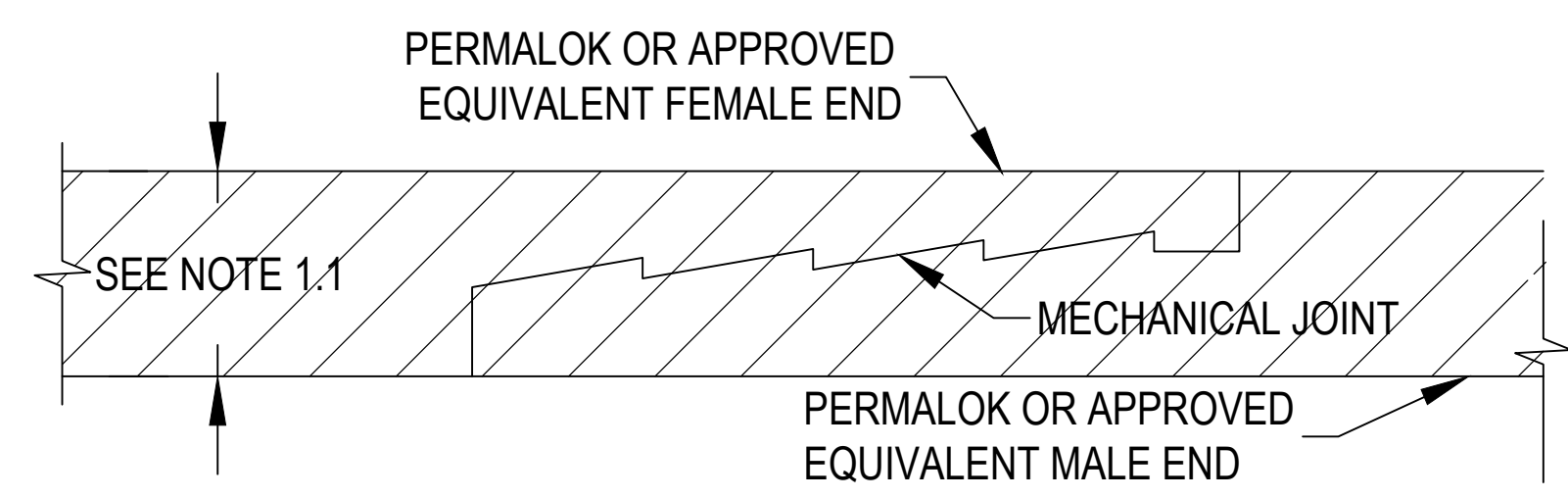
**S1** 51" CASING AND 42" CARRIER PIPE CROSS SECTION  
SCALE: NTS



**D1** WELDED JOINT DETAIL  
SCALE: NTS



**D2** END SEAL BULKHEAD DETAIL  
SCALE: NTS



**D3** MECHANICAL JOINT DETAIL, JACKED INSTALLATION  
SCALE: NTS

**GENERAL NOTES:**

1. TUNNEL EXCAVATION & INITIAL SUPPORT
  - 1.1. THE TUNNEL EXCAVATION AND INITIAL SUPPORT SPECIFICATION PROVIDES THE ACCEPTABLE TUNNELING TECHNIQUES, THE MINIMUM SPECIFIED INITIAL SUPPORT THICKNESS, AND INSTALLATION TOLERANCES.
  - 1.2. 42-INCH CARRIER PIPES SHALL BE HOUSED BY A 1.0-INCH THICK STEEL CASING PIPE WITH A MINIMUM DIAMETER OF 60-INCHES AS INDICATED ON THE PLAN AND PROFILE DRAWINGS.
2. INITIAL SUPPORT JOINTS
  - 2.1. STEEL CASING SEGMENTS SHALL EITHER BE WELDED TOGETHER OR UTILIZE A MECHANICAL JOINT AS INDICATED IN THE JOINT DETAILS AND SPECIFICATIONS.
  - 2.2. WELDED JOINTS SHALL UTILIZE BEVELED ENDS. WELDED JOINTS SHALL BE FULLY PENETRATING AS SHOWN IN DETAIL D-1.
  - 2.3. FOR JACKING INSTALLATIONS, MECHANICAL JOINTS SHALL BE T5 PERMALOK OR APPROVED EQUIVALENT AS SHOWN IN DETAIL D-3
  - 2.4. INITIAL SUPPORT SHALL RESIST TEMPORARY INSTALLATION JACKING LOADS.
  - 2.5. ALL INITIAL SUPPORT SHALL BE 1.0-INCH THICK STEEL CASING.
3. CONTACT GROUT
  - 3.1. CONTACT GROUT REQUIRED. SEE CONTACT GROUTING SPECIFICATION.
4. CARRIER PIPE INSTALLATION & BACKFILL GROUT
  - 4.1. SEE CARRIER PIPE INSTALLATION AND BACKFILL SPECIFICATION AND SHEET D-2, DETAIL P-2
  - 4.2. END SEALS OF INITIAL SUPPORT SHALL BE SEALED WITH BRICK AND MORTAR (DETAIL D-2) OR APPROVED EQUIVALENT. END SEALS SHALL PREVENT INFLOW OF SOIL AND/OR WATER INTO THE ANNULAR SPACE.
  - 4.3. CASING SPACERS SHALL BE STAINLESS STEEL WITH POLYMER FEET.

<b>APPROVED</b> City of Arvada, Colorado		
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0 — 1"  
0 — 25mm

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CHECKED	RD

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

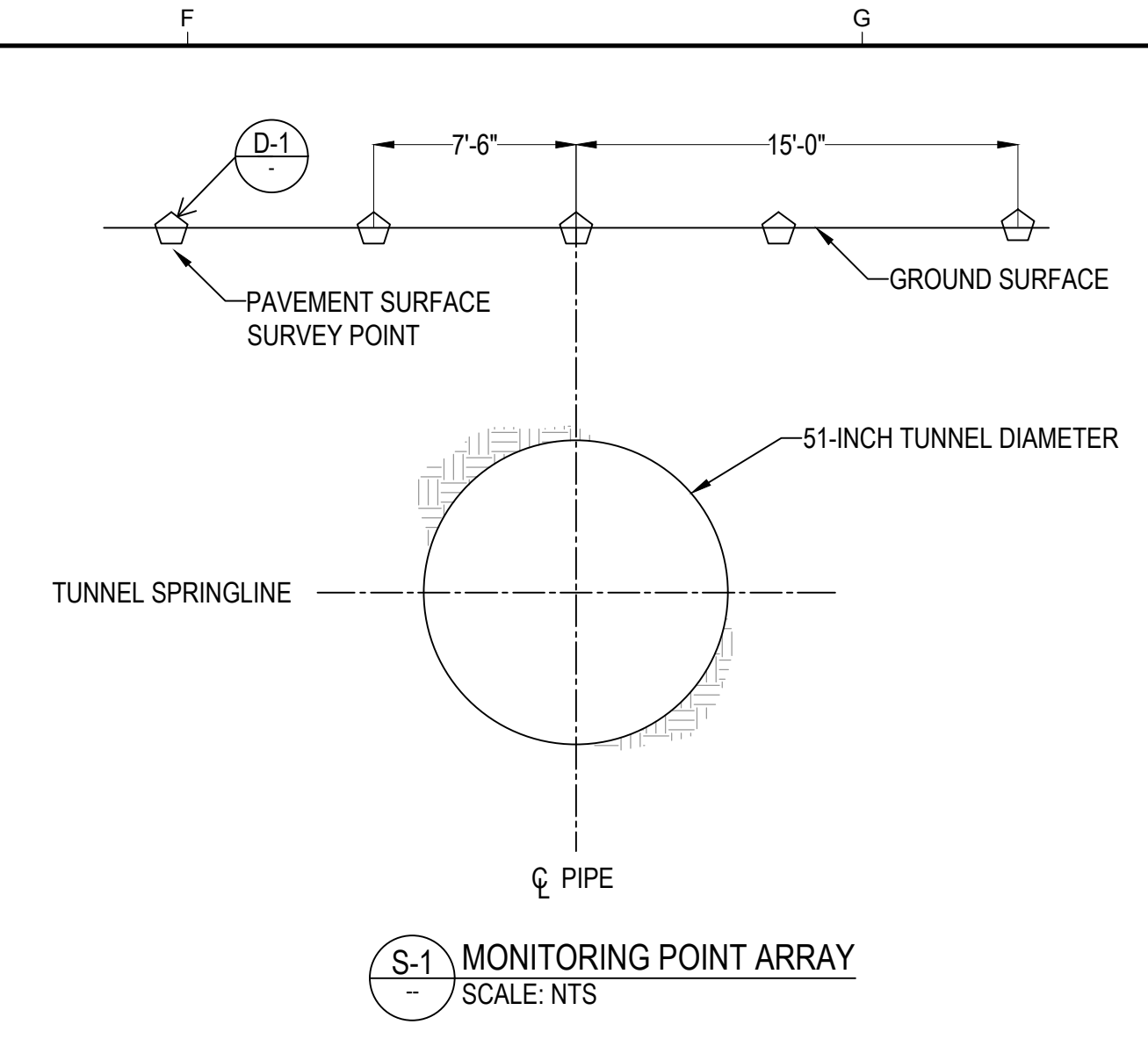
<b>TUNNELING DETAILS - II</b>	
SCALE	NTS
JOB NO	2246059*00
DATE	JAN 2024
SHEET	9 OF 52
<b>C-005</b>	

NOTES:

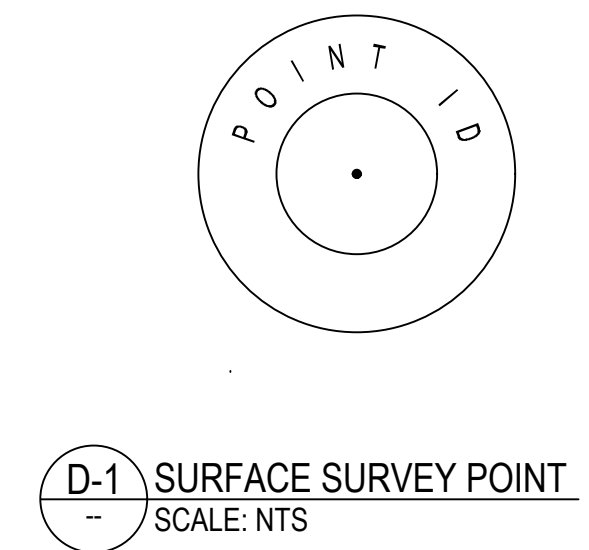
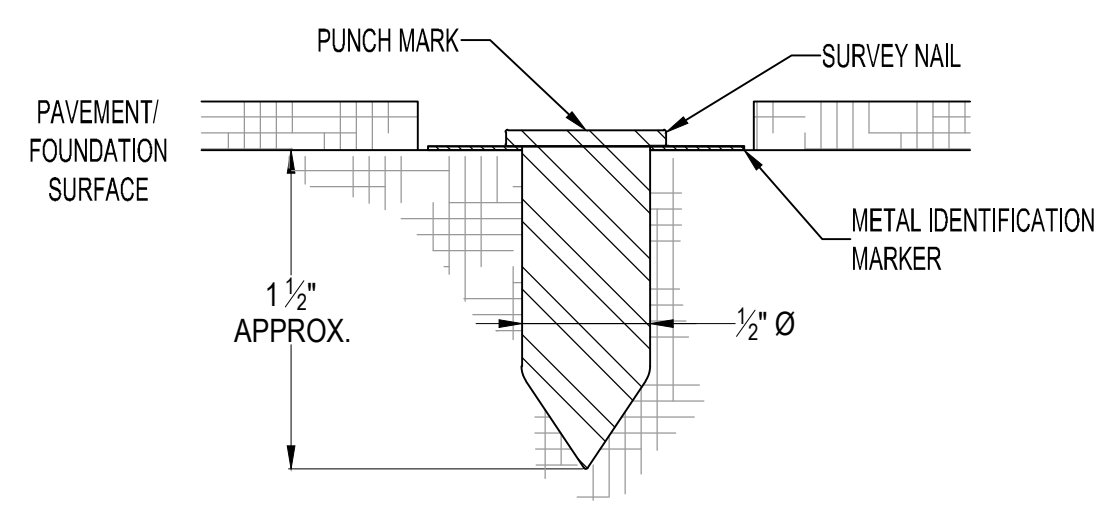
1. SITE SAFETY INCLUDING SURVEY READINGS CONDUCTED WITHIN RAILROAD RIGHT OF WAY AND ROADWAY SHOULDER SHALL BE AT THE INSTRUMENTATION SPECIALIST'S DISCRETION. RAILROAD FLAGGERS AND TRAFFIC CONTROL SHALL BE PROVIDED BY THE INSTRUMENTATION SPECIALIST AS NECESSARY TO MEET UPRR, BNSF, AND RTD REQUIREMENTS AND CONDUCT SURVEY READINGS IN THE RIGHT OF WAY.
2. THE SURFACE MONITORING ARRAYS SHALL CONSIST OF EVENLY SPACED SURFACE SURVEY POINTS, AS SHOWN IN SECTION S-1, INSTALLED AS CLOSE TO THE RAILROAD TRACKS AS POSSIBLE WITH PAINTED IDENTIFICATION MARKERS PLACED ON THE RAILROAD TRACKS CORRESPONDING TO THE MONITORING ARRAY (DETAIL D-3).
3. SURFACE MONITORING POINTS, UTILITY MONITORING POINTS, AND MONITORING POINT ARRAYS SHALL HAVE MEASUREMENT READ TWICE WEEKLY DURING SHAFT CONSTRUCTION, ONCE DAILY DURING TUNNELING, AND WEEKLY AFTER COMPLETION OF THE TUNNEL UNTIL MOVEMENT BETWEEN SUCCESSIVE MEASUREMENTS IS NEGLIGIBLE AS DETERMINED BY THE ENGINEER.
4. RESPONSE VALUES FOR COLLECTED SURVEY DATA ARE AS SHOWN IN THE TABLE BELOW:

INSTRUMENTATION RESPONSE VALUES		
INSTRUMENTATION TYPE	THRESHOLD VALUE	SHUTDOWN VALUE
UTILITY MONITORING POINTS	0.04 FEET IN Z	0.08 FEET IN Z
SURFACE MONITORING POINTS	0.01 FEET IN Z	0.02 FEET IN Z
	0.2 FEET IN ANY OF X OR Y	0.4 FEET IN ANY OF X OR Y

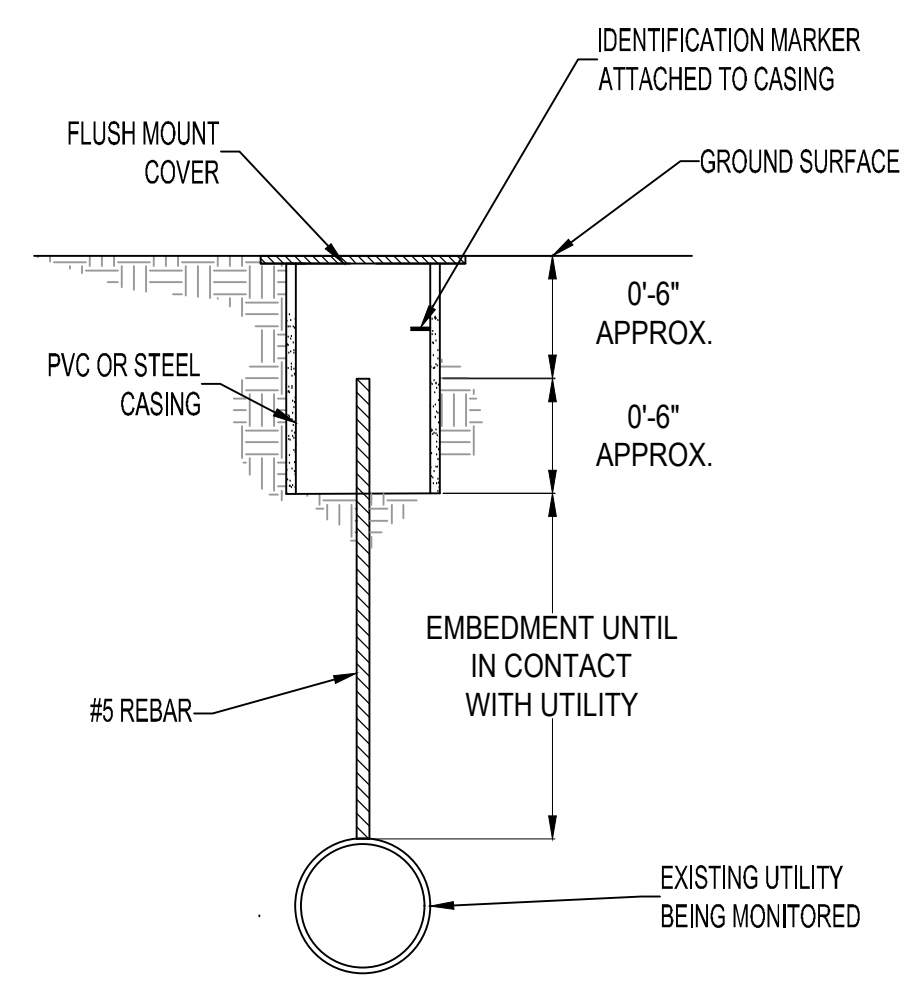
- 4.1. IF A THRESHOLD VALUE IS REACHED, ALL PARTIES TO INCLUDE BUT NOT NECESSARILY LIMITED TO THE OWNER, ENGINEER, UPRR, BNSF, AND/OR RTD SHALL BE NOTIFIED IMMEDIATELY BY THE INSTRUMENTATION SPECIALIST. THE CONTRACTOR SHALL MEET WITH THE OWNER, OWNER'S REPRESENTATIVE, ENGINEER, UPRR, BNSF, AND/OR RTD TO REVIEW COLLECTED DATA AND DETERMINE WHETHER ANY CHANGES TO THE CONSTRUCTION PROCEDURES ARE NECESSARY TO ENSURE THE SAFE COMPLETION OF THE WORK.
- 4.2. IF A SHUTDOWN VALUE IS REACHED, ALL PARTIES TO INCLUDE BUT NOT NECESSARILY LIMITED TO THE OWNER, ENGINEER, UPRR, BNSF, AND/OR RTD SHALL BE NOTIFIED IMMEDIATELY BY THE INSTRUMENTATION SPECIALIST AND THE CONTRACTOR SHALL STOP TUNNEL WORK UNTIL MEETING WITH THE OWNER, ENGINEER, UPRR, BNSF, RTD, AND/OR ANY OTHER AFFECTED THIRD PARTIES OCCURS. A SEPARATE PLAN OF ACTION DIFFERING FROM THE MEANS AND METHODS UTILIZED CAUSING EXCESSIVE MOVEMENT SHALL BE ADOPTED TO HELP MITIGATE FUTURE GROUND MOVEMENT. IF THE OWNER AND ENGINEER DEEM EXCESSIVE MOVEMENT HAS OCCURRED, MITIGATION TO CORRECT THE DISPLACED SURFACE SHALL BE COMPLETED FOR THE AFFECTED STRUCTURES AT THE CONTRACTORS EXPENSE.
5. ALL MONITORING INSTRUMENTATION SHALL BE REMOVED AND RESTORED IN ACCORDANCE WITH THE OWNER'S REPRESENTATIVE'S PERMIT REQUIREMENTS AFTER THE ENGINEER HAS DETERMINED THAT ADDITIONAL SURVEY DATA IS NO LONGER REQUIRED.



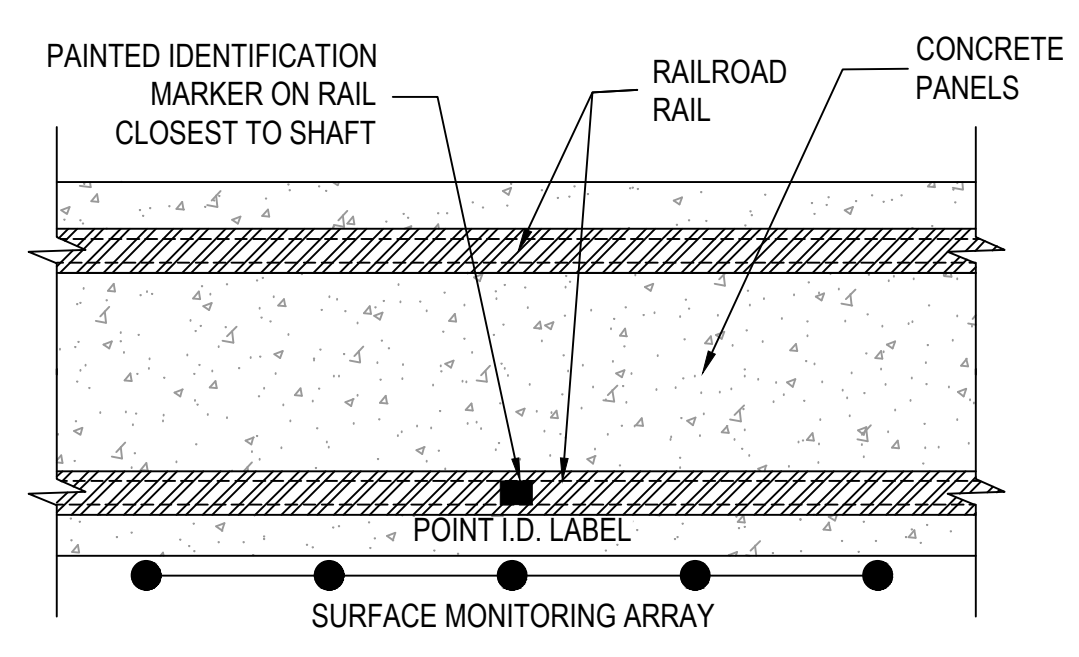
S-1 MONITORING POINT ARRAY  
SCALE: NTS



D-1 SURFACE SURVEY POINT  
SCALE: NTS



D-2 UTILITY MONITORING POINT  
SCALE: NTS



D-3 SURFACE SURVEY POINT  
SCALE: NTS

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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**JAN 2024 - INTERIM 100%**

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NO	REVISION	DATE	BY

**SCALES**

0 — 1"  
0 — 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED	JC
DRAWN	AM
CHECKED	RD

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**TUNNELING DETAILS - III**

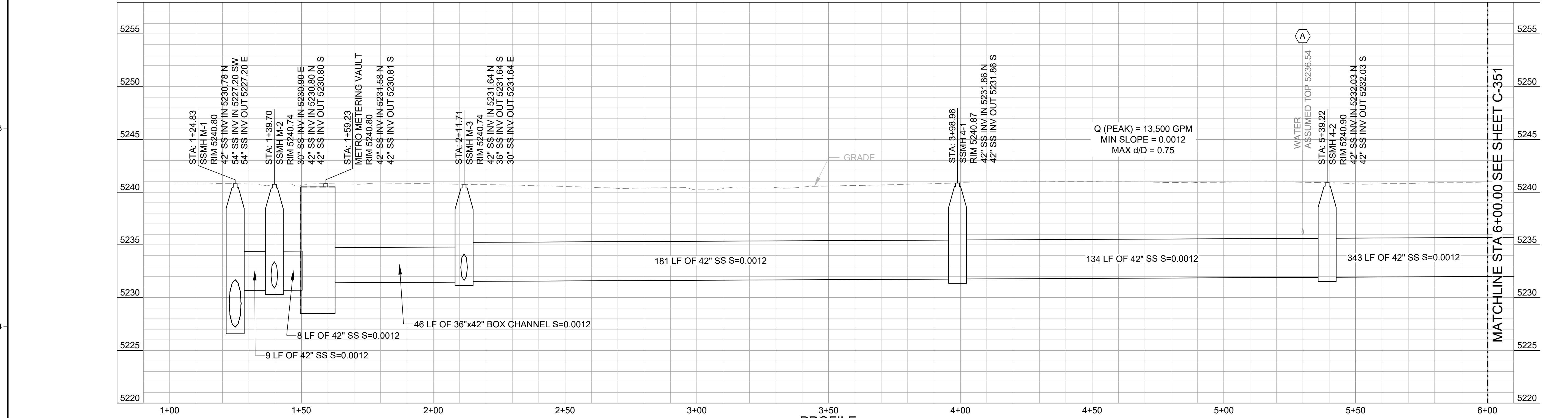
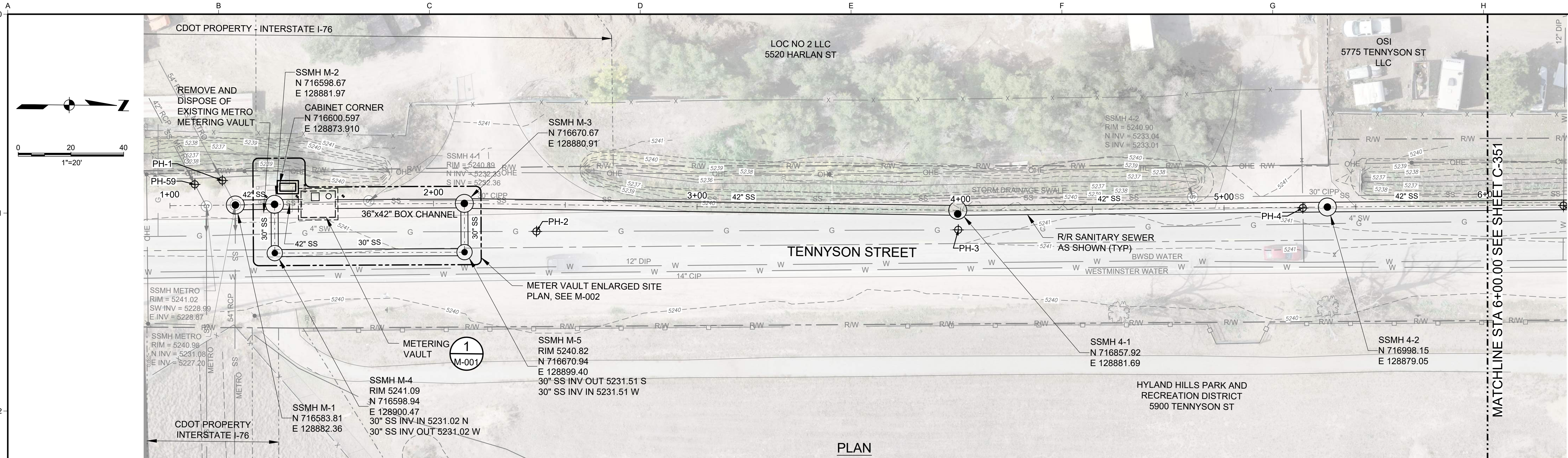
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JOB NO	2246059*00
DATE	JAN 2024
SHEET	10 OF 52
	C-006



Plot Date: 1/23/2024 9:25 AM

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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**SHEET KEYNOTES**

A. POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASEMENT AS NEEDED FOR VERTICAL CROSSINGS.

**SHEET KEYNOTES (CONT.)**

B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.

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0" = 25mm

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
STA 1+00 TO 6+00

SCALE  
1" = 20'

JOB NO  
2246059'00

DATE  
JAN 2024

SHEET 11 OF 52

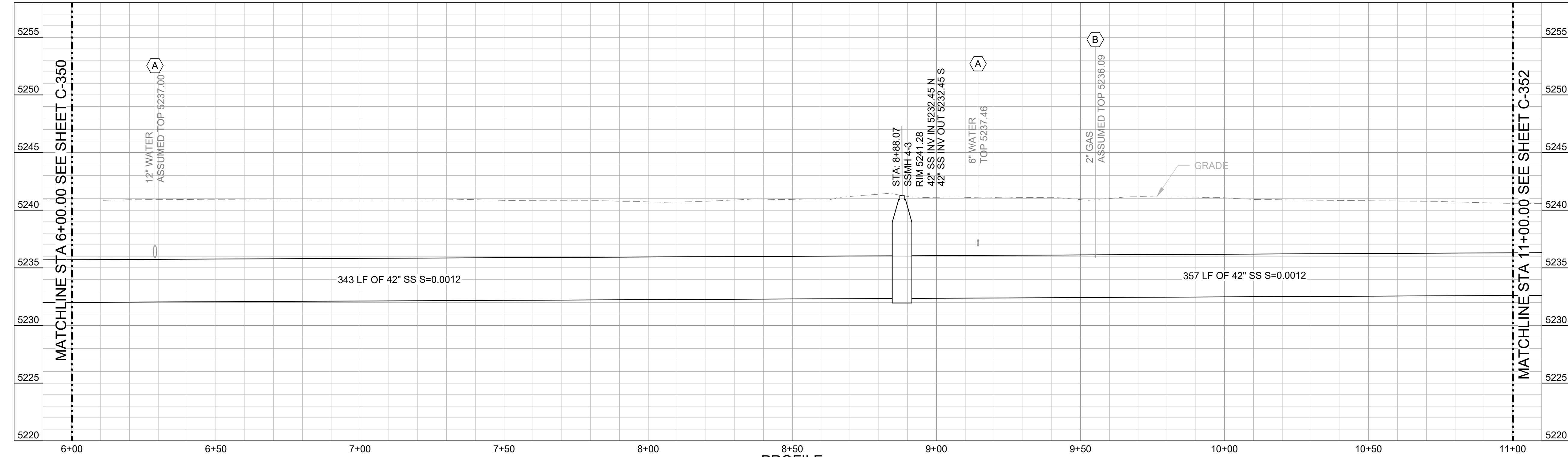
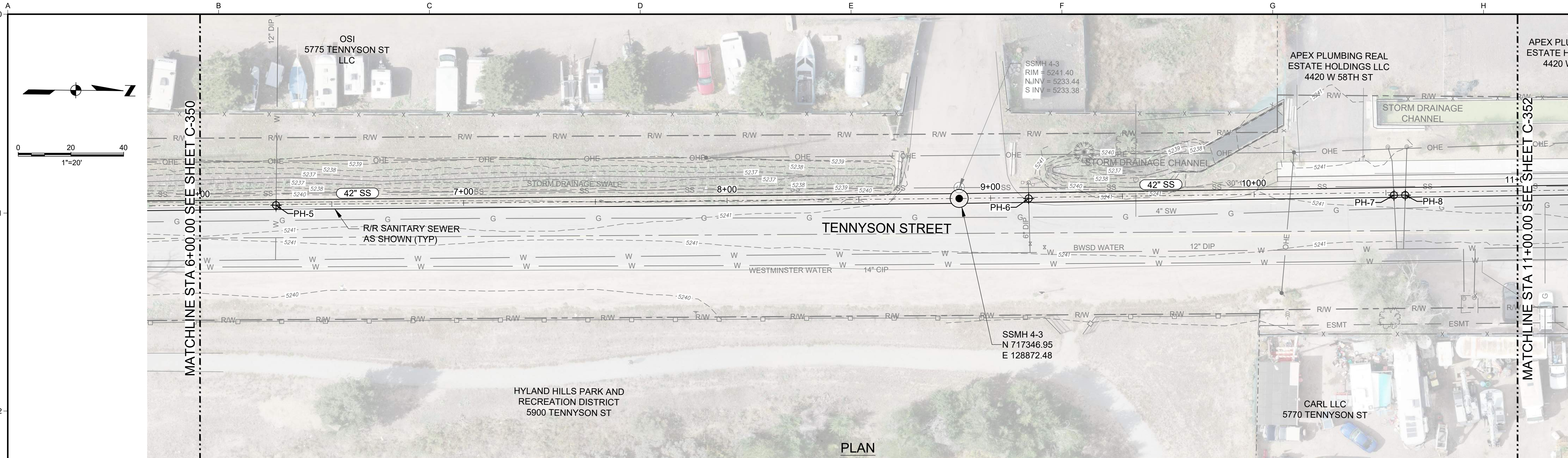
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**SHEET KEYNOTES (CONT.)**

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NO	REVISION	DATE	BY

**SCALES**

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0 25mm

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DESIGNED TS

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
STA 6+00 TO 11+00

SCALE 1" = 20'

JOB NO 2246059\*00

DATE JAN 2024

SHEET 12 OF 52

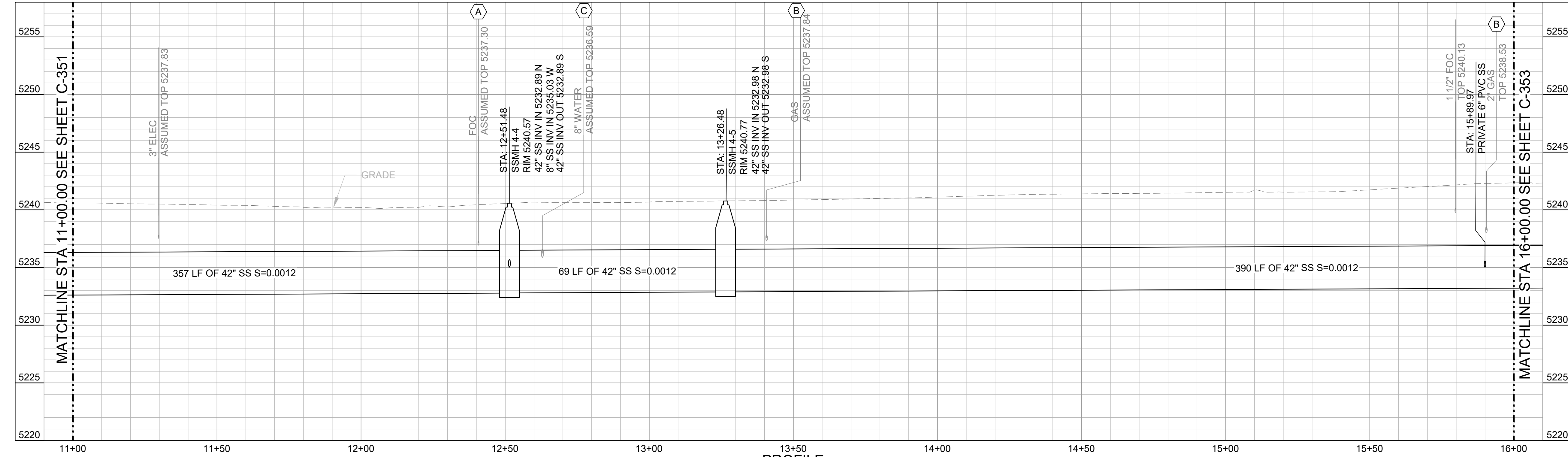
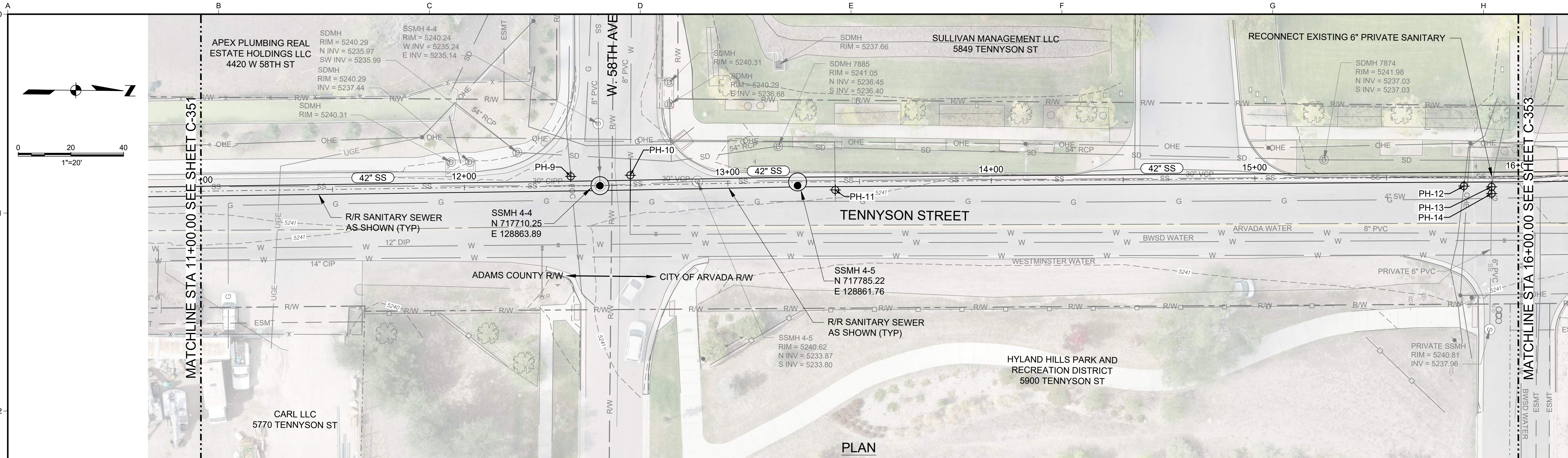
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City of Arvada, Colorado

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**SHEET KEYNOTES (CONT.)**

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**SHEET KEYNOTES (CONT.)**

C. LOWER 8" WATER MAIN AT SEWER CROSSING TO RELOCATE UNDER PROPOSED SEWER AT A MINIMUM OF 18" CLEARANCE. RELOCATE WATER MAIN PER CITY OF ARVADA CROSSING STORM AND SANITARY SEWERS AND OPEN CUT CROSSING BENEATH CONDUITS DETAILS ON C-003.

**JAN 2024 - INTERIM 100%**

NOT FOR CONSTRUCTION

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**SCALES**

0" = 1"  
0" = 25mm

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TS

DRAWN  
WAS

CHECKED  
WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
STA 11+00 TO 16+00

SCALE  
1" = 20'

JOB NO  
2246059'00

DATE  
JAN 2024

SHEET  
13 OF 52

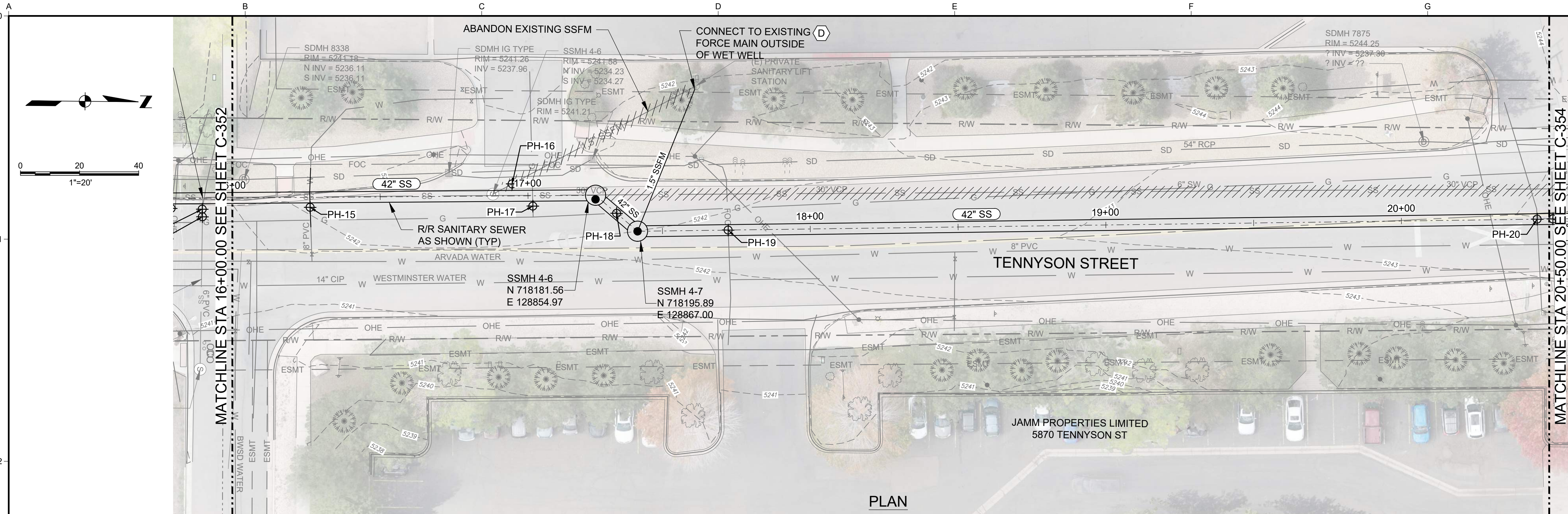
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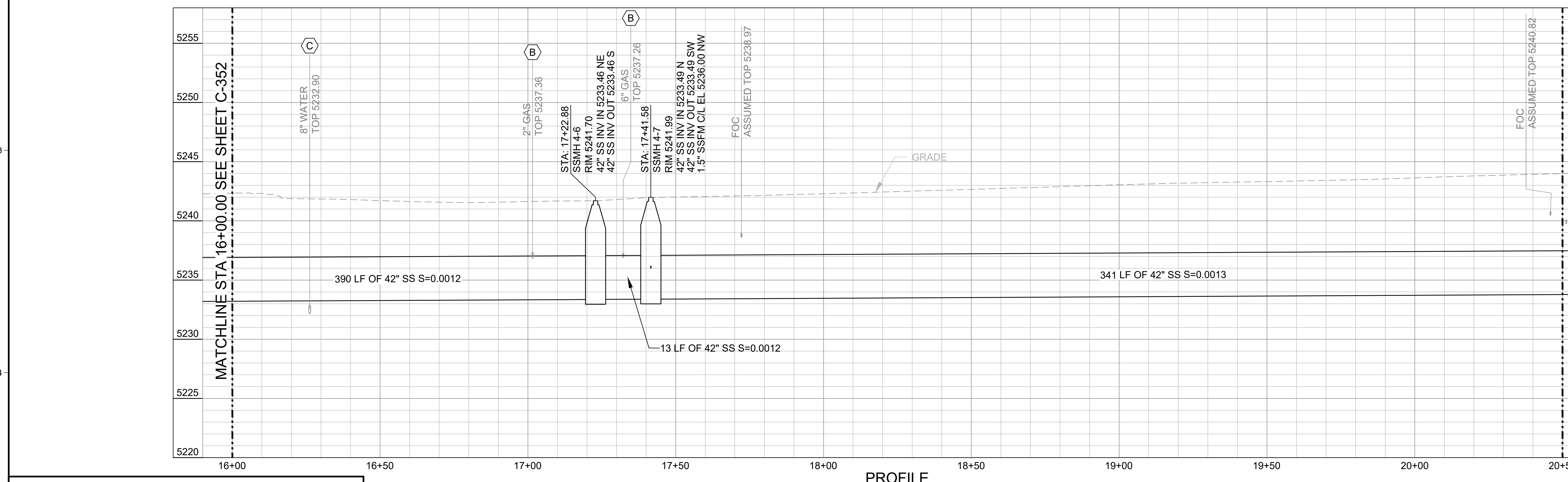
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- ### SHEET KEYNOTES
- A. POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASMENT AS NEEDED FOR VERTICAL CROSSINGS.
  - B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.
  - C. LOWER 8" WATER MAIN AT SEWER CROSSING TO RELOCATE UNDER PROPOSED SEWER AT A MINIMUM OF 18" CLEARANCE. RELOCATE WATER MAIN PER CITY OF ARVADA CROSSING STORM AND SANITARY SEWERS AND OPEN CUT CROSSING BENEATH CONDUITS DETAILS ON C-003.
  - D. CONTRACTOR TO RELOCATE FORCE MAIN TO AVOID EXISTING TREE AND TREE ROOTS WHERE POSSIBLE. IF TREE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REMOVE/REPLACE IN KIND.



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**DESIGNED**  
TS

**DRAWN**  
WAS

**CHECKED**  
WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**SCALE**  
1" = 20'

**JOB NO**  
2246059\*00

**DATE**  
JAN 2024

**SHEET** 14 OF 52

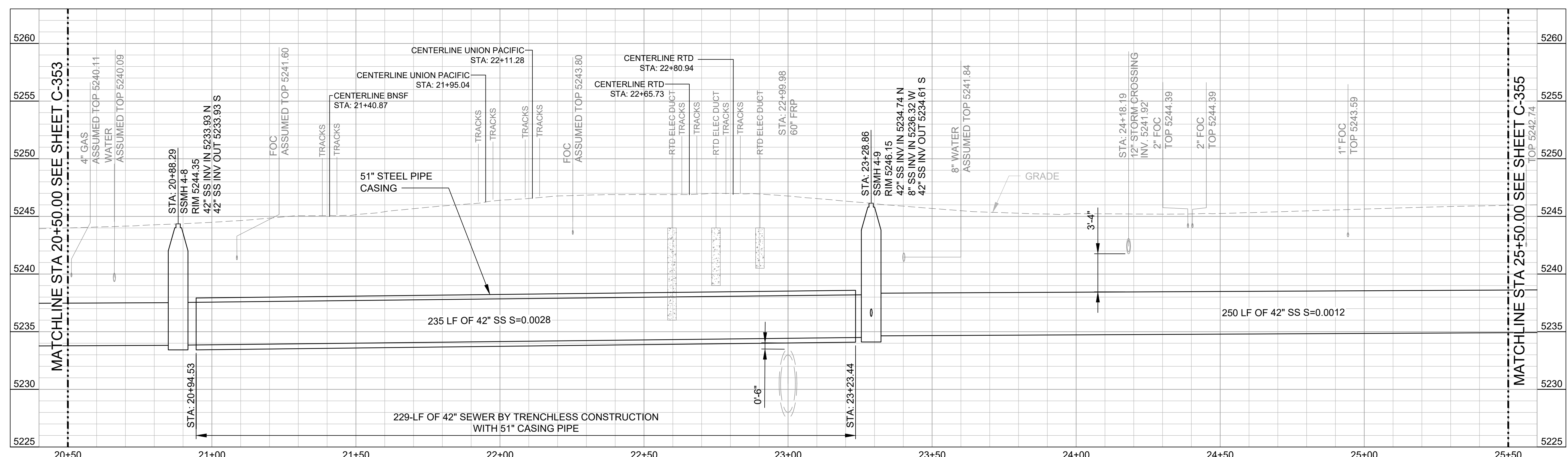
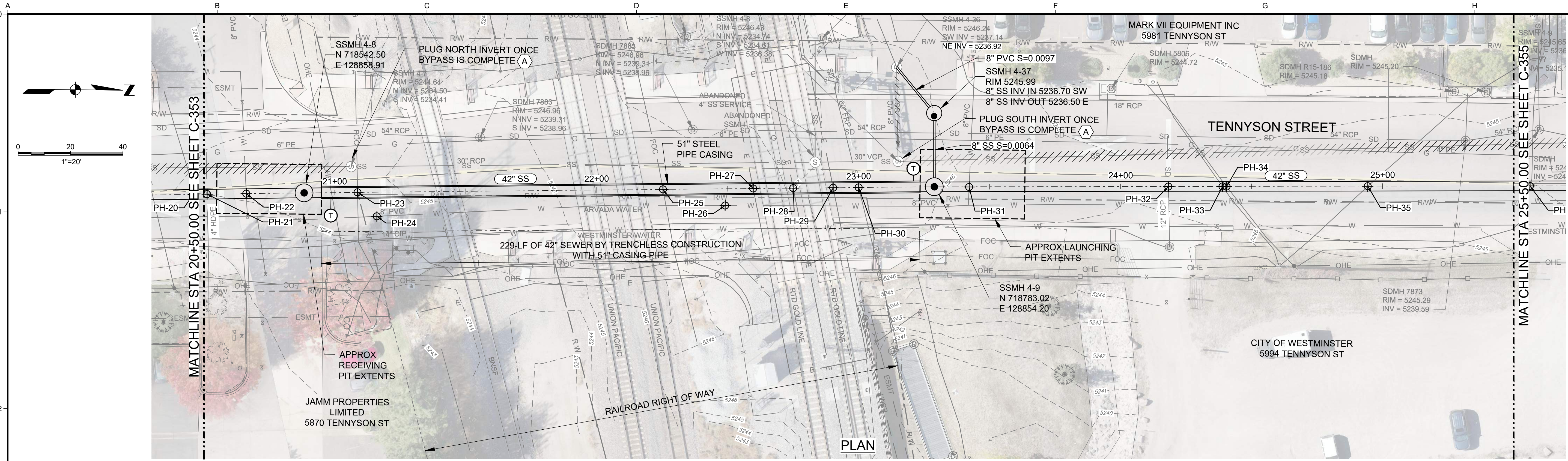
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City of Arvada, Colorado

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**GENERAL SHEET NOTES**

1. CONTRACTOR TO VERIFY WITH SURVEY THAT MANHOLES AND TEST STATIONS WILL BE LOCATED OUTSIDE OF RAILROAD R/W.

**SHEET KEYNOTES**

A. CONTRACTOR TO FILL THE FIRST 12" INSIDE THE EXISTING 30" SS PIPE WITH LOW STRENGTH GROUT (<200 PSI) FROM THE MANHOLE FACE. CONTRACTOR TO INSTALL ALL TEMP FORMS AS NECESSARY TO RETAIN THE GROUT IN PLACE UNTIL IT HAS FULLY SET.

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
STA 20+50 TO 25+50

SCALE 1" = 20'

JOB NO 2246059'00

DATE JAN 2024

SHEET 15 OF 52

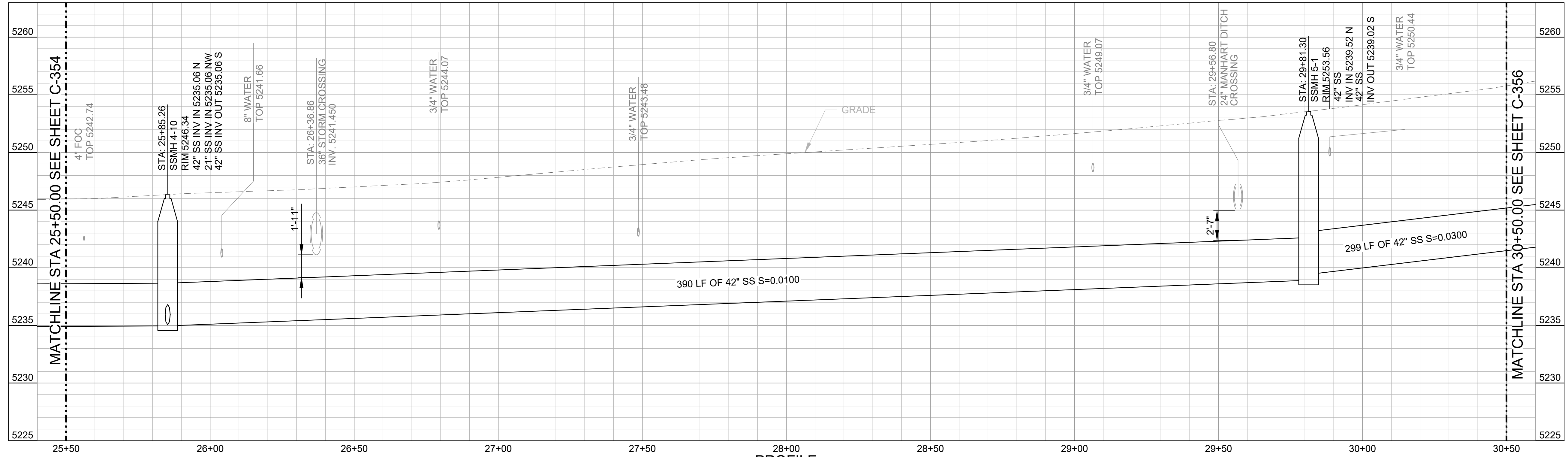
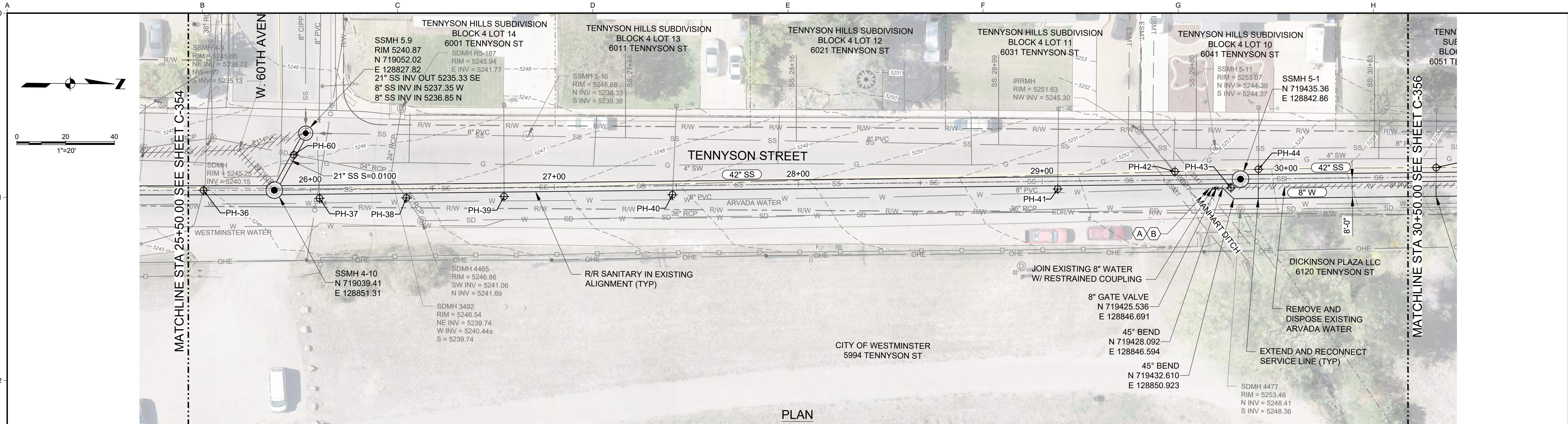
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City of Arvada, Colorado

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**GENERAL SHEET NOTES**

1. ALL PORTIONS OF MANHART DITCH BOTTOMS, SIDES, BANKS, FACILITIES, AND ALL AFFECTED PORTIONS OF MANHART'S PROPERTY OR EASEMENTS WHICH ARE DISTURBED SHALL BE RESTORED TO THEIR ORIGINAL CONDITION SO THAT THE FLOW OF WATER IN THE DITCH RUNS AT THE ORIGINAL AMOUNT AND

**GENERAL SHEET NOTES (CONT.)**

VELOCITY, ANY AND ALL FENCING AND OTHER FACILITIES APPURTENANT TO MANHART'S PROPERTY OR EASEMENTS SHALL BE REPLACED IN A CONDITION AT LEAST EQUAL TO THE CONSTITUTION OF SUCH FACILITIES AND APPURTENANCES PRIOR TO CONSTRUCTION.

**WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES**

A. INITIATE WATERLINE SHUT DOWN. ISOLATE AND CUT EXISTING 8" WATERLINE TO THE SOUTH.

B. CONNECT NEW WATERLINE TO EXISTING WATERLINE AND START SEGMENT 1 INSTALL. INSTALL GATE VALVE AND ENOUGH LINE SEGMENT TO RECHARGE EXISTING WATERLINE TO THE SOUTH.

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**SCALES**

0" = 1"  
0" = 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED TS  
DRAWN WAS  
CHECKED WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**PLAN AND PROFILE  
STA 25+50 TO 30+50**

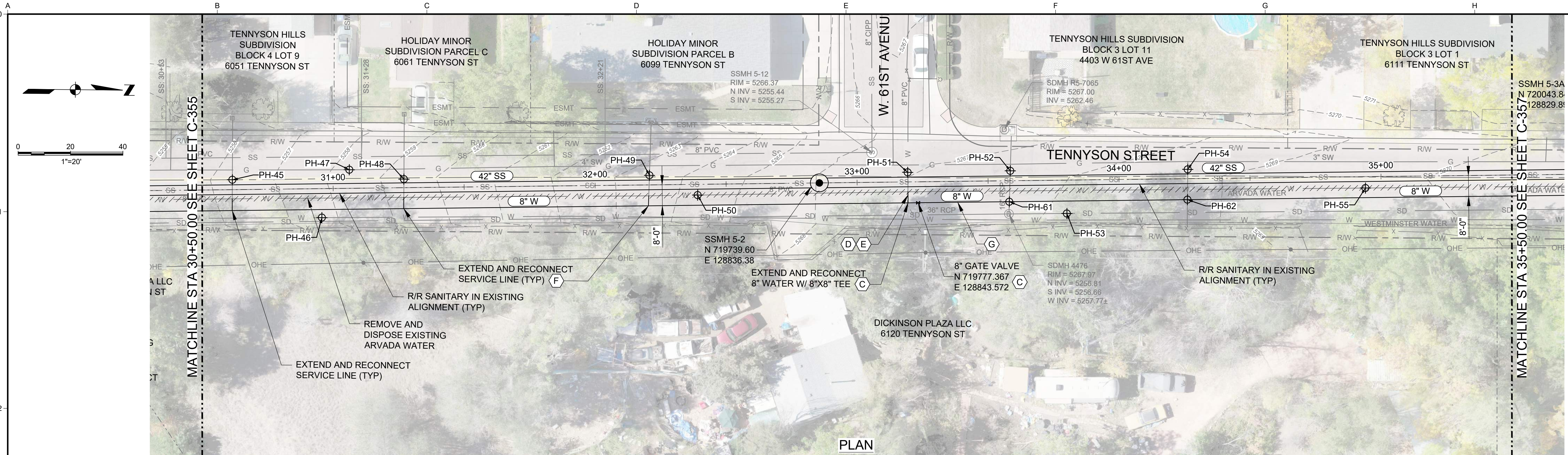
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DATE JAN 2024  
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**C-355**



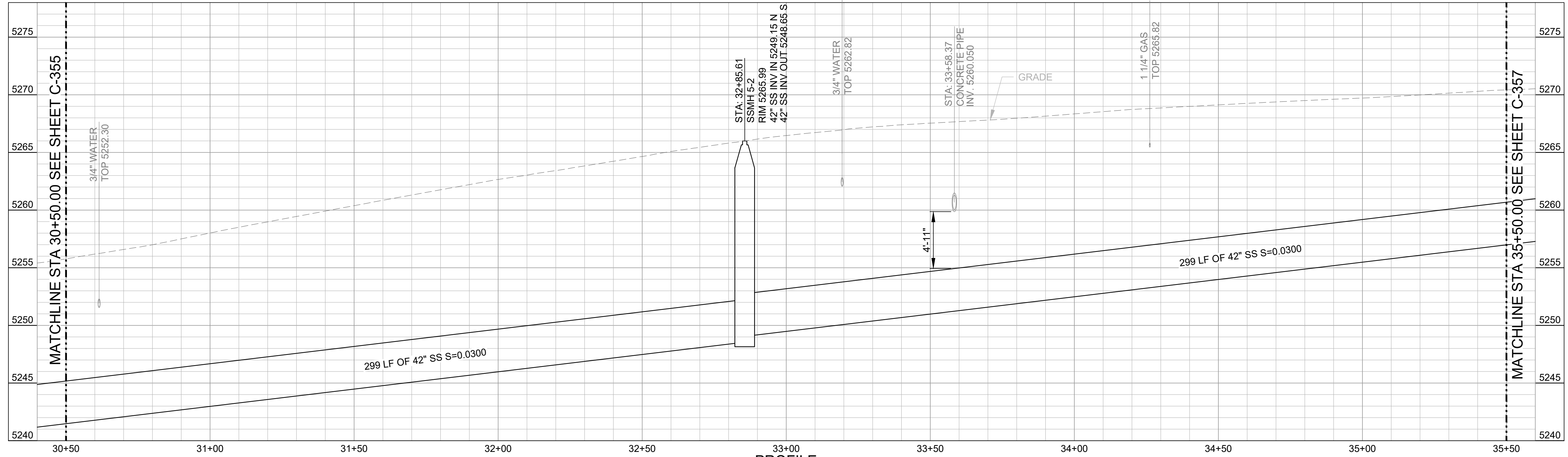
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PLAN



PROFILE

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER	DATE	JOB NUMBER

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KEYNOTE	DESCRIPTION
C.	INSTALL TEMPORARY PLUG ON THE WEST SIDE OF THE NEW TEE. INSTALL SEGMENT 1 THROUGH THE GATE VALVE NORTH OF THE TEE.
D.	ISOLATE, CUT, AND DRAIN 8" WATERLINE LATERAL TO THE WEST.

KEYNOTE	DESCRIPTION
E.	REMOVE TEMPORARY PLUG FROM TEE, EXTEND NEW WATERLINE WEST, AND CONNECT TO 8" WATERLINE LATERAL FOR W. 61ST AVE.
F.	DISINFECT AND TEST SEGMENT 1. UPON COMPLETION, SERVICE LINE RECONNECTIONS AND EXTENSIONS CAN BE COMPLETED.

KEYNOTE	DESCRIPTION
G.	RECHARGE SEGMENT 1 AND WEST LATERAL AND BEGIN INSTALL OF SEGMENT 2.

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NO	REVISION	DATE	BY

**SCALES**

0 1" = 20'

0 25mm

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DRAWN: WAS  
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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**PLAN AND PROFILE  
STA 30+50 TO 35+50**

SCALE: 1" = 20'

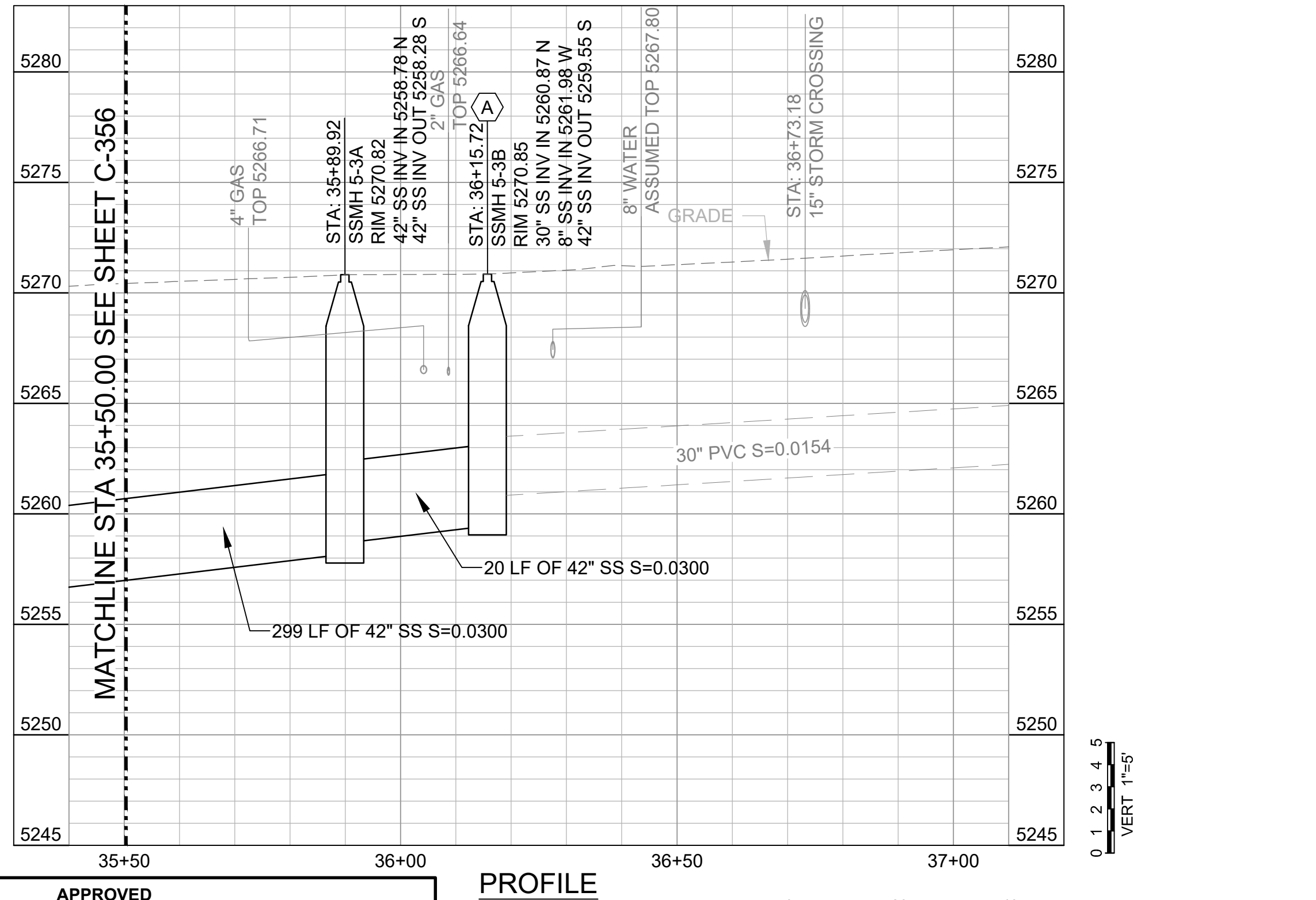
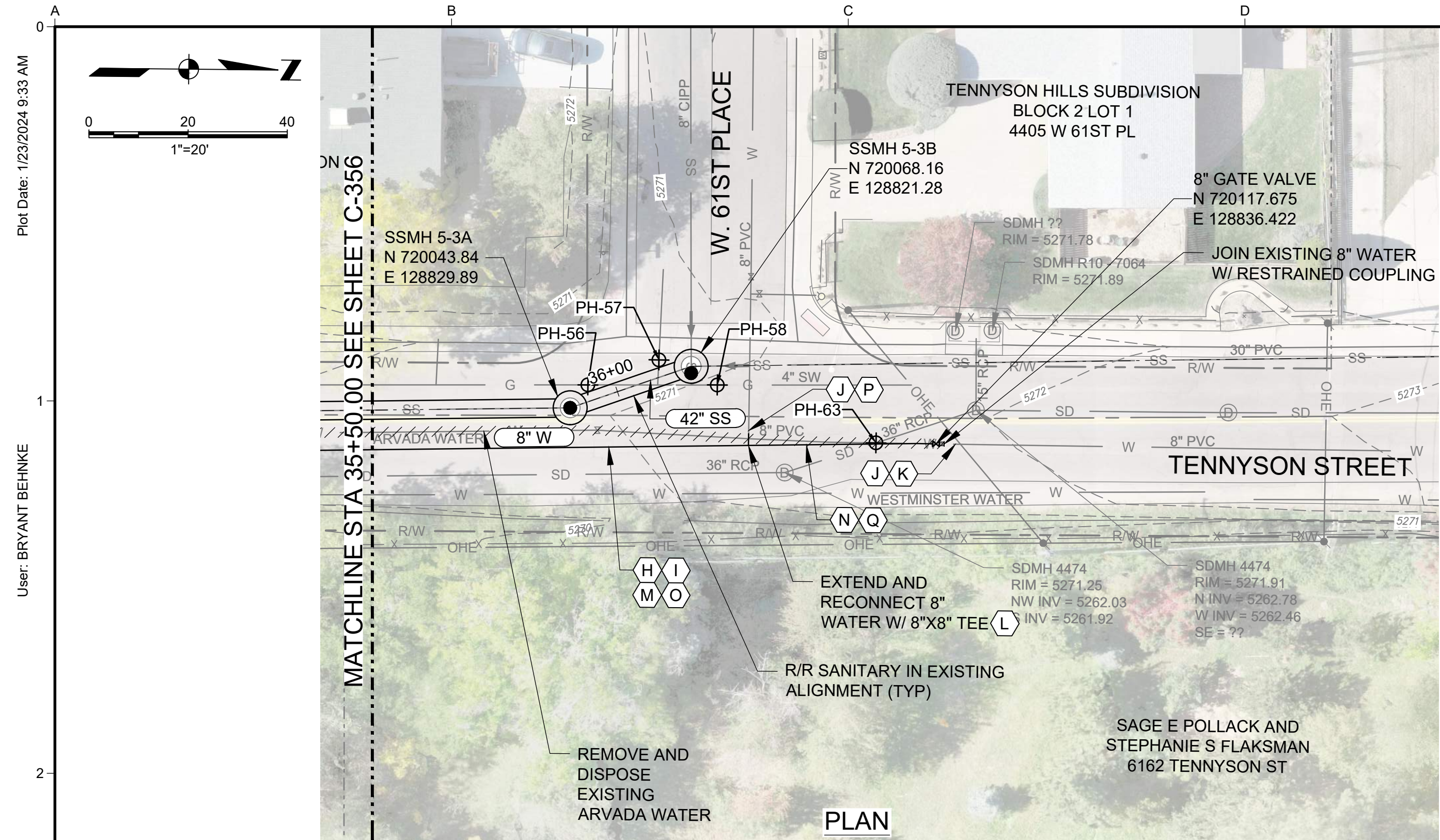
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DATE: JAN 2024

SHEET 17 OF 52

**C-356**





POTHOLE TABLE						
POTHOLE NUMBER	NORTHING	EASTING	UTILITY	PIPE SIZE AND MATERIAL	DEPTH TO TOP	NOTES
PH-1	716578.76	128873.09	SANITARY SEWER	54" RCP		DNF, CLEARED @6.62', HAD TO STOP DUE TO ROCK
PH-2	716698.15	128891.26	GAS	4" SW		
PH-3	716858.18	128889.08	GAS	4" SW	4.36'	
PH-4	716988.86	128879.48	WATER SERVICE	UNKNOWN		DNF, CLEARED @4.40', HAD TO STOP DUE TO SQUEEGEE
PH-5	717087.77	128877.62	WATER	12" DIP		DNF, DUG TO 5.50' DNF WATER
PH-6	717373.31	128872.24	WATER	6" DIP	3.58'	
PH-7	717511.90	128869.63	WATER SERVICE	3/4" CUP	3.00'	
PH-8	717516.21	128869.55	WATER SERVICE	3/4" CUP	3.24'	
PH-9	717699.12	128860.48	FIBER OPTIC CABLE	UNKNOWN		DNF, DUG TO 6.18' UNDER DNF COM
PH-10	717721.73	128859.82	WATER	8" PVC		DNF, DUG TO 6' UNDER DNF WATER
PH-11	717799.52	128864.63	GAS SERVICE	UNKNOWN		DNF, FLOW FILL UNDER CORE
PH-12	718038.07	128860.81	FIBER OPTIC CABLE	1 1/2" PE	2.26'	
PH-13	718048.57	128860.98	GAS SERVICE	2" PE	3.82'	
PH-14	718048.65	128863.55	SANITARY SEWER	6" PVC		DNF, FLOW FILL UNDER CORE
PH-15	718085.04	128859.99	WATER SERVICE	8" PVC	8.92'	MOVED OUT OF RD INTO ROCK AREA
PH-16	718153.30	128851.40	SANITARY FORCE MAIN	1.5"		DNF, CONCRETE UNDER CORE
PH-17	718160.39	128858.82	GAS SERVICE	2" HDPE C/S	4.64'	
PH-18	718188.73	128860.99	GAS	6" SW	4.42'	
PH-19	718226.53	128866.28	FIBER OPTIC CABLE	UNKNOWN		DNF, CLEARED @6.52'
PH-20	718500.14	128859.90	FIBER OPTIC CABLE	UNKNOWN		DNF, COULDN'T CORE THROUGH
PH-21	718505.47	128859.78	GAS SERVICE	4" HDPE	4.00'	
PH-22	718520.43	128859.43	WATER SERVICE	UNKNOWN		DNF, COULDN'T CORE THROUGH
PH-23	718562.89	128858.49	FIBER OPTIC CABLE	UNKNOWN		
PH-24	718570.35	128867.58	WATER	8" PVC		
PH-25	718679.47	128856.22	FIBER OPTIC CABLE	UNKNOWN		
PH-26	718703.26	128862.15	WATER	8" PVC		
PH-27	718713.89	128855.55	RTD DUCK BANK	UNKNOWN		
PH-28	718729.16	128855.25	RTD DUCK BANK	UNKNOWN		
PH-29	718744.42	128854.95	RTD DUCK BANK	UNKNOWN		
PH-30	718754.15	128854.77	STORM DRAIN	60" FRP		
PH-31	718796.32	128854.16	WATER	8" PVC		DNF, FLOW FILL UNDER CORE
PH-32	718872.36	128853.27	STORM DRAIN	12" RCP	2.43'	DNF, FLOW FILL UNDER CORE
PH-33	718893.02	128853.02	FIBER OPTIC CABLE	2" PE	1.00'	
PH-34	718894.59	128853.01	FIBER OPTIC CABLE	2" PE	1.00'	
PH-35	718948.48	128852.37	FIBER OPTIC CABLE	1" DB 100 PR	2.26'	
PH-36	719010.38	128851.65	FIBER OPTIC CABLE	14" RCP	2.26'	
PH-37	719057.97	128854.44	WATER	8" PVC	4.84'	
PH-38	719093.54	128853.91	STORM DRAIN	36" RCP	2.40'	
PH-39	719133.58	128852.95	WATER SERVICE	3/4" CUP	3.96'	
PH-40	719202.62	128851.56	WATER SERVICE	3/4" CUP	6.06'	
PH-41	719360.49	128847.66	WATER SERVICE	3/4" CUP	3.32'	
PH-42	719408.45	128840.04	MANHART DITCH	24" RCP	5.54'	DNF, MEASURED PIPE WHERE EXPOSED IN CULVERT
PH-43	719431.49	128846.46	WATER	8" PVC		DNF, FLOW FILL UNDER CORE
PH-44	719442.69	128838.77	WATER SERVICE	3/4" CUP	3.96'	
PH-45	719515.53	128837.37	WATER SERVICE	3/4" CUP	4.56'	
PH-46	719549.84	128851.51	RAW WATER	14" CIP		DNF, FLOW FILL UNDER CORE
PH-47	719560.12	128833.11	GAS	4" SW	3.82'	
PH-48	719581.00	128836.49	WATER SERVICE	3/4" CUP	3.96'	
PH-49	719674.70	128834.11	WATER SERVICE	3/4" CUP	4.49'	
PH-50	719693.19	128841.47	WATER	8" PVC	4.08'	
PH-51	719773.26	128831.99	WATER	8" PVC	4.06'	
PH-52	719812.43	128831.03	STORM DRAIN	16" RCP	6.10'	
PH-53	719834.19	128847.12	STORM DRAIN	36" RCP		DNF, FLOW FILL UNDER CORE
PH-54	719880.16	128829.81	GAS SERVICE	1 1/4" SW	3.29'	
PH-55	719948.06	128836.26	WATER	8" PVC	4.00'	
PH-56	720047.38	128825.23	GAS	4" SW	4.23'	
PH-57	720061.65	128820.04	GAS	2" SW	4.38'	
PH-58	720073.47	128824.98	GAS	4" SW	4.36'	

**GENERAL SHEET NOTES**

- POTHOLES INFORMATION IS PROVIDED IN ACCORDANCE WITH SUE REQUIREMENTS FOR THE DESIGN OF THE WORK. POTHOLES INFORMATION LISTED HERE DOES NOT RELIEVE THE CONTRACTOR FROM VERIFYING POTHOLES INFORMATION IN THE FIELD PRIOR TO CONSTRUCTION.

**POTHOLE TABLE (CONT)**

POTHOLE NUMBER	NORTHING	EASTING	UTILITY	PIPE SIZE AND MATERIAL	DEPTH TO TOP	NOTES
PH-59	716568.33	128874.69	SANITARY SEWER	42" RCP		DNF, CLEARED @ 6.16', LARGE RIVER ROCK COULD NOT CONTINUE
PH-60	719047.24	128836.73	STORM DRAIN	54" RCP	1.11'	
PH-61	719812.18	128842.83	STORM DRAIN	16" RCP	5.88'	
PH-62	719880.17	128841.38	GAS SERVICE	1 1/4" SW	3.25'	
PH-63	720105.58	128836.35	STORM DRAIN	36" RCP/8" PVC	5.70' / 3.2'	

- WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES (CONT.)**
- H. END SEGMENT 2 WITH TEMPORARY BLOWOFF ASSEMBLY.
  - I. DISINFECT AND TEST SEGMENT 2.
  - J. ISOLATE, CUT, AND DRAIN EXISTING 8" WATERLINE TO THE NORTH AND 8" WATERLINE LATERAL TO THE WEST.
  - K. CONNECT TO EXISTING WATERLINE USING 8" GATE VALVE. INSTALL GATE VALVE AND ENOUGH LINE SEGMENT TO RECHARGE EXISTING WATERLINE TO THE NORTH. START SEGMENT 3 INSTALL.
  - L. INSTALL TEMPORARY PLUG ON THE WEST SIDE OF THE NEW TEE.
  - M. END SEGMENT 3 WITH A TEMPORARY BLOWOFF ASSEMBLY.
  - N. DISINFECT AND TEST SEGMENT 3.
  - O. REMOVE TEMPORARY BLOWOFFS AND CONNECT SEGMENTS 2 AND 3 WITH A SOLID SLEEVE.
  - P. REMOVE TEMPORARY PLUG FROM TEE, EXTEND NEW WATERLINE TO THE WEST, AND CONNECT TO EXISTING 8" WATERLINE LATERAL FOR W. 61ST PL.
  - Q. RECHARGE SEGMENTS 2, 3, AND WEST LATERAL.

- SHEET KEYNOTES**
- A. CONTRACTOR SHALL FORM A UNIFORMED SLOPED MANHOLE BENCH FROM UPSTREAM INVERTS TO DOWNSTREAM INVERT WITHOUT FREEFALL OF WASTEWATER WITHIN THE MANHOLE. CITY OF ARVADA DESIGN STANDARDS DO NOT ALLOW FOR DROP MANHOLES.

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

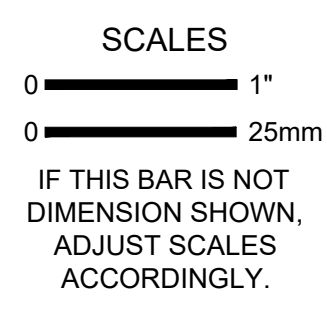
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CHECKED WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**PLAN AND PROFILE  
STA 35+50 TO 37+00**

SCALE 1" = 20'

JOB NO 2246059'00

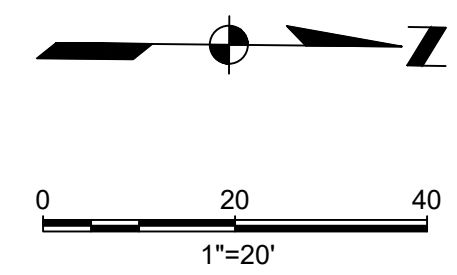
DATE JAN 2024

SHEET 18 OF 52

**C-357**

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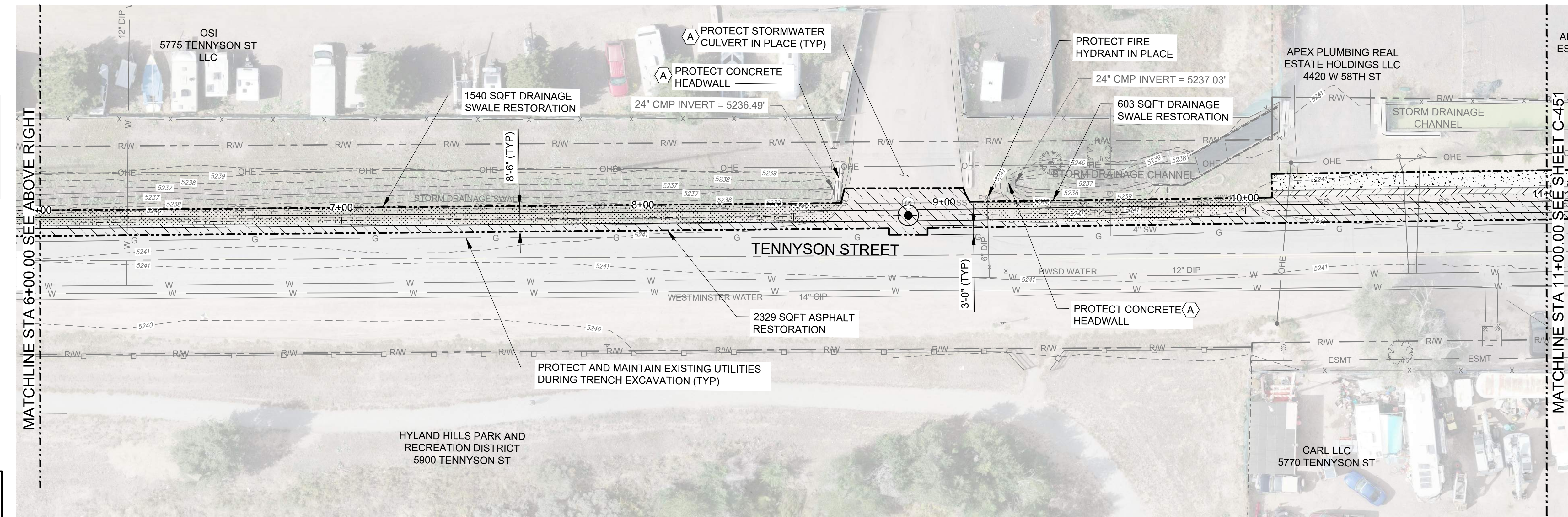
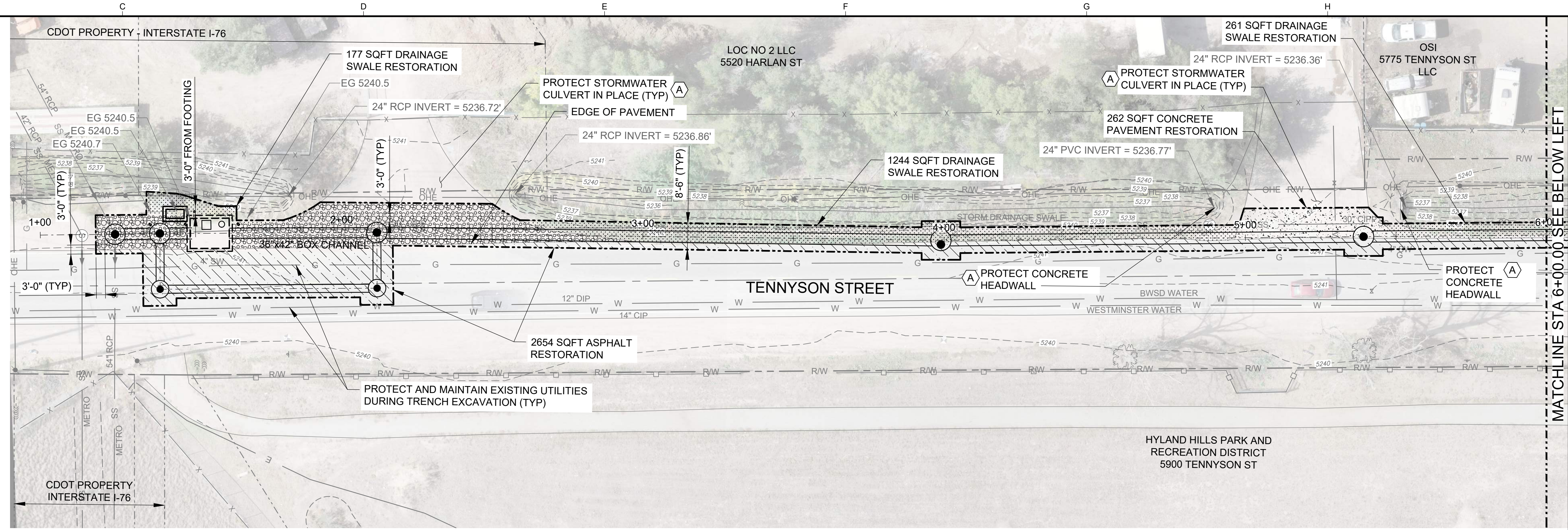


### SITE RESTORATION LEGEND

- APPROX ASPHALT PATCHING, CONCRETE REPAIR, AND TRENCH RESTORATION EXTENTS (LIMITS OF WORK)
- ASPHALT RESTORATION
- CONCRETE RESTORATION
- DRAINAGE SWALE RESTORATION
- CURB AND GUTTER RESTORATION
- LANDSCAPE/GRAVEL RESTORATION
- ADA RAMP REPLACEMENT

### SHEET KEYNOTES

- A. CONTRACTOR SHALL PROTECT STORMWATER HEADWALLS, CULVERTS, AND SWALE IN PLACE. IF EXISTING INFRASTRUCTURE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REPLACE IN KIND.



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City of Arvada, Colorado

CITY ENGINEER      DATE      JOB NUMBER

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 DRAWN WAS  
 CHECKED LS

CITY OF ARVADA  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

SCALE 1" = 20'  
 JOB NO 2246059'00  
 DATE JAN 2024  
 SHEET 19 OF 52  
 C-450

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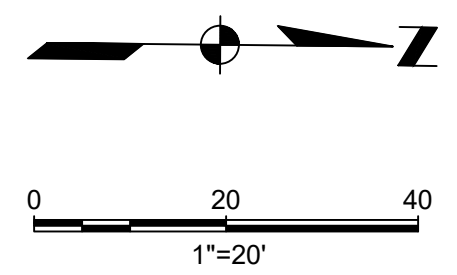
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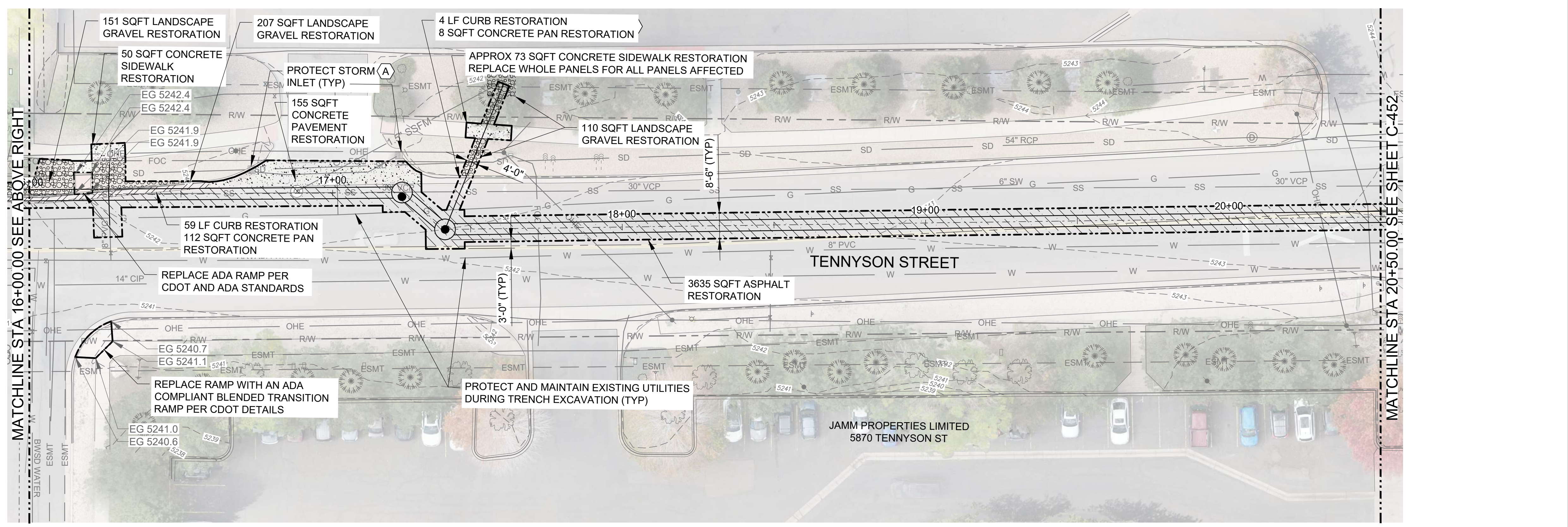
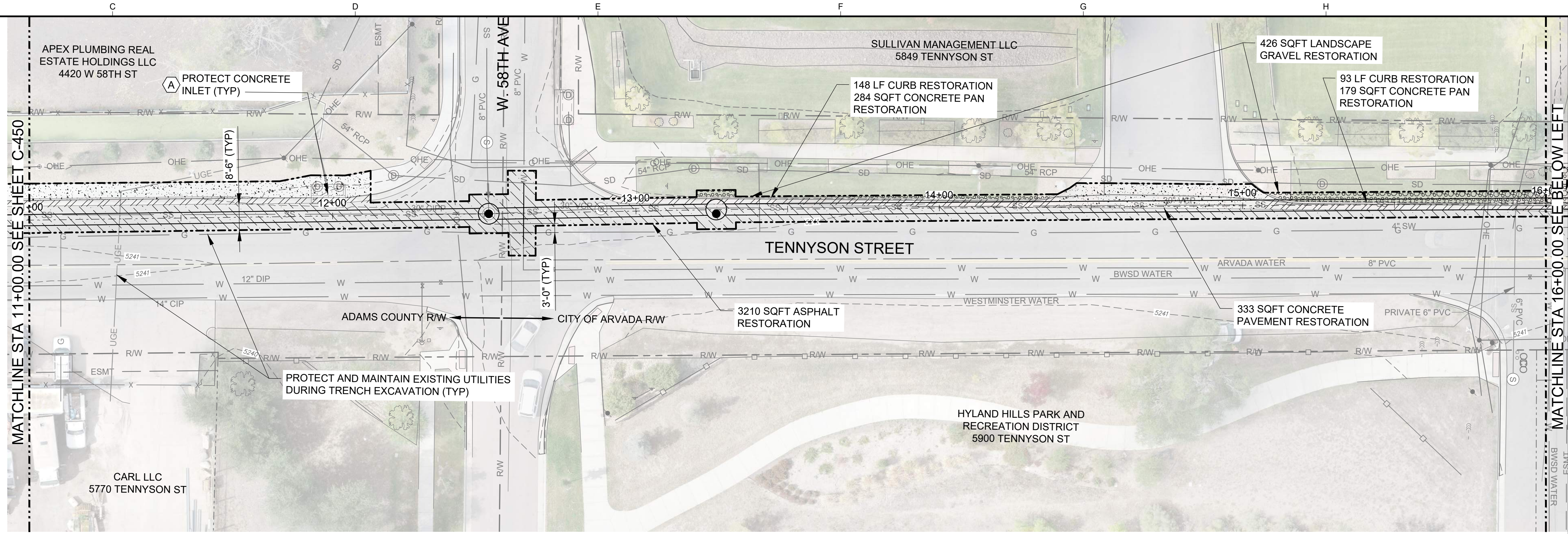


### SITE RESTORATION LEGEND

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### SHEET KEYNOTES

- A. CONTRACTOR SHALL PROTECT STORMWATER INLETS IN PLACE. IF EXISTING INFRASTRUCTURE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REPLACE IN KIND.



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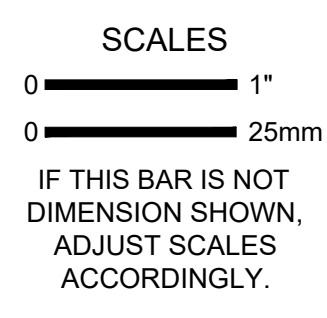
CITY ENGINEER      DATE      JOB NUMBER

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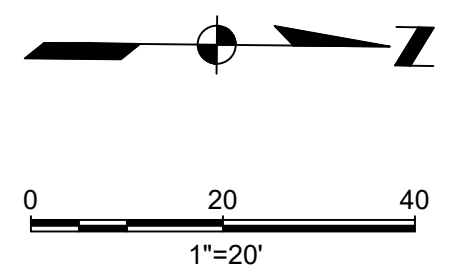


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CITY OF ARVADA  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11  
 Kennedy Jenks

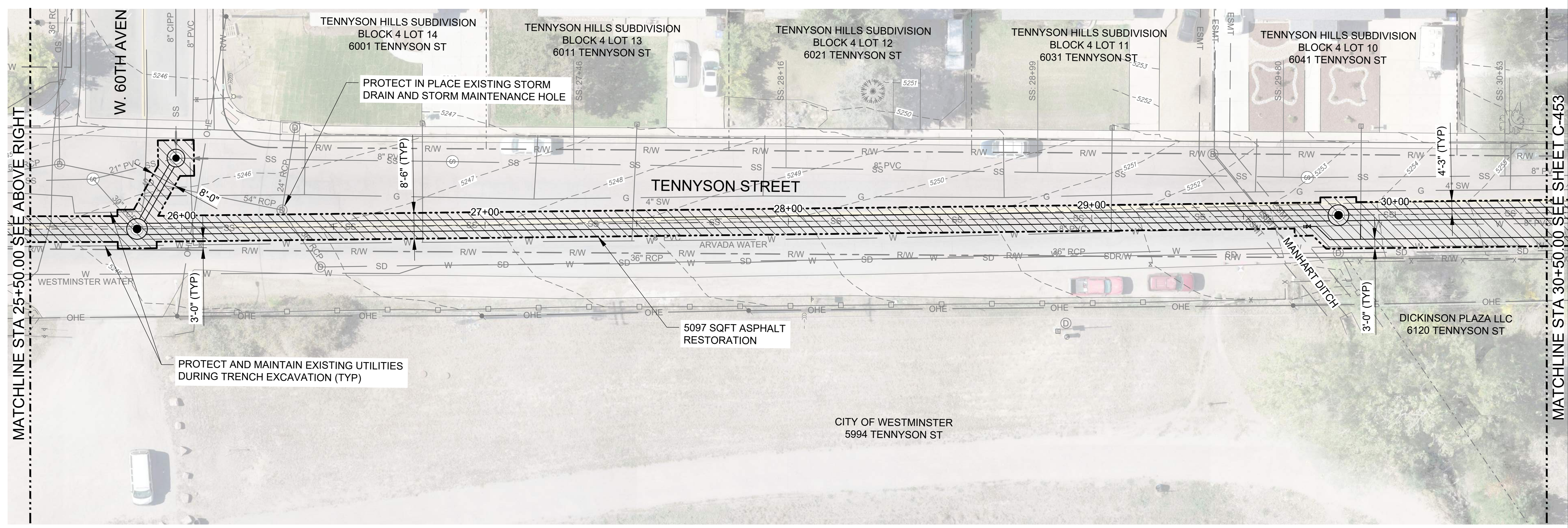
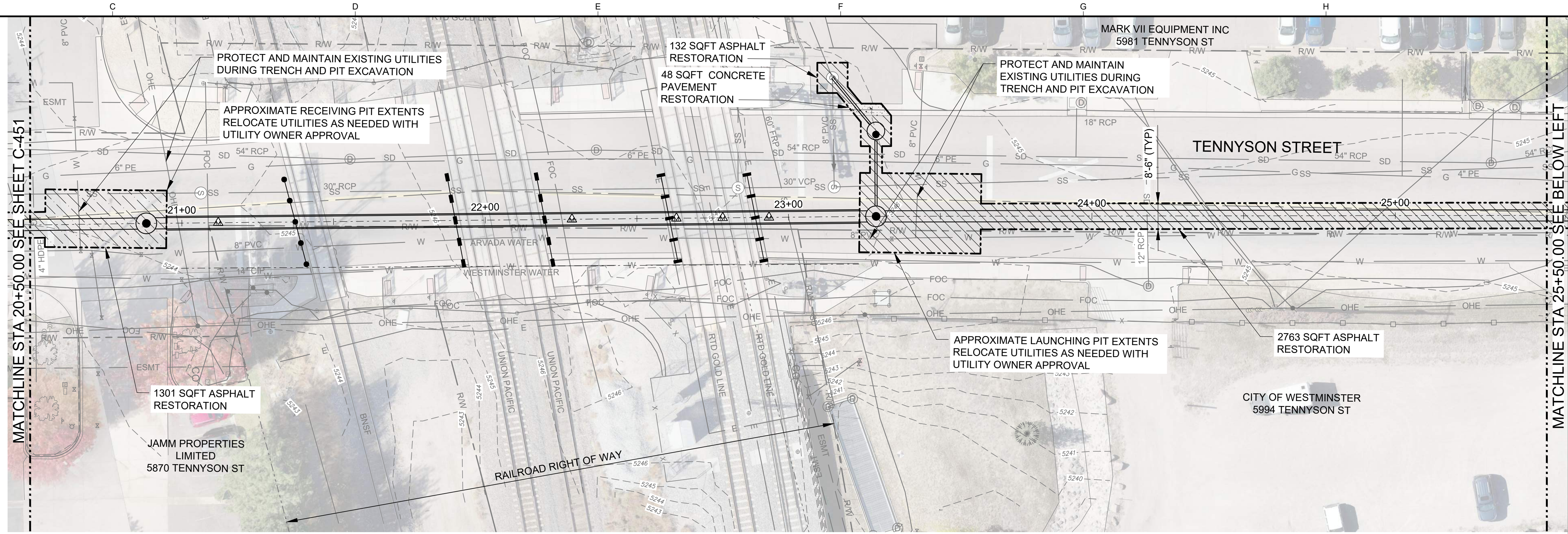
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JOB NO	2246059'00
DATE	JAN 2024
SHEET	20 OF 52
	C-451





**SITE RESTORATION LEGEND**

- APPROX ASPHALT PATCHING, CONCRETE REPAIR, AND TRENCH RESTORATION EXTENTS (LIMITS OF WORK)
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**SCALES**

0" = 1"  
0" = 25mm

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CITY OF ARVADA  
**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**  
 Kennedy Jenks

**SITE RESTORATION**  
STA 20+50 TO 30+50

SCALE 1" = 20'  
JOB NO 2246059\*00  
DATE JAN 2024  
SHEET 21 OF 52  
C-452

MATCHLINE STA 20+50.00 SEE SHEET C-451

MATCHLINE STA 25+50.00 SEE BELOW LEFT

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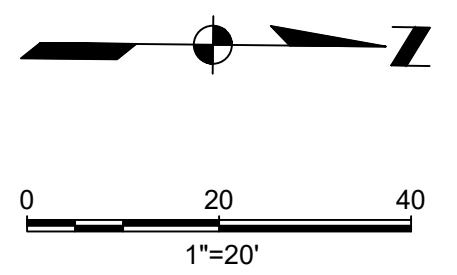
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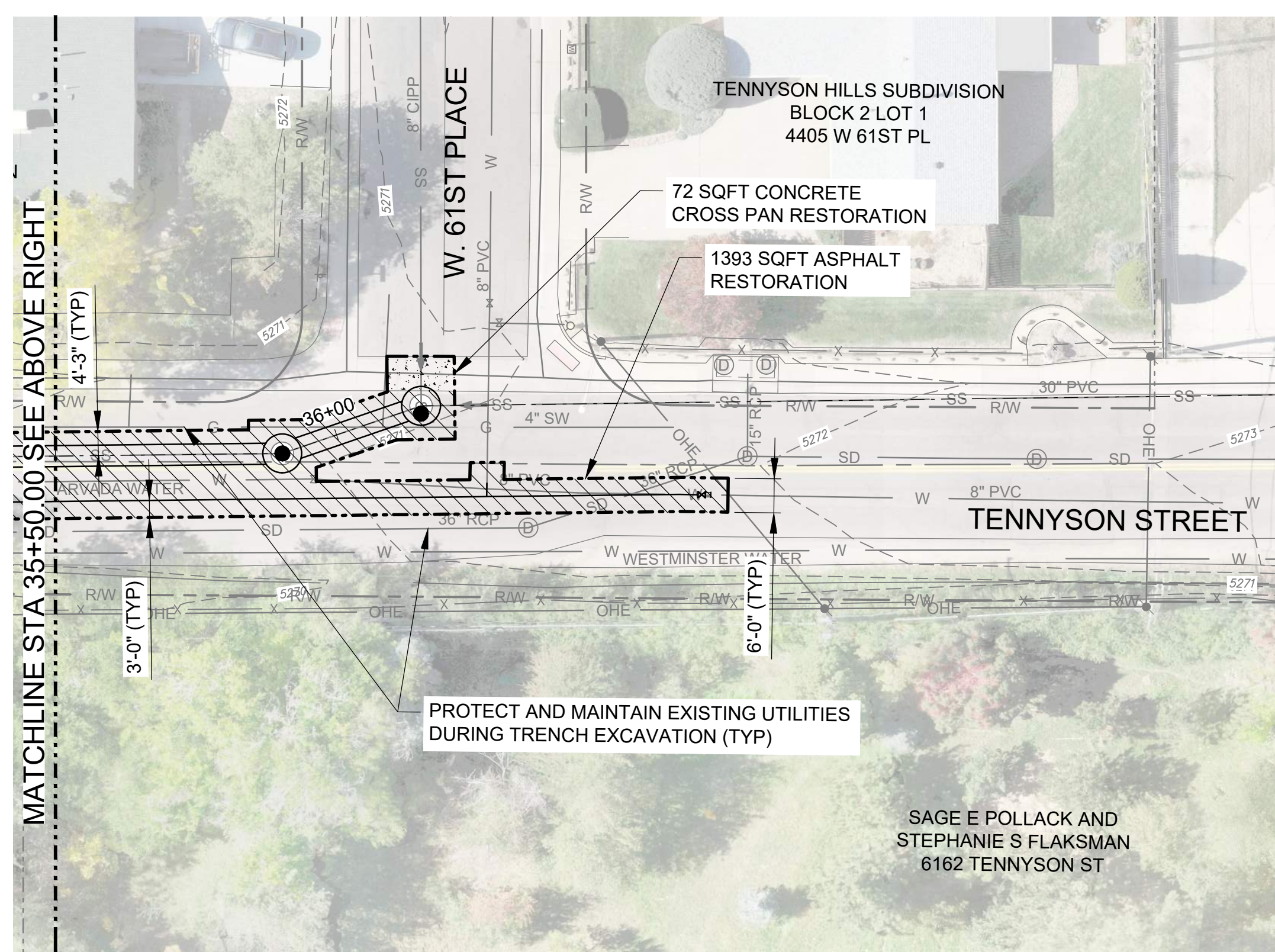
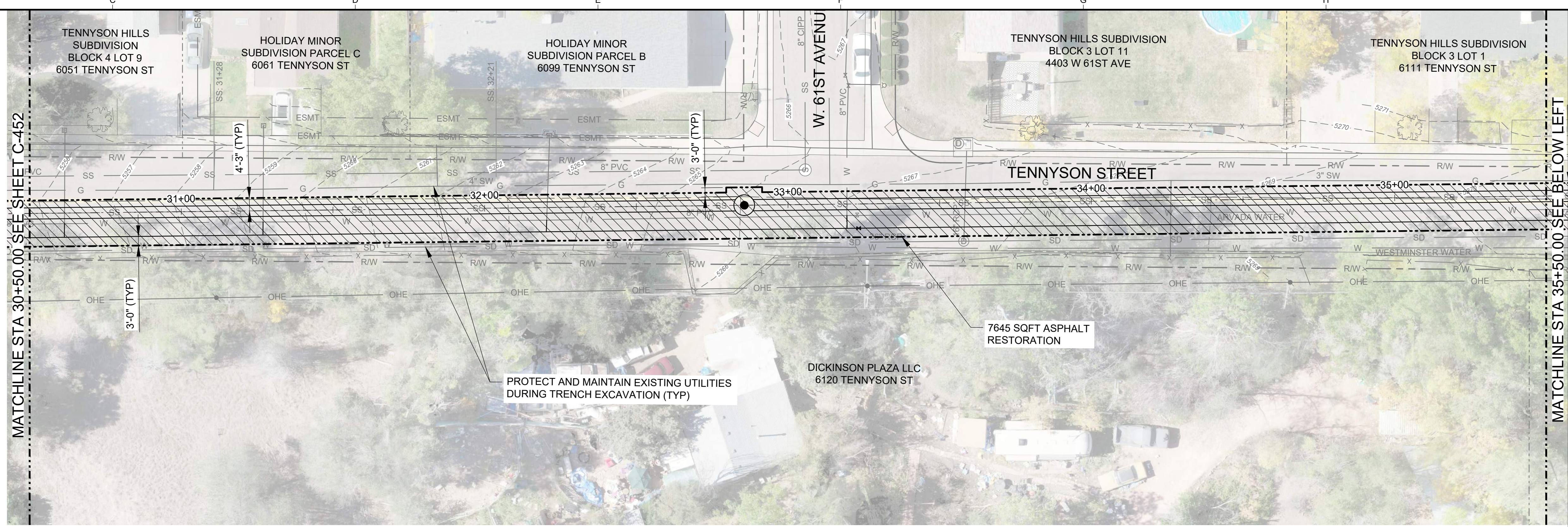
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### SITE RESTORATION LEGEND

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- ADA RAMP REPLACEMENT



QUANTITIES TABLE				
#	ITEM	DESCRIPTION	QUANTITY	UNIT
1	TRENCH RESTORATION - ASPHALT	ASPHALT ROAD	28,858	SF
2	TRENCH RESTORATION - CONCRETE	CONCRETE ROAD/DRIVE	798	SF
3	TRENCH RESTORATION - SWALE	GRASS DRAINAGE SWALE	3,720	SF
4	TRENCH RESTORATION - SIDEWALK	CONCRETE SIDEWALK	123	SF
5	TRENCH RESTORATION - CURB	CONCRETE CURB	304	LF
6	TRENCH RESTORATION - PAN	CONCRETE PAN	655	SF
7	TRENCH RESTORATION - ADA RAMP	CITY OF ARVADA ADA RAMP	2	EA
8	TRENCH RESTORATION - GRAVEL	LANDSCAPE GRAVEL	894	SF
9	UTILITY - WATER	8" PVC WATER MAIN	733	LF
10	UTILITY - WATER	8" GATE VALVE	5	EA
11	UTILITY - WATER	8" 45° BEND	2	EA
12	UTILITY - WATER	8" RESTRAINED COUPLING	2	EA
13	UTILITY - WATER	SERVICE LINE EXTEND AND RECONNECT	4	EA
14	UTILITY - WATER	8" X 8" TEE	2	EA
15	UTILITY - SANITARY	42" GRAVITY PIPE	3,381	LF
16	UTILITY - SANITARY	30" GRAVITY PIPE	93	LF
16	UTILITY - SANITARY	21" GRAVITY PIPE	24	LF
17	UTILITY - SANITARY	8" GRAVITY PIPE	50	LF
18	UTILITY - SANITARY	1.5" FORCE MAIN	52	LF
19	UTILITY - SANITARY	5' DIA MAINTENANCE HOLE	4	EA
20	UTILITY - SANITARY	6' DIA MAINTENANCE HOLE	17	EA
21	UTILITY - WATER RELOCATION	WATER SERVICE RELOCATION	1	EA
22	UTILITY - WATER RELOCATION	6" WATER RELOCATION	1	EA
23	UTILITY - WATER RELOCATION	8" WATER RELOCATION	2	EA
24	UTILITY - WATER RELOCATION	12" WATER RELOCATION	1	EA
25	UTILITY - GAS RELOCATION	2" GAS RELOCATION	4	EA
26	UTILITY - GAS RELOCATION	6" GAS RELOCATION	1	EA
27	UTILITY - FIBER/ELEC RELOCATION	FIBER/ELEC RELOCATION	1	EA

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

**SCALES**

0" = 1"  
0" = 25mm

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TS

DRAWN  
WAS

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**SITE RESTORATION  
STA 30+50 TO 37+00**

SCALE  
1" = 20'

JOB NO  
2246059'00

DATE  
JAN 2024

SHEET 22 OF 52

**C-453**



**GENERAL STRUCTURAL NOTES**

- GENERAL**
- DESIGN AND CONSTRUCTION SHALL CONFORM TO THE 2018 INTERNATIONAL BUILDING CODE AND THE REFERENCED BUILDING CODE STANDARDS.
  - THESE NOTES AS WELL AS THE TYPICAL DETAILS APPLY TO ALL PARTS OF THE PROJECT, UNLESS NOTED OTHERWISE.
  - SHOP DRAWINGS FOR THIS CONTRACT SHALL BE COORDINATED WITH FAVORABLY REVIEWED EQUIPMENT MANUFACTURER'S DRAWINGS.
  - DIMENSIONS NOTED WITH AN ASTERISK, "\*", ARE TO BE COORDINATED WITH FAVORABLY REVIEWED SUBMITTAL BY THE EQUIPMENT MANUFACTURER(S).
  - APPLY THE DETAILS SHOWN WHERE APPLICABLE AND COORDINATE WITH OTHER DISCIPLINE DRAWINGS.
  - ALL STRUCTURES HAVE BEEN DESIGNED FOR THE COMPLETE CONDITION, CONSIDERING OPERATIONAL, HYDROSTATIC, AND BACKFILL LOADS ONLY. THE STRUCTURES HAVE NOT BEEN DESIGNED TO RESIST OPERATIONAL, HYDROSTATIC, OR BACKFILL LOADS WHILE PARTIALLY CONSTRUCTED. OVERLOADING OF ANY STRUCTURES WHILE PARTIALLY CONSTRUCTED IS PROHIBITED.
  - ALL DIMENSIONS AND SIZES SHOWN ARE APPROXIMATE AND PROVIDED AS AN AID IN INTERPRETING THE ANTICIPATED EXISTING CONDITIONS. FIELD VERIFY ALL DIMENSIONS SHOWN WITH EXISTING CONDITIONS.
  - THE CONTRACTOR SHALL FIELD VERIFY ALL EXISTING CONDITIONS PRIOR TO ORDERING OR FABRICATING ANY MATERIALS. NOTIFY THE STRUCTURAL ENGINEER OF RECORD OF ANY POSSIBLE DISCREPANCIES BEFORE CONSTRUCTION.
  - DO NOT DAMAGE, OVERCUT, SCRATCH, OR CRACK ANY PORTION OF THE EXISTING STRUCTURE NOT INTENDED TO BE MODIFIED, PROTECT AND PRESERVE PORTIONS OF THE EXISTING STRUCTURE NOT INTENDED TO BE MODIFIED.

- PERMITS AND INSPECTIONS**
- THE CONTRACTOR IS RESPONSIBLE FOR OBTAINING ALL PERMITS AND INSPECTIONS REQUIRED BY THE LOCAL BUILDING INSPECTOR AND AS DESCRIBED IN THE SPECIFICATIONS.
  - THE CONTRACTOR SHALL SELECT, INSTALL AND MAINTAIN SHORING, SHEETING, BRACING AND SLOPING AS NECESSARY TO MAINTAIN SAFE WORKING CONDITIONS. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ENSURING FULL COMPLIANCE WITH 29 CFR PART 1926 OSHA SUBPART P EXCAVATIONS AND TRENCHES REQUIREMENTS. ALL EARTHWORK SHALL BE PERFORMED IN STRICT ACCORDANCE WITH APPLICABLE LAW, INCLUDING LOCAL ORDINANCES AND APPLICABLE OSHA REQUIREMENTS.

- SPECIAL INSPECTIONS AND STRUCTURAL OBSERVATIONS**
- THE CONTRACTOR SHALL NOTIFY THE ENGINEER 48-HOURS BEFORE PLACEMENT OF REINFORCING STEEL AND CONCRETE SO THAT EXISTING CONDITIONS MAY BE INSPECTED BY ENGINEER.
  - STRUCTURAL OBSERVATION SHALL BE PROVIDED BY THE DESIGN ENGINEER(S) OF RECORD OR THEIR AUTHORIZED REPRESENTATIVES IN ACCORDANCE WITH THE IBC, CHAPTER 17. STRUCTURAL OBSERVATION SHALL CONSIST OF SITE VISITS AT INTERVALS APPROPRIATE TO THE STAGE OF CONSTRUCTION TO OBSERVE CONSTRUCTION IN PROGRESS AND REVIEW OF TESTING AND INSPECTION REPORTS FOR GENERAL COMPLIANCE WITH THE CONSTRUCTION DOCUMENTS RELATING TO THE STRUCTURAL WORK AND THE NONSTRUCTURAL COMPONENTS AND EQUIPMENT ANCHORAGE.
  - SPECIAL INSPECTION IN ACCORDANCE WITH IBC CHAPTER 17, SHALL BE REQUIRED AS INDICATED IN THE SPECIAL INSPECTION AND TESTING SCHEDULE ON THIS SHEET.

- SOIL AND FOUNDATIONS**
- (PENDING FINAL GEOTECHNICAL RECOMMENDATIONS REPORT)
  - ALLOWABLE BEARING CAPACITY OF THE METERING VAULT IS 3500 PSF.
  - SUBGRADE PREPARATION: THE EXPOSED SUBGRADE SHOULD BE CAREFULLY INSPECTED VIA PROOF ROLLING, PROBING, AND TESTING, AS DETERMINED NECESSARY BY THE GEOTECHNICAL ENGINEER. FROZEN, WET, SOFT, OR LOOSE SOIL, AS WELL AS ANY OTHER UNDESIRABLE MATERIAL SHOULD BE REMOVED. ONCE SUITABLE SOIL CONDITIONS ARE ACHIEVED, THE SUBGRADE SHOULD BE SCARIFIED AND COMPACTED PRIOR TO FILL PLACEMENT. THE SUITABLE EXPOSED SOIL MATERIALS SHOULD BE SCARIFIED AND MOISTENED OR DRIED, AS NECESSARY, TO A MINIMUM DEPTH OF 8 INCHES BELOW THE PROPOSED CONSTRUCTION.
  - BACKFILL: BACKFILL STRUCTURE WITH SUITABLE MATERIAL, MOISTURE CONDITIONED TO WITHIN -1% AND +3% RELATIVE TO THE MAXIMUM DRY DENSITY PER ASTM D698. COMPACT TO 95% RELATIVE COMPACTION PER ASTM D698. BACKFILL IN LIFTS NOT EXCEEDING 8-INCHES.

- LOADING CRITERIA**
- MINIMUM LOADING REQUIREMENTS PER CHAPTER 16 OF THE 2018 IBC.
  - DEAD LOAD:
 

MATERIAL SELF WEIGHT	SEE DRAWINGS, CONC. 150PCF
METERING VAULT LIVE LOADS:	
ROOF SLAB	250 PSF UNIFORM OR H20 VEHICLE (HL-93)
LADDER RUNGS	300 LBS POINT
TRAFFIC LOADING:	HL-93
  - WIND LOAD:
 

BASIC WIND SPEED, $V_{ULT}$	134 MPH (CITY OF ARVADA)
NOMINAL WIND SPEED, $V_{ASD}$	106 MPH
EXPOSURE	C
RISK CATEGORY	III
  - SNOW LOAD:
 

IMPORTANCE FACTOR, $I_s$	1.10
BASIC GROUND SNOW LOAD, $P_g$	30 PSF (CITY OF ARVADA)
  - SEISMIC LOAD:
 

SEISMIC IMPORTANCE FACTOR, $I_e$	1.25
MAPPED RESPONSE PARAMETER, $S_s$	0.216
MAPPED RESPONSE PARAMETER, $S_1$	0.059
SITE CLASS	D, DEFAULT
DESIGN RESPONSE PARAMETER, $S_{DS}$	0.23
DESIGN RESPONSE PARAMETER, $S_{D1}$	0.094
SEISMIC DESIGN CATEGORY	B
LONG PERIOD TRANSITION PERIOD, $T_L$	4s

- REINFORCING STEEL**
- REINFORCING BARS SHALL BE ASTM A615-GRADE 60.
  - ARRANGEMENT AND DETAILING OF REINFORCING STEEL, INCLUDING BAR SUPPORTS AND SPACERS, SHALL BE IN ACCORDANCE WITH THE LATEST ACI 315 DETAILING MANUAL.
  - NO WELDING OF REINFORCING BARS SHALL BE PERMITTED, UNLESS APPROVAL IN WRITING IS OBTAINED FROM THE ENGINEER PRIOR TO CONSTRUCTION.
  - DIMENSIONS TO REINFORCING ARE TO BAR CENTERLINES, UNLESS NOTED OTHERWISE. BAR COVER IS CLEAR DISTANCE BETWEEN THE BAR AND THE CONCRETE SURFACE. UNLESS NOTED OR SHOWN OTHERWISE BAR COVER FOR REINFORCING STEEL SHALL BE AS FOLLOWS:

SLAB AND PADS, EXTERIOR:  
 FORMED SURFACES AND BOTTOMS ON CONCRETE WORK MAT 2-INCH  
 TOP SURFACES EXPOSED TO EARTH, WATER, OR WEATHER 2-INCH  
 BOTTOMS AND SIDES IN CONTACT WITH EARTH 3-INCH  
 EQUIPMENT PADS, INTERIOR:  
 FORMED SURFACES AND TOP SURFACE 1-1/2-INCH

- CONCRETE:**
- CEMENT SHALL BE ASTM C150 TYPE II FOR ALL STRUCTURES. CONCRETE SHALL HAVE A MINIMUM 28 DAY COMPRESSIVE STRENGTH (PSI) AS NOTED IN THE TABLE BELOW AND AS FURTHER DEFINED IN THE SPECIFICATIONS:

CONCRETE STRENGTH (PSI)		
TYPE	STRENGTH	LOCATION
A	4,500	ALL CONCRETE UNLESS OTHERWISE NOTED
B	4,000	CONCRETE FILL, PAVING/ SIDEWAKS

- CONCRETE CONSTRUCTION SHALL CONFORM TO ACI 350-06 INCLUDING BAR BENDS AND HOOKS, UNLESS DETAILED OTHERWISE.
- OPENINGS, PIPE SLEEVES, CONDUITS, INSERTS AND OTHER EMBEDDED ITEMS SHALL BE IN PLACE BEFORE CONCRETE IS PLACED. IT IS THE CONTRACTOR'S RESPONSIBILITY TO COORDINATE ARCHITECTURAL, CIVIL, MECHANICAL, ELECTRICAL, LANDSCAPING, HVAC, PLUMBING, INSTRUMENTATION AND OTHER PLANS FOR ITEMS REQUIRING SLEEVES AND EMBEDMENTS IN CONCRETE WHICH ARE NOT INDICATED OR SHOWN ON STRUCTURAL DRAWINGS. NO PIPES OR SLEEVES SHALL PASS THROUGH STRUCTURAL MEMBERS (UNLESS SHOWN ON STRUCTURAL DRAWINGS); COORDINATE WITH EQUIPMENT MANUFACTURERS DRAWINGS FOR ANCHORING DEVICES.
- UNLESS OTHERWISE NOTED, ALL EXPOSED EDGES AND CORNERS SHALL BE CHAMFERED 3/4-INCH. INTERIOR FLOOR SLABS AND EXTERIOR SIDEWALKS SHALL HAVE TOOLED 3/8-INCH RADIUS CONSTRUCTION JOINT.

- FRP:**
- SEE SPECIFICATION 06600.

- DEFERRED SUBMITTALS**
- IN ACCORDANCE WITH THE IBC, SUBMITTAL DOCUMENTS FOR DEFERRED SUBMITTAL ITEMS SHALL BE SUBMITTED TO THE ARCHITECT OR ENGINEER OF RECORD WHO SHALL REVIEW THEM WITH SUBSEQUENT SUBMITTAL TO THE BUILDING OFFICIAL WITH A NOTATION INDICATING THAT THE DEFERRED SUBMITTAL DOCUMENTS HAVE BEEN REVIEWED AND THAT THEY HAVE BEEN FOUND TO BE IN GENERAL CONFORMANCE WITH THE DESIGN. THE DEFERRED SUBMITTAL ITEMS SHALL NOT BE INSTALLED UNTIL DESIGN AND SUBMITTAL DOCUMENTS HAVE BEEN APPROVED BY THE BUILDING OFFICIAL. THE FOLLOWING ITEMS WILL BE DEFINED AS DEFERRED SUBMITTAL ITEMS:
- METERING VAULT ACCESS HATCH
  - FRP GRATING

**SPECIAL INSPECTIONS AND TESTING**

- GENERAL**
- THE OWNER OR THE OWNER'S AUTHORIZED AGENT, OTHER THAN THE CONTRACTOR, SHALL EMPLOY ONE OR MORE APPROVED AGENCIES TO PROVIDE SPECIAL INSPECTIONS AND TESTS IN ACCORDANCE WITH CHAPTER 17 OF THE 2018 INTERNATIONAL BUILDING CODE DURING CONSTRUCTION ON THE TYPES OF WORK SPECIFIED AND IDENTIFY THE APPROVED AGENCIES TO THE BUILDING OFFICIAL. STRUCTURAL SPECIAL INSPECTIONS AND TESTS SHALL GOVERN THE QUALITY, WORKMANSHIP AND REQUIREMENTS FOR MATERIALS COVERED. MATERIALS OF CONSTRUCTION AND TESTS SHALL CONFORM TO THE APPLICABLE STANDARDS LISTED IN THE REFERENCED BUILDING CODE.
  - APPROVED AGENCY: AN ESTABLISHED AND RECOGNIZED AGENCY THAT IS REGULARLY ENGAGED IN CONDUCTING TESTS OR FURNISHING INSPECTION SERVICES, WHERE SUCH AGENCY HAS BEEN APPROVED BY THE BUILDING OFFICIAL. THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE AND ENGINEERS OF RECORD INVOLVED IN THE DESIGN OF THE PROJECT ARE PERMITTED TO ACT AS THE APPROVED AGENCY.
  - ACCESS FOR SPECIAL INSPECTION: THE CONSTRUCTION OR WORK FOR WHICH SPECIAL INSPECTION OR TESTING IS REQUIRED SHALL REMAIN ACCESSIBLE AND EXPOSED FOR SPECIAL INSPECTION OR TESTING PURPOSES UNTIL COMPLETION OF THE REQUIRED SPECIAL INSPECTIONS OR TESTS.
  - REPORT REQUIREMENT: APPROVED AGENCIES SHALL KEEP RECORDS OF SPECIAL INSPECTIONS AND TESTS. THE APPROVED AGENCY SHALL SUBMIT REPORTS OF SPECIAL INSPECTIONS AND TESTS TO THE BUILDING OFFICIAL AND TO THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE. REPORTS SHALL INDICATE THAT WORK INSPECTED OR TESTED WAS OR WAS NOT COMPLETED IN CONFORMANCE TO APPROVED CONSTRUCTION DOCUMENTS. DISCREPANCIES SHALL BE BROUGHT TO THE IMMEDIATE ATTENTION OF THE CONTRACTOR FOR CORRECTION. IF THEY ARE NOT CORRECTED, THE DISCREPANCIES SHALL BE BROUGHT TO THE ATTENTION OF THE BUILDING OFFICIAL AND TO THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE PRIOR TO THE COMPLETION OF THAT PHASE OF THE WORK. A FINAL REPORT DOCUMENTING REQUIRED SPECIAL INSPECTIONS AND TESTS AND CORRECTION OF ANY DISCREPANCIES NOTED IN THE INSPECTIONS OR TESTS SHALL BE SUBMITTED AT A POINT IN TIME AGREED UPON PRIOR TO THE START OF WORK BY THE OWNER OR THE OWNER'S AUTHORIZED AGENT TO THE BUILDING OFFICIAL.
  - SPECIAL INSPECTIONS OF FABRICATED ITEMS: WHERE FABRICATION OF STRUCTURAL, LOAD-BEARING OR LATERAL LOAD-RESISTING MEMBERS OR ASSEMBLIES IS BEING CONDUCTED ON THE PREMISES OF A FABRICATOR'S SHOP, SPECIAL INSPECTIONS OF THE FABRICATED ITEMS SHALL BE PERFORMED DURING FABRICATION.
  - STATEMENT OF SPECIAL INSPECTIONS: THE REGISTERED DESIGN PROFESSIONAL IN RESPONSIBLE CHARGE SHALL PREPARE A STATEMENT OF SPECIAL INSPECTIONS.
  - MATERIAL TESTS: IN THE ABSENCE OF SUFFICIENT DATA OR DOCUMENTATION PROVIDING EVIDENCE OF CONFORMANCE TO QUALITY STANDARDS FOR MATERIALS IN CHAPTERS 19 AND 20 OF ACI 318, THE BUILDING OFFICIAL SHALL REQUIRE TESTING OF MATERIALS IN ACCORDANCE WITH THE APPROPRIATE STANDARDS AND CRITERIA FOR THE MATERIAL IN CHAPTERS 19 AND 20 OF ACI 318.
  - CONTRACTOR RESPONSIBILITY: CORRECT DISCREPANCIES IDENTIFIED IN THE SPECIAL INSPECTIONS AND TESTS WHERE WORK WAS NOT COMPLETED IN CONFORMANCE TO APPROVED CONSTRUCTION DOCUMENTS.

- STRUCTURAL OBSERVATIONS**
- STRUCTURAL OBSERVATIONS SHALL BE PROVIDED AT THE FOLLOWING EXTENT AND FREQUENCY:
    - PRIOR TO METERING VAULT BASE SLAB PLACEMENT AFTER REINFORCEMENT AND FORMWORK IS INSTALLED.
    - PRIOR TO METERING VAULT WALL PLACEMENT AFTER REINFORCEMENT IS INSTALLED.
    - PRIOR TO METERING VAULT TOP SLAB PLACEMENT AFTER REINFORCEMENT AND FORMWORK IS INSTALLED.

- CONCRETE TESTING SCHEDULE:**
- [X] EACH MIX PLACED, EACH DAY PLACED, SEE SPECIFICATIONS FOR QUANTITY OF CYLINDERS
  - [X] SLUMP TEST - PER 50 CY & AT STRENGTH SAMPLE
  - [X] AIR TEST - PER STRENGTH SAMPLES SCHEDULE
  - [X] UNIT WEIGHT TEST - PER STRENGTH SAMPLES

REQUIRED VERIFICATION AND INSPECTION OF CONCRETE CONSTRUCTION					
SPECIAL INSPECTION REQUIRED	VERIFICATION AND INSPECTION	CONT	PERIODIC	REFERENCED STANDARD	IBC REF
YES	1. INSPECTION OF REINFORCING STEEL, AND VERIFY PLACEMENT	--	X	ACI 318: CH. 20, 25.2, 25.3, 26.6.1-26.6.3	1908.4
YES	2. INSPECT ANCHORS CAST IN CONCRETE	--	X	ACI 318: 17.8.2	--
3. INSPECTION OF ANCHORS POST-INSTALLED IN HARDENED CONCRETE MEMBERS:					
YES	a. ADHESIVE ANCHORS INSTALLED IN HORIZONTALLY OR UPWARDLY INCLINED ORIENTATIONS TO RESIST SUSTAINED TENSION LOADS	--	X	ACI 318 17.8.2.4	--
	b. MECHANICALLY ANCHORS AND ADHESIVE ANCHORS NOT DEFINED IN 3.a				
YES	4. VERIFYING USE OF REQUIRED DESIGN MIX	--	X	ACI 318:Ch 19.26.4.3, 26.4.4	1904.1, 1904.2, 1908.2, 1908.3
YES	5. PRIOR TO CONCRETE PLACEMENT, FABRICATE SPECIMENS FOR STRENGTH TESTS, PERFORM SLUMP AND AIR CONTENT TESTS, AND DETERMINE THE TEMPERATURE OF THE CONCRETE	X	--	ASTM C172 ASTM C31 ACI 318:26.5, 26.12	1908.10
YES	6. INSPECT CONCRETE FOR PROPER APPLICATION TECHNIQUES.	X	--	ACI 318: 26.5	1908.6, 1908.7, 1908.8
YES	7. VERIFY MAINTENANCE OF SPECIAL CURING TEMPERATURE AND TECHNIQUES.	--	X	ACI 318: 26.5.3-26.5.5	1908.9
YES	8. VERIFY MAINTENANCE OF SPECIFIED CURING TEMPERATURE AND TECHNIQUES.	--	X	ACI 318: 26.5.3-26.5.5	1908.9

SOILS			
REQUIRED SPECIAL INSPECTIONS AND TESTS			
SPECIAL INSPECTION REQUIRED	TYPE	CONT	PERIODIC
YES	1. VERIFY MATERIALS BELOW FOUNDATIONS ARE ADEQUATE TO ACHIEVE THE DESIGN BEARING CAPACITY.	--	X
YES	2. VERIFY EXCAVATIONS ARE EXTENDED TO PROPER DEPTH AND HAVE REACHED PROPER MATERIAL.	--	X
YES	3. PERFORM CLASSIFICATION AND TESTING OF COMPACTED FILL MATERIALS.	--	X
YES	4. VERIFY USE OF PROPER MATERIALS, DENSITIES AND LIFT THICKNESSES DURING PLACEMENT AND COMPACTION OF COMPACTED FILL.	X	--
YES	5. PRIOR TO PLACEMENT OF COMPACTED FILL, OBSERVE SUBGRADE AND VERIFY THAT SITE HAS BEEN PREPARED PROPERLY.	--	X

**APPROVED**  
City of Arvada, Colorado

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CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

**SCALES**

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 DRAWN: MW  
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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**GENERAL NOTES AND SPECIAL INSPECTIONS**

SCALE

JOB NO 2246059\*00

DATE FEB 2024

SHEET 23 OF 52

**S-001**

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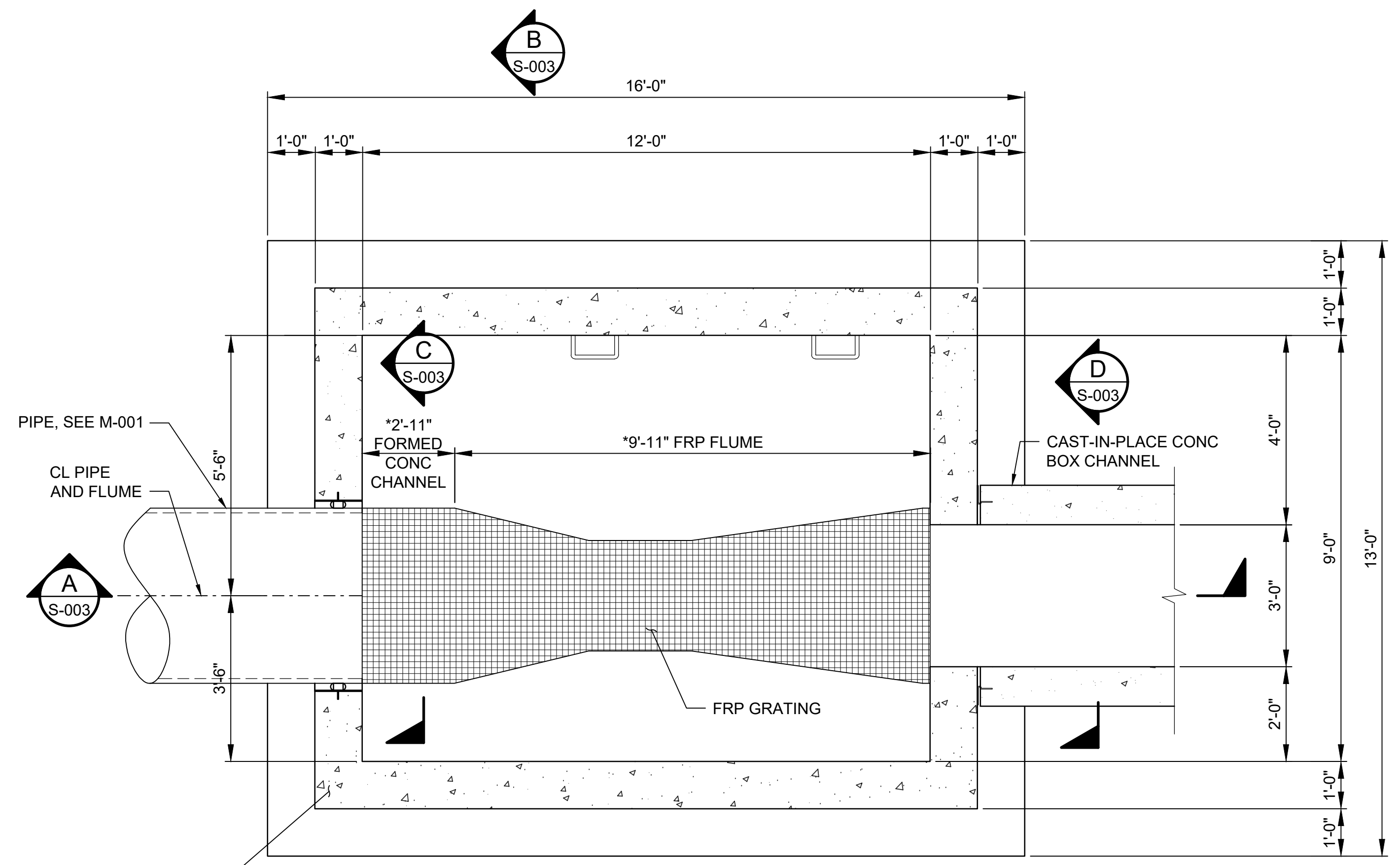
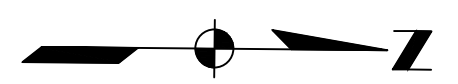


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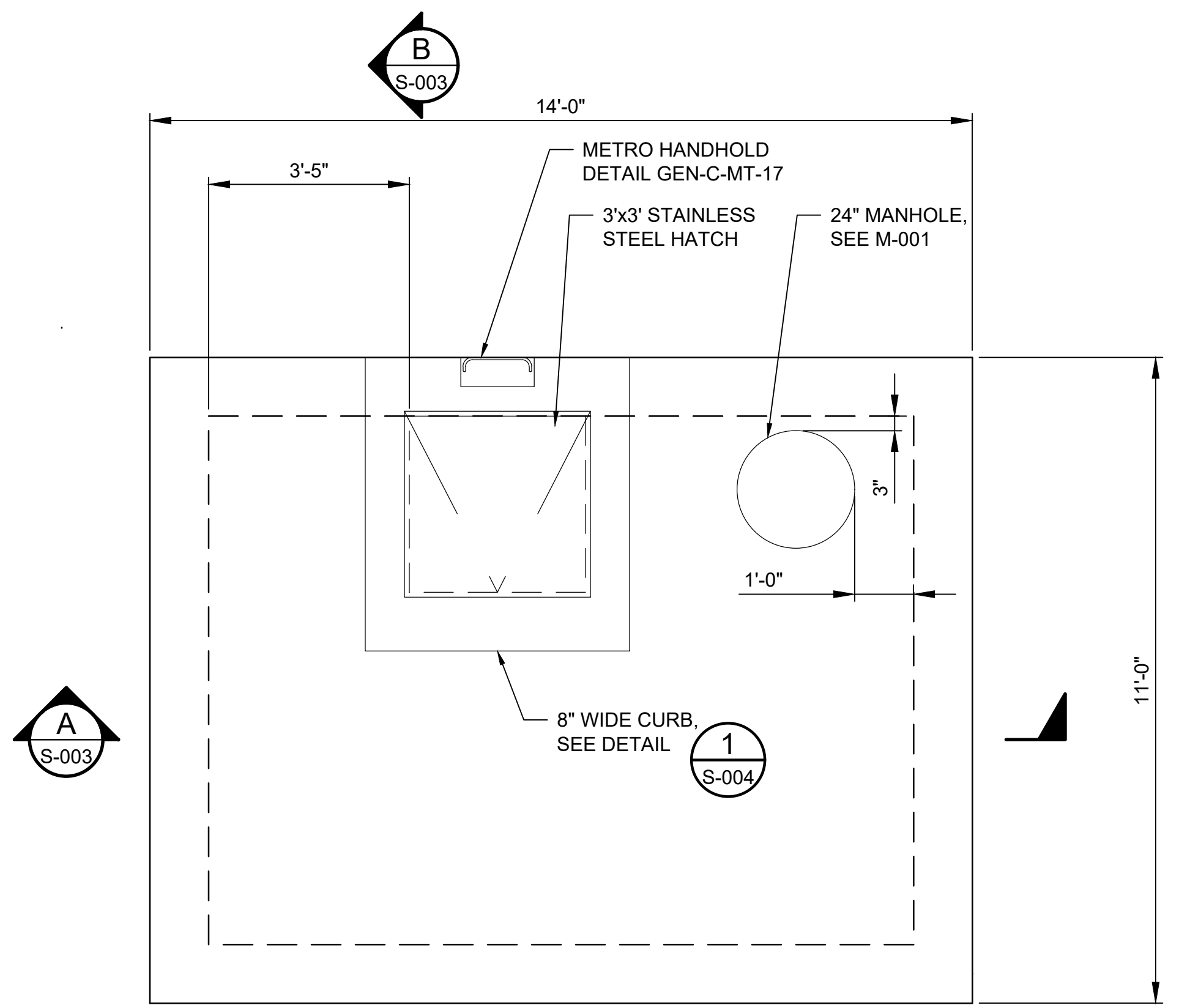
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- GENERAL SHEET NOTES**
- SEE DRAWING S-001 FOR STRUCTURAL GENERAL NOTES.
  - OPENINGS IN GRATING NOT SHOWN FOR CLARITY. COORDINATE GRATING LAYOUT WITH FAVORABLY REVIEWED EQUIPMENT SHOP DRAWINGS.
  - COATING SYSTEMS NOT SHOWN. SEE MECHANICAL DRAWINGS AND PROJECT SPECIFICATIONS FOR COATING REQUIREMENTS.
  - PROVIDE CONSTRUCTION JOINT IN SLAB, WALLS, AND TOP SLAB AT CENTER POINT ALONG THE LENGTH OF CAST-IN-PLACE BOX CHANNEL
  - PROVIDE ADDITIONAL REINFORCEMENT AT ALL OPENINGS PER DETAIL S-3421.



**FOUNDATION PLAN**  
SCALE: 1/2"=1'-0"



**TOP PLAN**  
SCALE: 1/2"=1'-0"

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**STRUCTURAL PLANS**

SCALE

JOB NO: 2246059\*00

DATE: FEB 2024

SHEET 24 OF 52

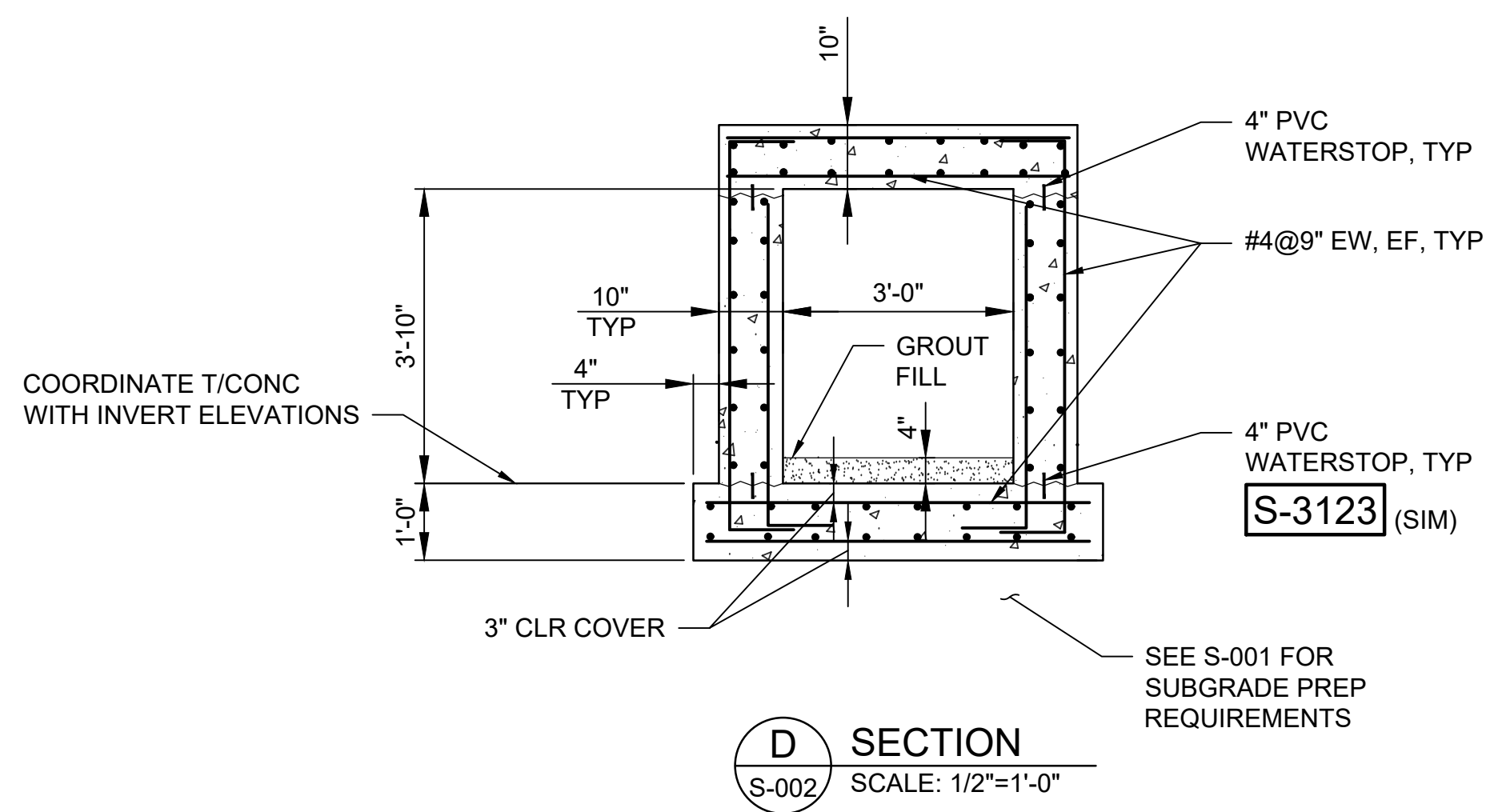
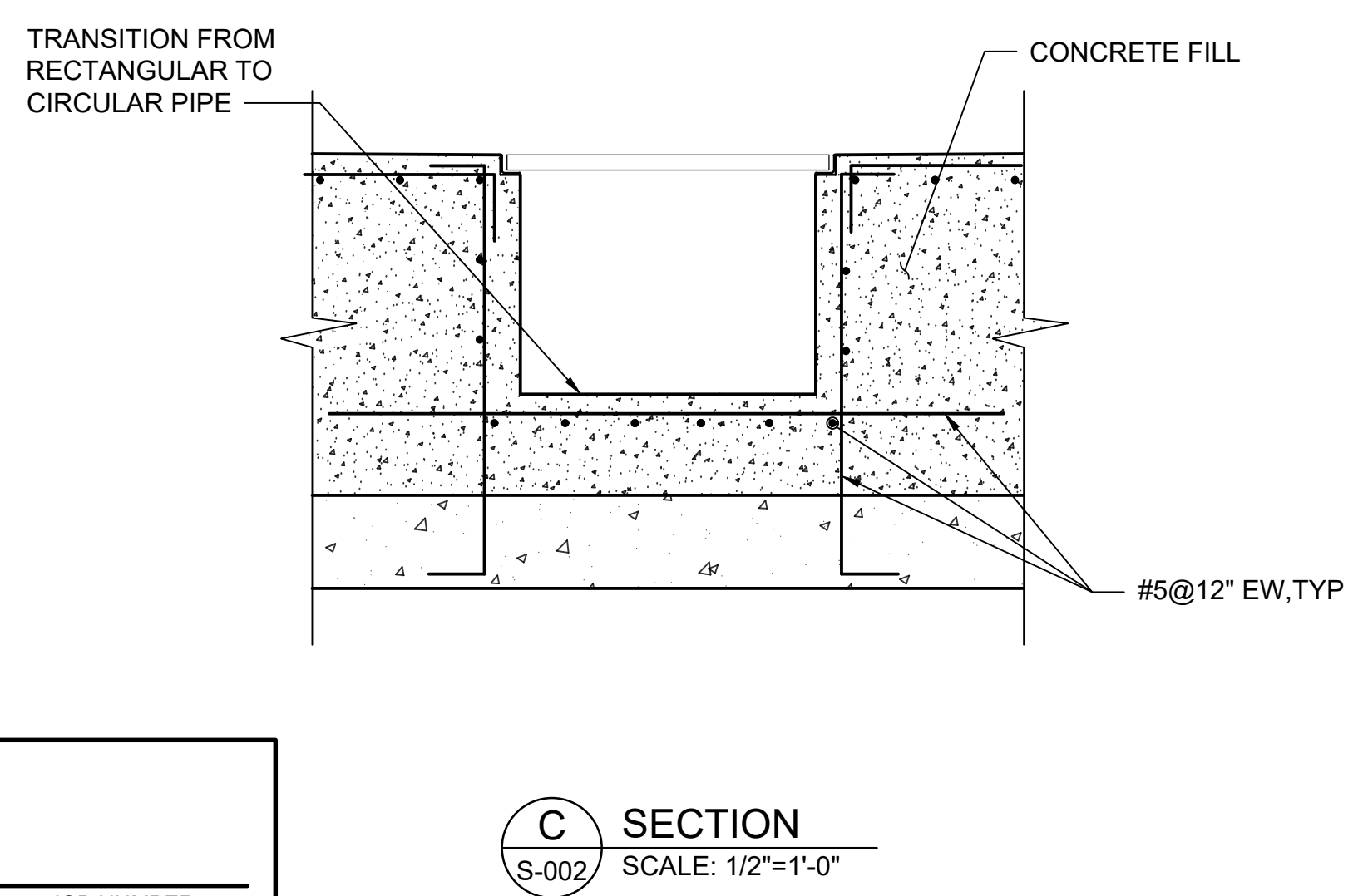
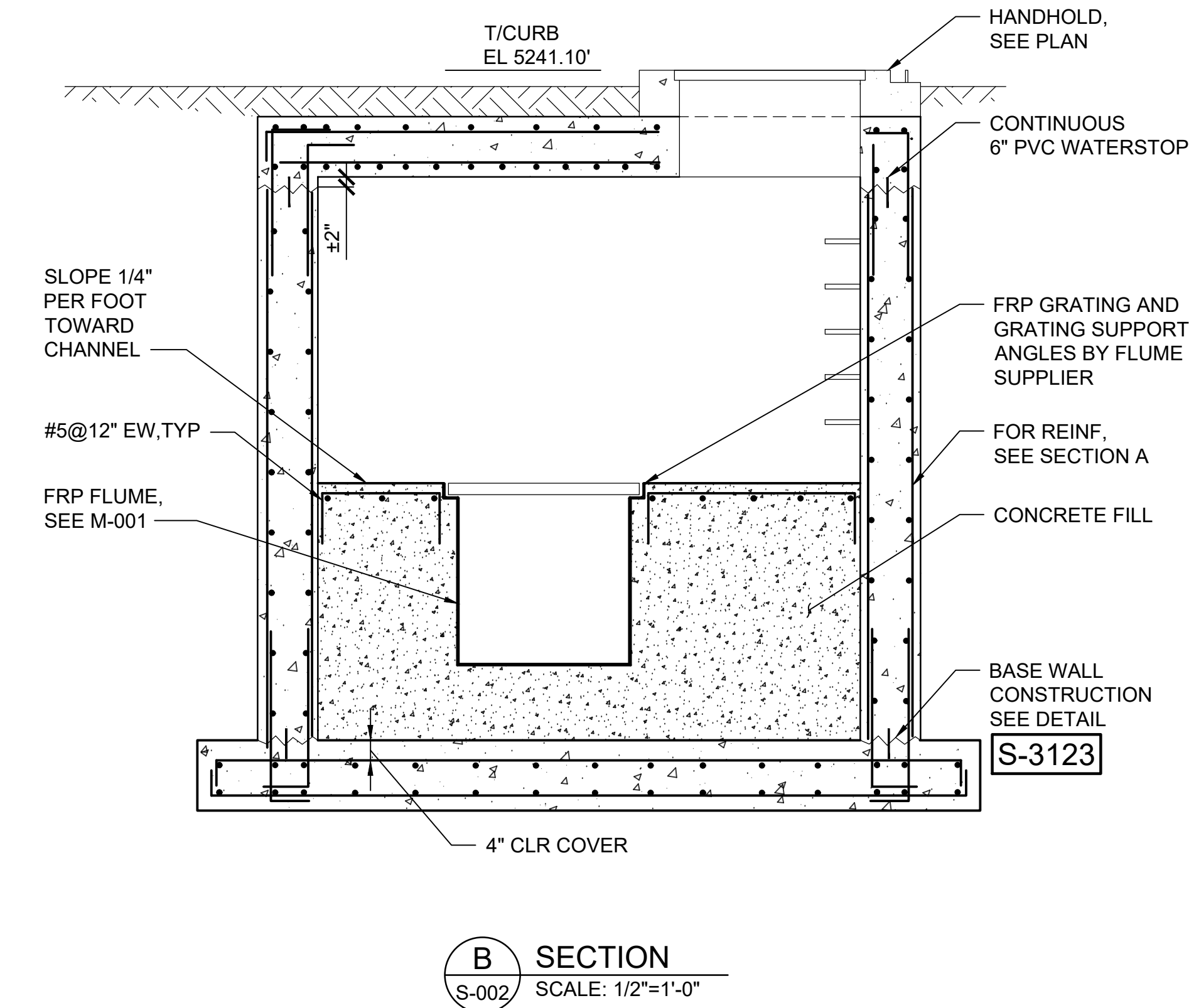
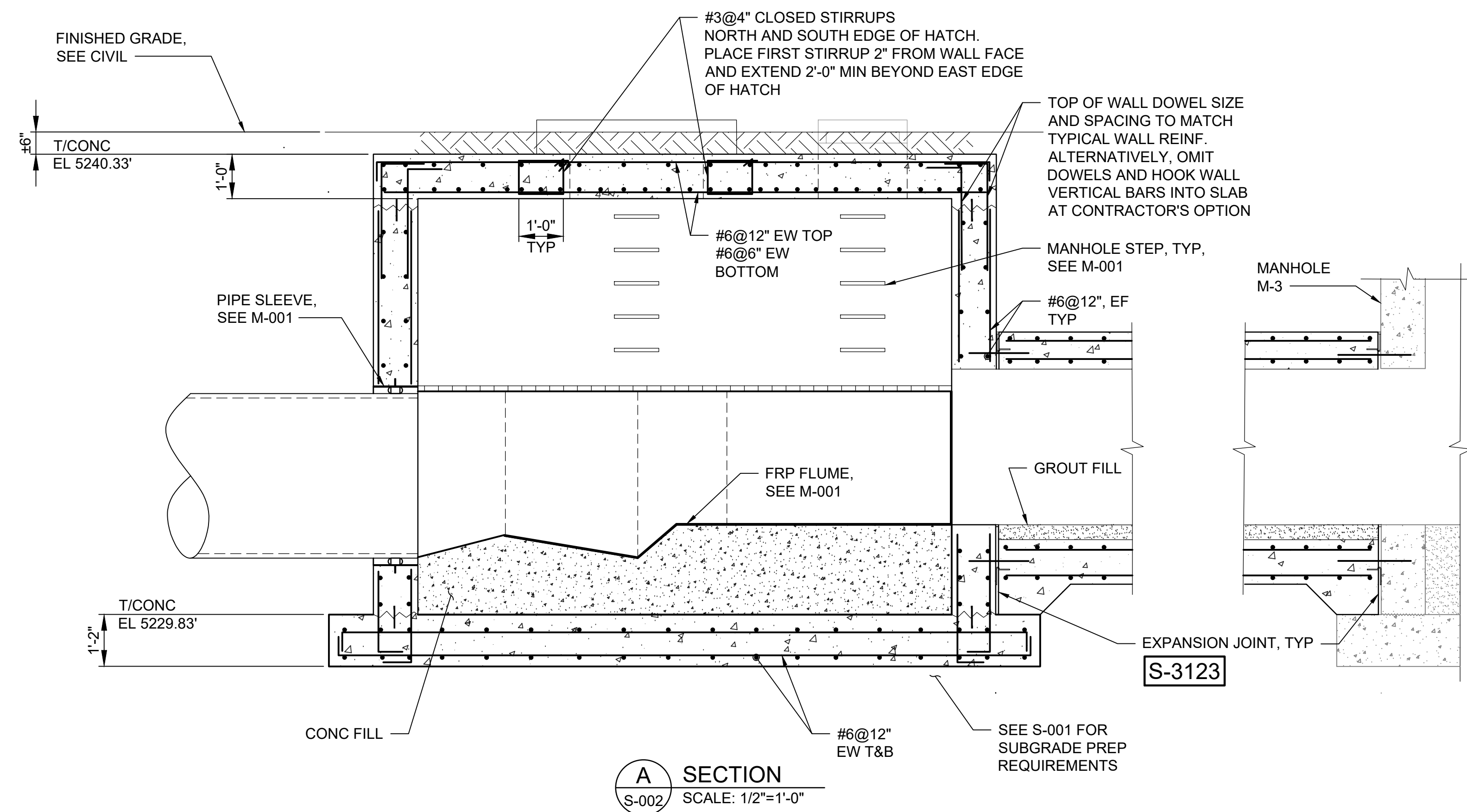
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- GENERAL SHEET NOTES**
- SEE DRAWING S-001 FOR STRUCTURAL GENERAL NOTES.
  - PLACEMENT OF CONCRETE FILL SHALL FOLLOW ACI 301 TEMPERATURE LIMITATIONS. SUBMIT THERMAL CONTROL PLAN FOR REVIEW.
  - ROUGHEN SURFACES IN CONTACT WITH CONCRETE FILL AND GROUT FILL TO 1/4" AMPLITUDE.



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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

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0" = 25mm

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

<b>STRUCTURAL SECTIONS</b>		SCALE
		JOB NO 2246059*00
		DATE FEB 2024
		SHEET 25 OF 52
		S-003



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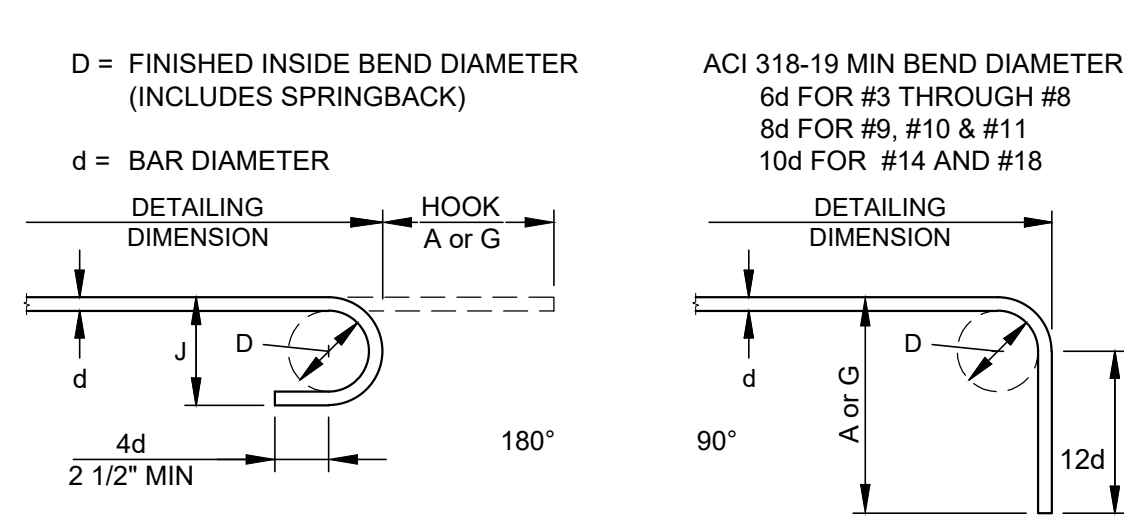
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LAP SPLICE LENGTH FOR REINFORCING BARS IN WALLS, SLABS & FTNGS (INCHES)

BAR SIZE	CONCRETE COMPRESSIVE STRENGTH, $f_c \geq 3,000$ PSI	
	COVER=1.00 IN.	COVER=2.00 IN.
IMPERIAL [SOFT METRIC]	TOP <sup>4</sup> OTHER	TOP <sup>4</sup> OTHER
#3 [#10]	17 13	17 13
#4 [#13]	23 17	23 17
#5 [#16]	33 26	28 22
#6 [#19]	46 35	34 26
#7 [#22]	74 57	55 43
#8 [#25]	93 72	70 54
#9 [#29]	113 87	86 66
#10 [#32]	137 106	105 81
#11 [#36]	162 125	125 97

- NOTES:
- THE SPLICE LENGTH TABLE IS SPECIFIC TO TENSION DEVELOPMENT AND TENSION LAP SPLICE LENGTHS FOR WALLS, SLABS AND FOOTINGS DETERMINED IN ACCORDANCE WITH ACI 318-19, CHAPTER 25, ACI 350-06 CHAPTER 12, AND THE CRITERIA IN THIS DETAIL. CONTACT THE EOR FOR ANY DISCREPANCIES TO THE CRITERIA IN THIS DETAIL.
  - LAP SPLICE LENGTHS ARE CLASS B LAPS, IN INCHES, FOR GRADE 60 REINF IN NORMAL-WEIGHT CONC WITH  $f_c \geq 3,000$  PSI.
  - OC SPACING OF REINF SHALL BE  $>$  TWICE THE CONC COVER PLUS ONE BAR DIA.
  - TOP BARS ARE HORIZ BARS WITH  $>$  12" OF CONC CAST BELOW BARS.
  - FOR EPOXY-COATED REINF OR LIGHTWEIGHT CONC, CONTACT THE EOR FOR LAP SPLICE LENGTHS.
  - FOR BARS OF DIFFERENT SIZES, THE LAP SPLICE LENGTHS OF THE SMALLER BAR SHALL BE USED.
  - STAGGER LAPS A DISTANCE OF ONE-HALF THE SPLICE LENGTH, UON.
  - DO NOT LOCATE LAP SPLICE IN CONSTRUCTION JOINTS (CJ), EXPANSION JOINTS (EJ), OR CONTRACTION JOINTS (CNJ). LOCATE LAPS AT LEAST 4" PAST JOINT UON, TYP.

**CONCRETE REBAR LAP SPLICE** **S-3010**  
SCALE: NTS REV 00

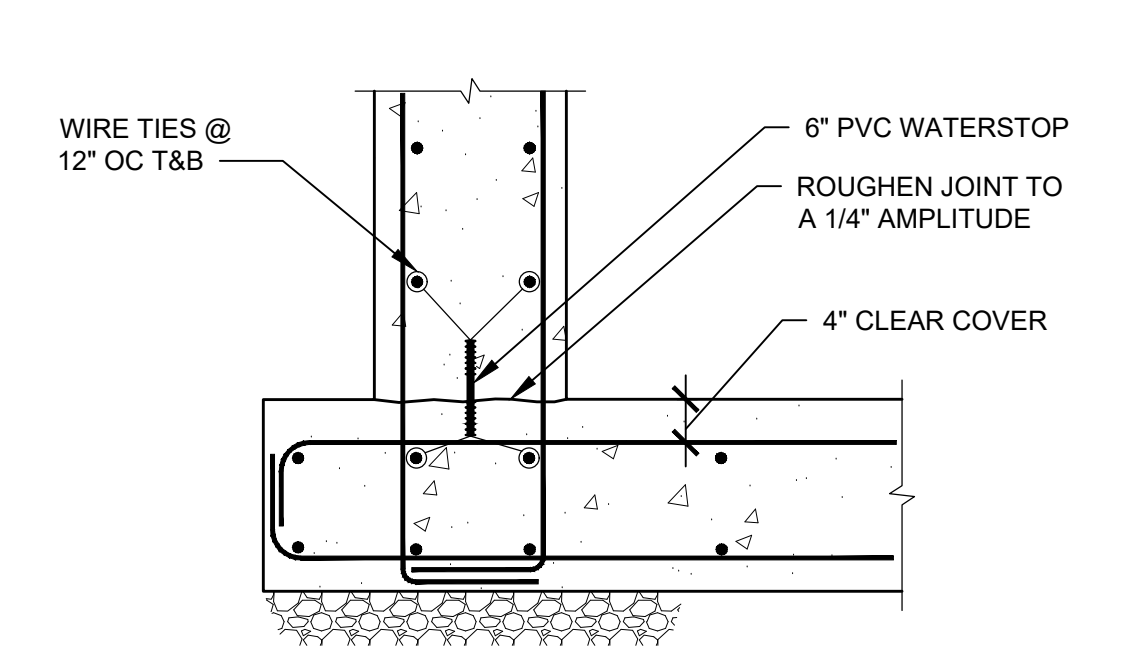


RECOMMENDED END HOOK DIMENSIONS

BAR SIZE	D	180° HOOKS		90° HOOKS
		A or G	J	A or G
#3	0'-2 1/4"	0'-5"	0'-3"	0'-6"
#4	0'-3"	0'-6"	0'-4"	0'-8"
#5	0'-3 3/4"	0'-7"	0'-5"	0'-10"
#6	0'-4 1/2"	0'-8"	0'-6"	1'-0"
#7	0'-5 1/4"	0'-10"	0'-7"	1'-2"
#8	0'-6"	0'-11"	0'-8"	1'-4"
#9	0'-9 1/2"	1'-3"	0'-11 3/4"	1'-7"
#10	0'-10 3/4"	1'-5"	1'-1 1/4"	1'-10"
#11	1'-0"	1'-7"	1'-2 3/4"	2'-0"

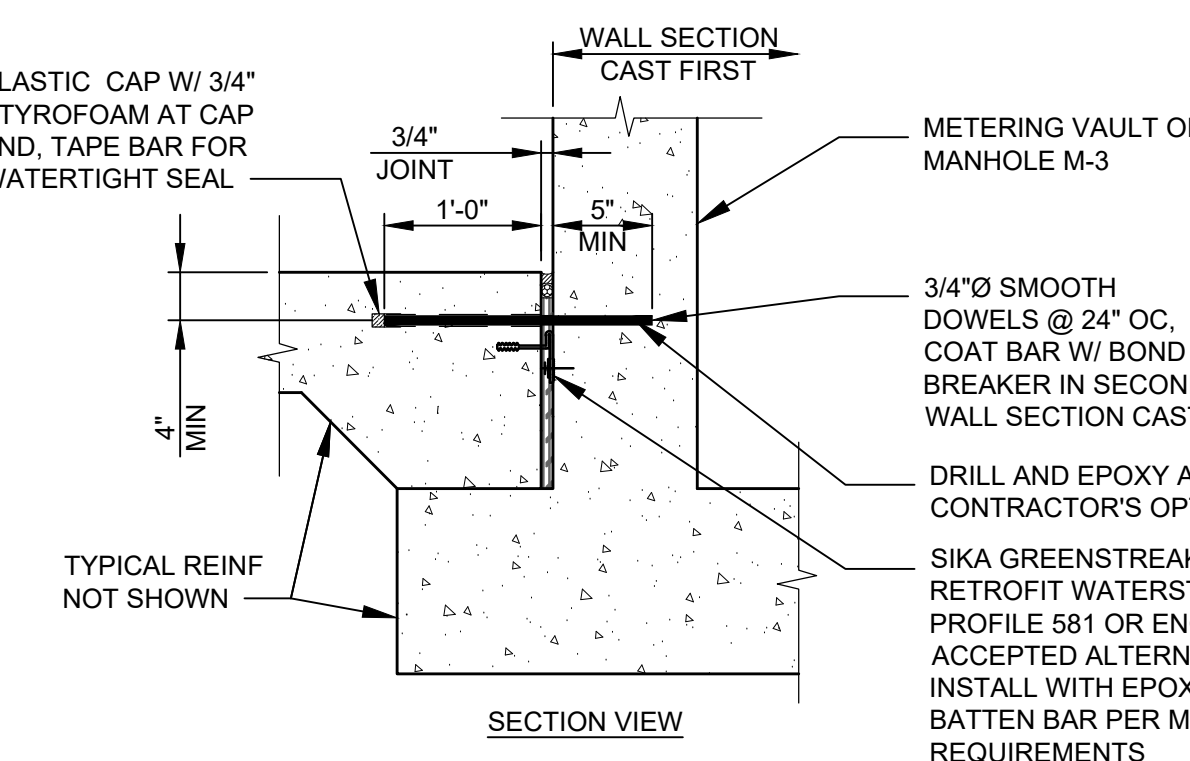
**REINFORCING HOOKS** **S-3020**  
SCALE: NTS REV 00

- NOTES:
- LOCATE WATERSTOP WITH WIRE TIES BETWEEN TWO CURTAINS OF REINFORCING.
  - AT INTERSECTIONS OF CONST JOINTS, CONNECT WATERSTOP WITH FACTORY MITERED ELLS AND TEES TO FORM CONTINUOUS WATER BARRIER. REFER TO SPECS FOR INSTALLATION & DETAILED PRODUCT REQ'S.
  - EXTEND BAR HOOKED ENDS TO BOTTOM OF SLAB.



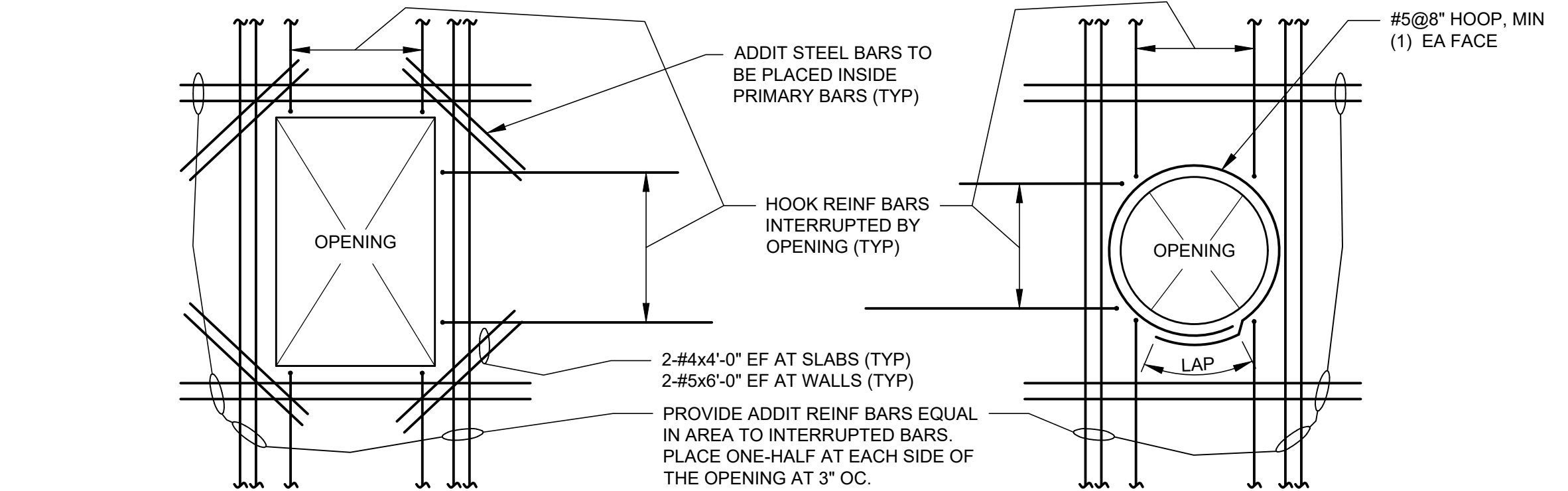
**WALL-TO-SLAB JOINT** **S-3123**  
INVERTED KEY SCALE: NTS REV 01

- NOTES:
- WATERSTOP SHALL BE CONTINUOUS. PROVIDE SHOP FABRICATED BENDS AS REQUIRED.
  - SCAN FOR EXISTING REINF. PRIOR TO POST INSTALLING BARS AND ANCHORS. NO EXISTING REINF. SHALL BE DAMAGED.



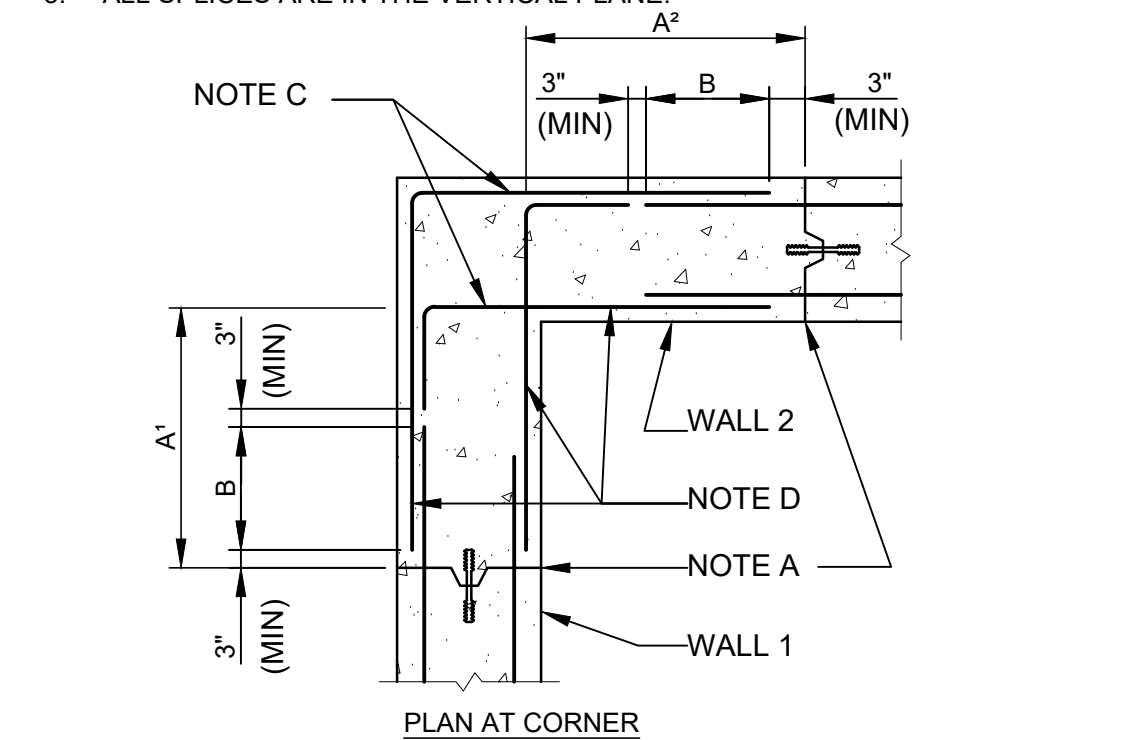
**EXPANSION JOINT** **S-3164**  
SCALE: NTS REV 00

- NOTES:
- PROVIDE ADDITIONAL VERTICAL REINF EQUAL IN LENGTH TO THE UNINTERRUPTED BARS.
  - EXTEND ADDITIONAL HORIZONTAL REINF 5'-0" MIN BEYOND EITHER SIDE OF OPENING (HOOK BARS IF 5'-0" NOT AVAILABLE).
  - THIS DETAIL APPLIES TO ALL WALLS AND SLABS USED FOR RETAINING LIQUIDS AND SOIL.



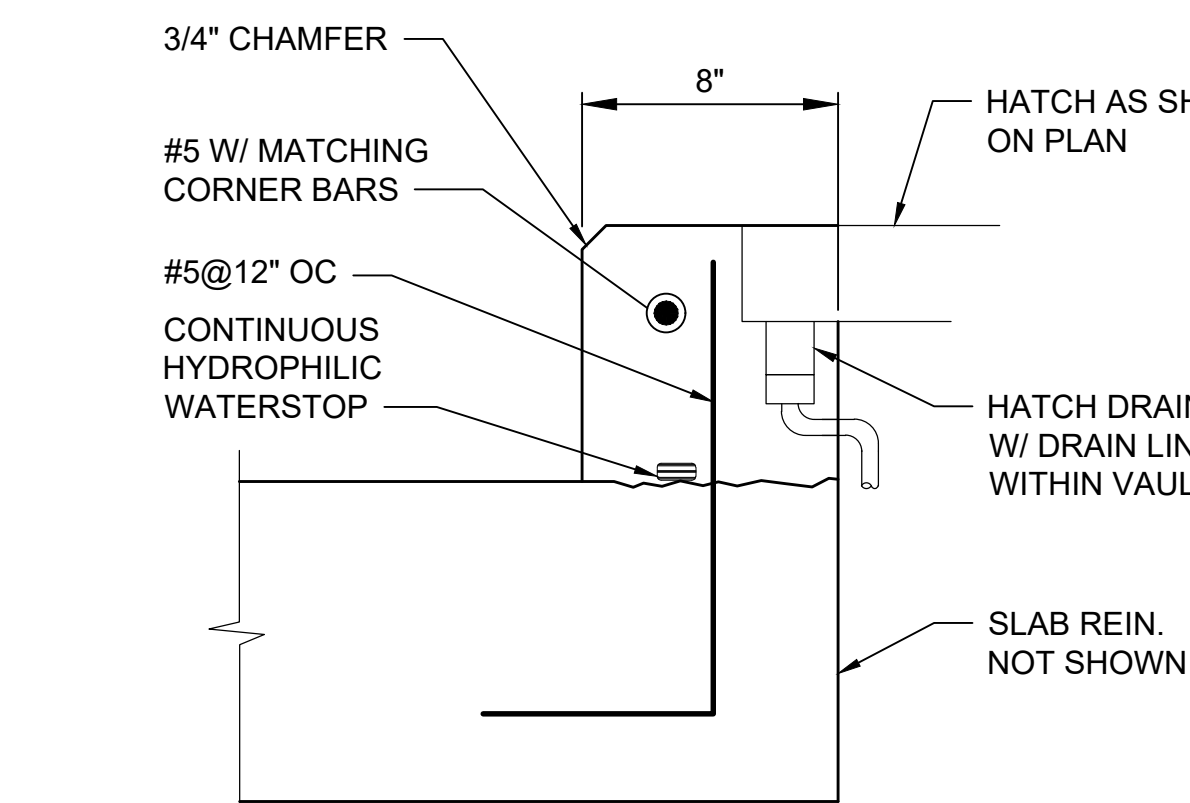
**ADDIT REINF AT OPENINGS** **S-3421**  
PRESSURE WALLS AND SLABS SCALE: 1" = 1'-0" REV 00

- NOTES:
- VERTICAL REINFORCING NOT SHOWN.
  - THESE DETAILS SHALL BE APPLICABLE TO ALL WALL CORNERS UNLESS NOTED OTHERWISE ON THE PLANS.
  - ALL SPLICES ARE IN THE VERTICAL PLANE.

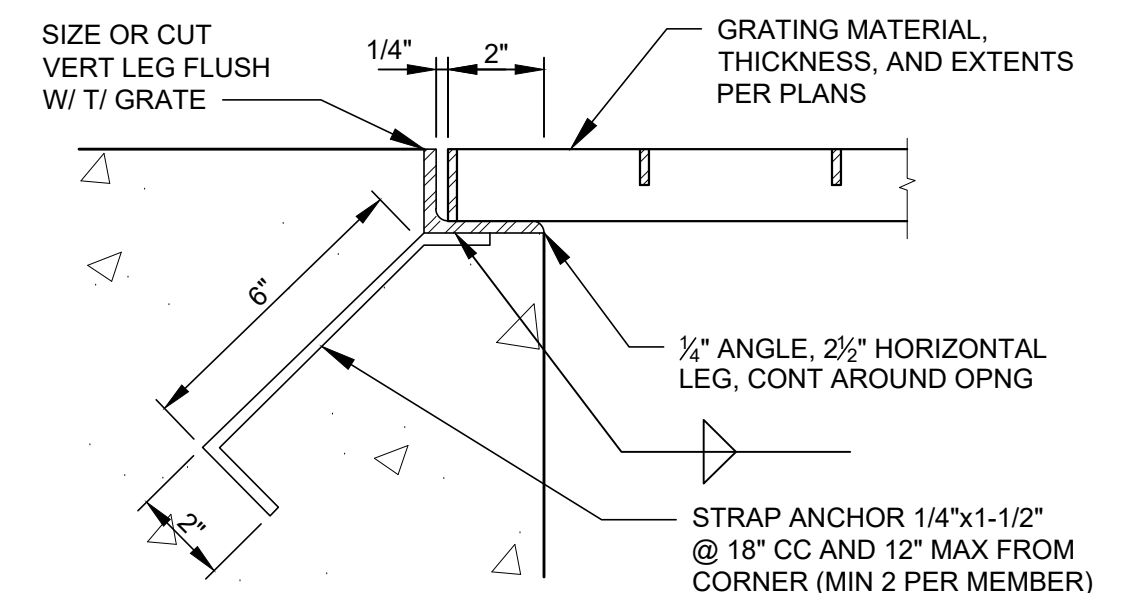


- A = VERTICAL CONSTRUCTION JOINT NEAREST TO WALL CORNER. WITH WATERSTOP AT CONTAINMENT STRUCTURES ONLY WHERE SHOWN IN PLAN. DISTANCE FROM INSIDE CORNER FACE TO NEAREST VERTICAL CONSTRUCTION JOINT IN SIMILARLY NUMBERED WALL. "A" SHALL NOT BE LESS THAN DIMENSIONS INDICATED BY THESE DETAILS; NOR GREATER THAN INDICATED ON PLAN DRAWINGS; BUT IN ANY CASE THE SUM OF TWO ADJACENT "A" DIMENSIONS SHALL NOT EXCEED 30 FEET.
- B = STANDARD LAP SPLICE LENGTH. USE SPLICE LENGTH FOR THE SMALLER OF THE TWO BARS BEING SPLICED.
- C = STANDARD HOOK
- D = TYPICAL CORNER REINFORCEMENT. SIZE SHALL MATCH LARGEST ADJACENT WALL HORIZONTAL REINFORCEMENT; SPACING SHALL MATCH MINIMUM ADJACENT WALL HORIZONTAL REINFORCEMENT SPACING.

**WALL CORNER REINFORCING** **S-3412**  
DOUBLE MAT SCALE: 3/8" = 1'-0" REV 00



**1 HATCH CURB DETAIL** **S-002**  
SCALE: NTS



SUPPORT MATERIAL SCHEDULE

FRP	FRP	FRP
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**GRATING SUPPORT** **S-3560**  
EMBEDDED ANGLE SCALE: 3" = 1'-0" REV 00

APPROVED  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

DESIGNED MW  
DRAWN MS  
CHECKED PIB

PRELIMINARY NOT FOR CONSTRUCTION

CITY OF ARVADA

NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

SCALE

JOB NO 2246059-00

DATE FEB 2024

SHEET 26 OF 52

S-004

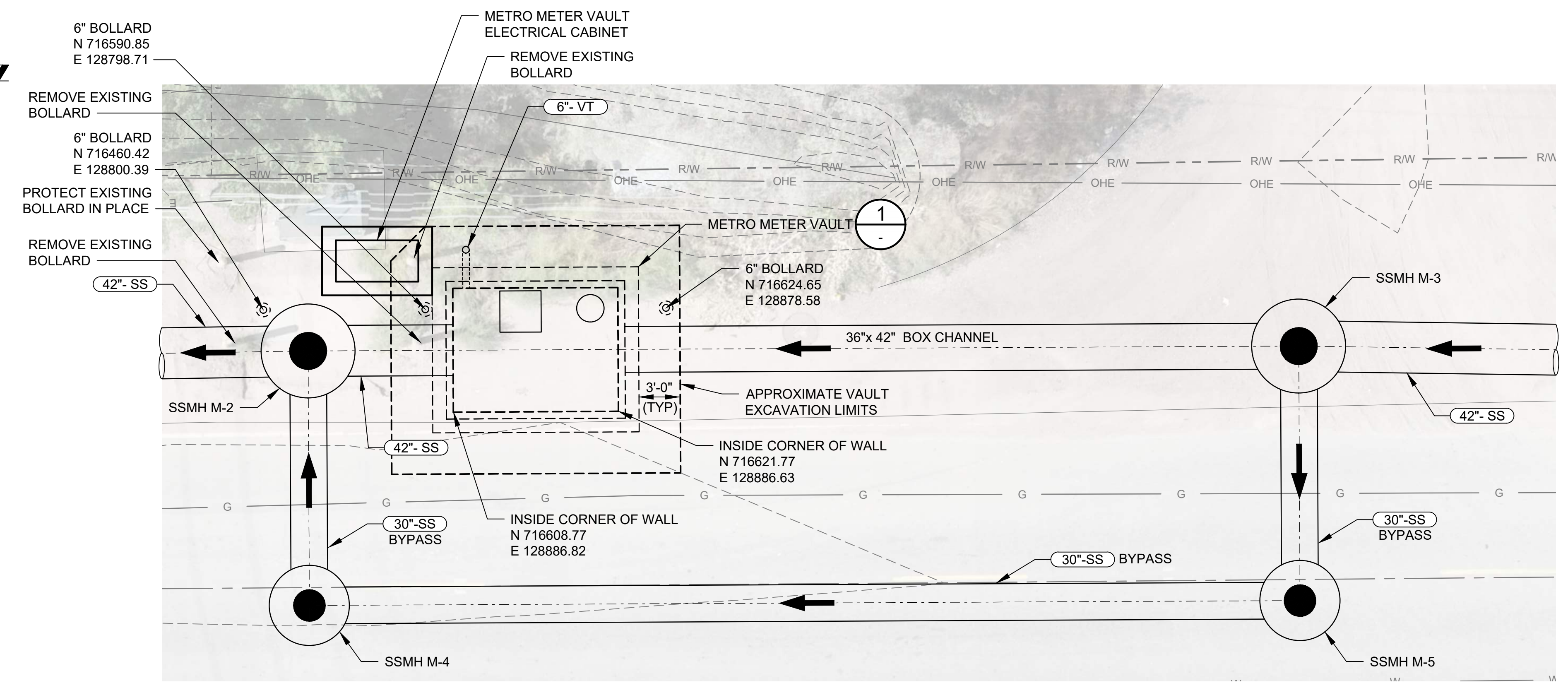
STRUCTURAL DETAILS - I



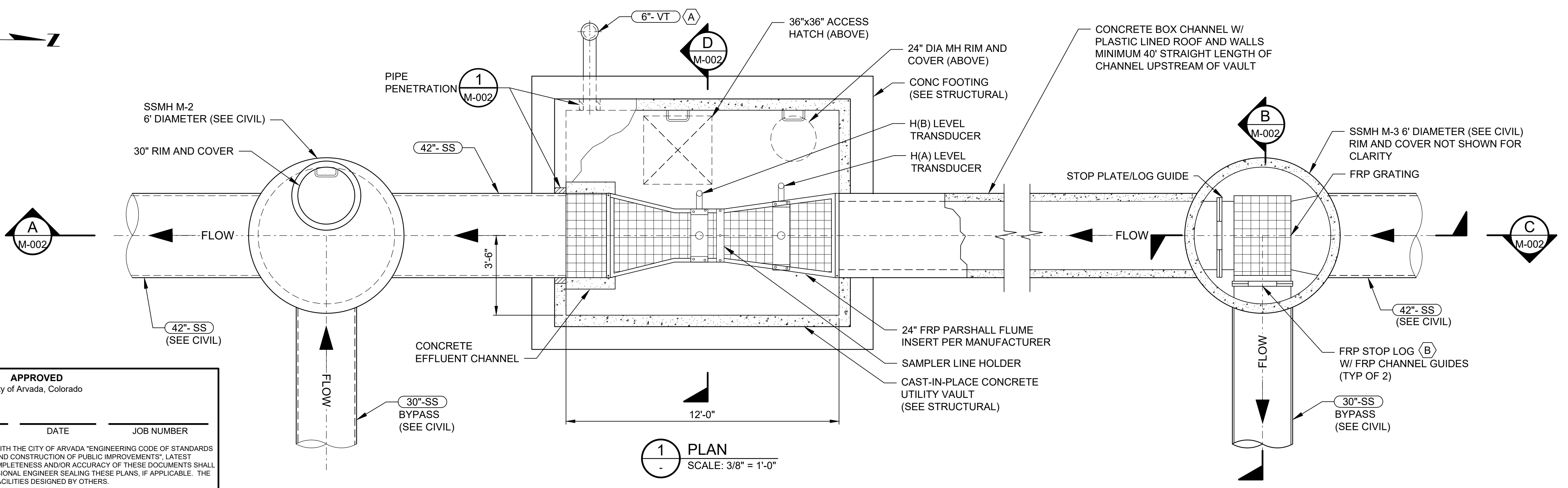
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**METERING VAULT ENLARGED SITE PLAN**  
SCALE: 3/16"=1'-0"



**1 PLAN**  
SCALE: 3/8" = 1'-0"

GENERAL SHEET NOTES	
1.	CONFINED SPACE ENTRY SAFETY PRECAUTIONS MEETING OR EXCEEDING OSHA REQUIREMENTS SHALL BE IMPLEMENTED PRIOR TO ENTERING THE VAULT. A CONFINED SPACE ENTRY PERMIT MAY BE REQUIRED BY THE OWNER PRIOR TO ENTRY BY NON-AUTHORIZED PERSONNEL.
2.	METER VAULT SHALL INCLUDE EXTERNAL SEALING BANDS ON THE OUTSIDE OF THE STRUCTURE AT ALL JOINTS TO PREVENT GROUNDWATER INTRUSION. COAL TAR EPOXY COAT THE EXTERIOR OF THE VAULT. LINE THE INSIDE OF THE VAULT WITH AN H2S RESISTANT COATING.
3.	ONCE THE VAULT IS CONSTRUCTED, INSTALLED, AND TESTED PER THE PROJECT SPECIFICATIONS, IT SHALL BECOME THE PROPERTY OF METRO.
4.	CONTRACTOR SHALL DESIGN AND CONSTRUCT THE METER VAULT IN ACCORDANCE WITH METRO'S STANDARD METER VAULT DETAILS. SEE TABLE THIS SHEET.
5.	CONTRACTOR MUST RECEIVE APPROVAL FROM METRO OF THE METER VAULT DESIGN AND CONSTRUCTION PRIOR TO ACCEPTANCE OF THE WORK.
6.	THE CONTRACTOR SHALL FURNISH AND INSTALL AN AUTOSAMPLER WITHIN THE METRO METER VAULT ELECTRICAL CABINET. SEE SHEET E-010 FOR ADDITIONAL INFORMATION.
7.	SEE ELECTRICAL DRAWINGS FOR SAMPLE LINE ROUTING. CONTRACTOR SHALL LIMIT BENDS IN THE SAMPLE LINE TO THE EXTENT POSSIBLE IN THE FIELD.
8.	CONTRACTOR SHALL USE CUTOFF WALLS AS NEEDED FOR EXCAVATION STABILIZATION IF APPROVED BY THE AUTHORITY HAVING JURISDICTION.
9.	OWNERSHIP OF THE BOX CHANNEL, BYPASS PIPING AND ASSOCIATED MAINTENANCE HOLES, METER VAULT, AND PIPING AND MAINTENANCE HOLES DOWNSTREAM OF THE METER VAULT SHALL BECOME THE OWNERSHIP OF METRO WATER RECOVERY UPON ACCEPTANCE BY METRO.
SHEET KEYNOTES	
A.	CONTRACTOR SHALL LOCATE VENT PIPING OUTSIDE OF DRIVEWAY AND ROADWAY AREAS AND PROTECT WITH BOLLARDS.
B.	PROVIDE A LEAK TIGHT CONNECTION BETWEEN THE STOP LOGS AND CHANNEL GUIDES. PROPOSED MATERIALS SHALL BE SUITABLE FOR MUNICIPAL WASTEWATER SERVICE.
METRO DETAIL NO.	METRO TYPICAL METER/SAMPLER FACILITIES DETAIL TITLE
GEC-C-MT-12	VPP FLOOR LEVEL PLAN AND SECTION
GEN-C-MT-16	GRATING PLANS AND DETAILS
GEN-C-MT-17	HANDHOLD DETAILS
GEN-C-MT-18	STOP PLATE HOOK AND LIFTING EYE DETAILS
GEN-C-MT-19	SAMPLE LINE HOLDER DETAILS
GEN-C-MT-20	CABINET EQUIPMENT DETAILS

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

DESIGNED TS

DRAWN WAS

CHECKED WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

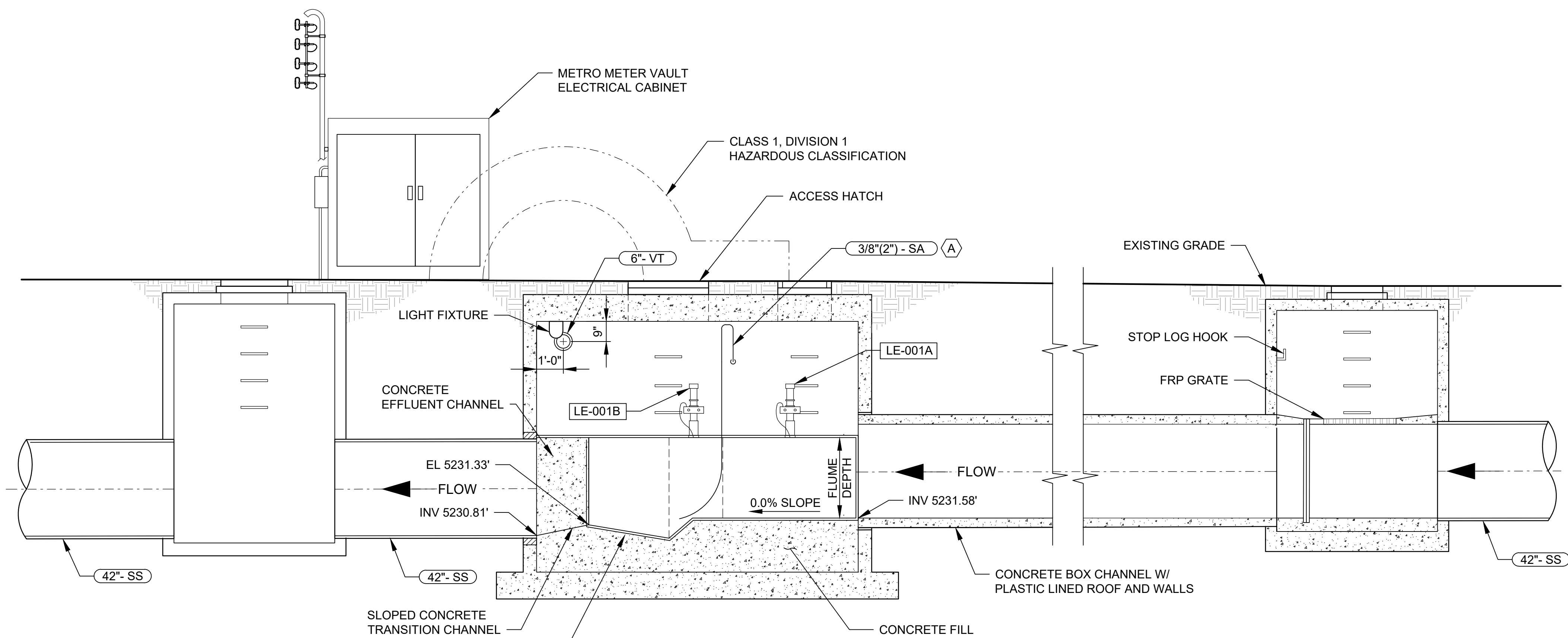
**Kennedy Jenks**

SCALE	1" = 5'
JOB NO	2246059*00
DATE	FEB 2024
SHEET	28 OF 52
	M-001

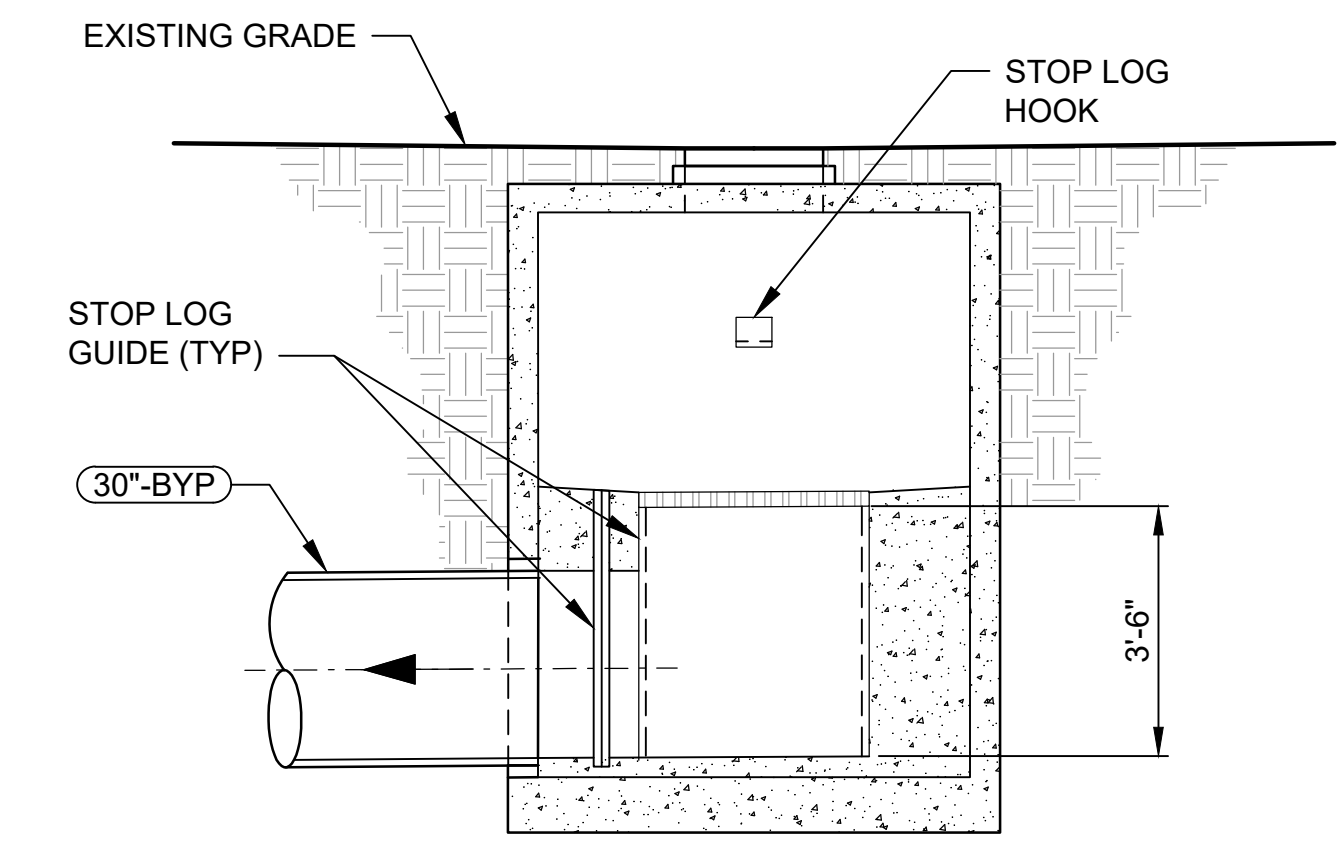


**SHEET KEYNOTES**

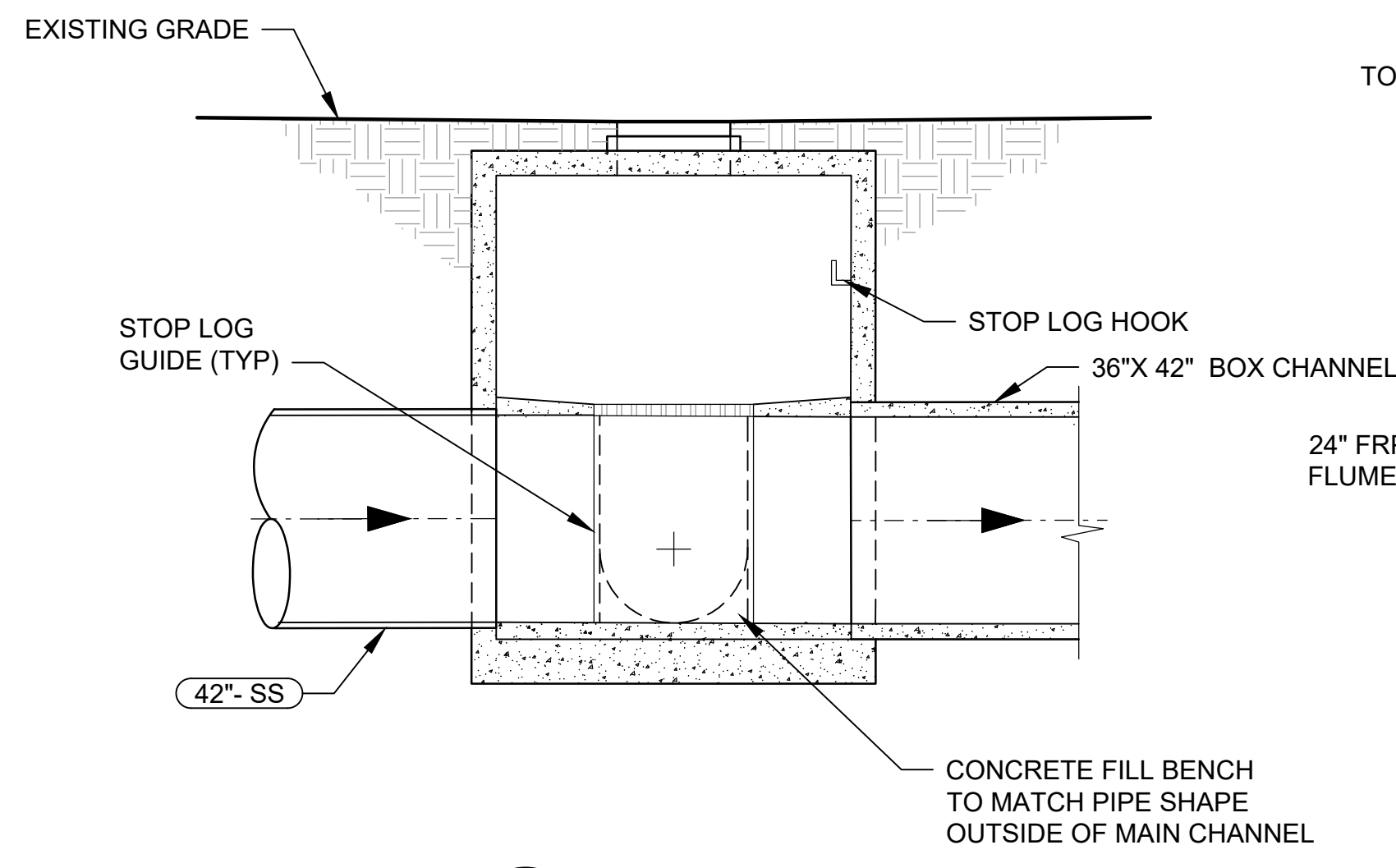
A. SEE SECTION 17110 FOR SAMPLE LINE REQUIREMENTS. SEE CONDUIT SCHEDULE FOR CARRIER PIPE REQUIREMENTS.



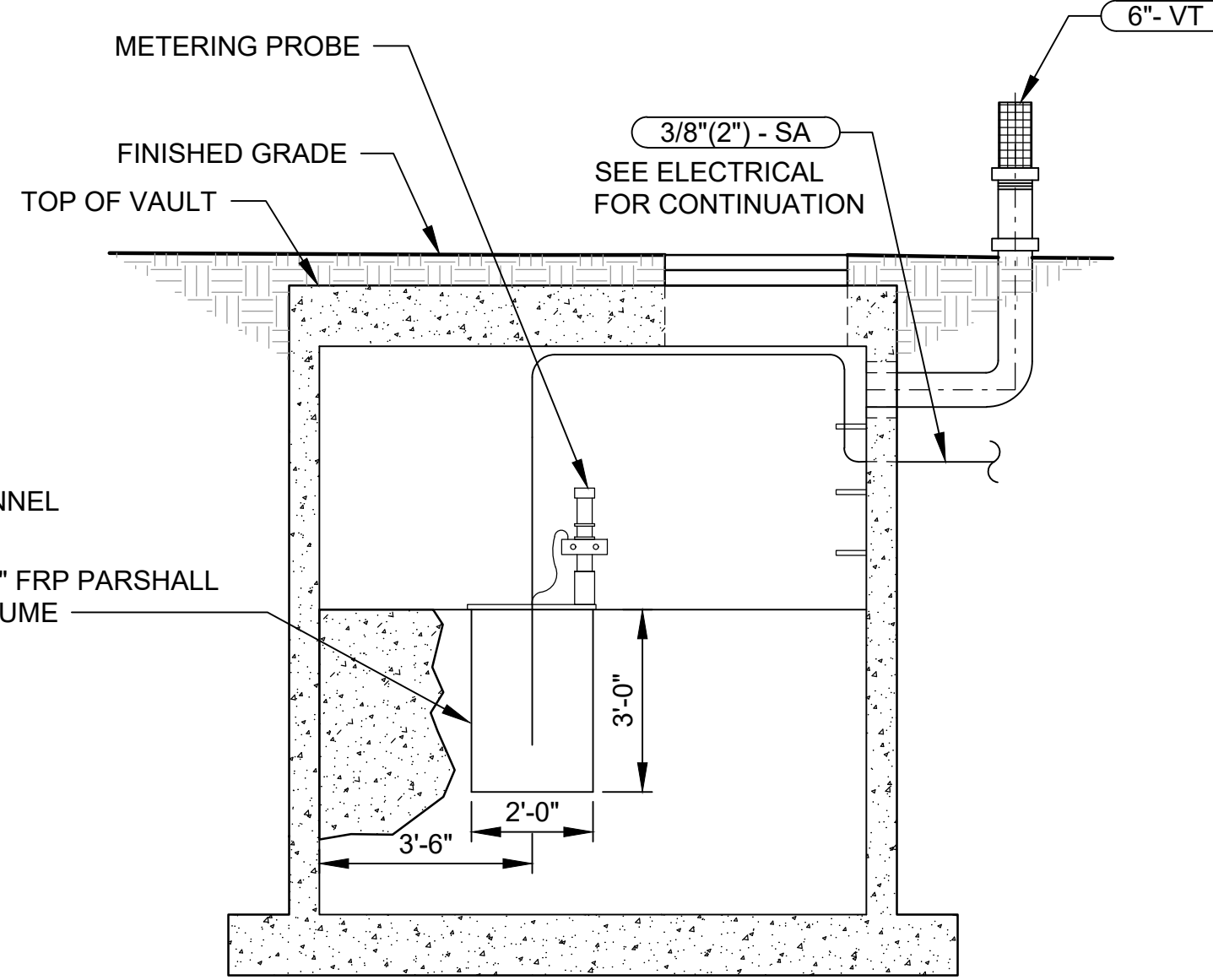
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M-001 SCALE: 3/8" = 1'-0"



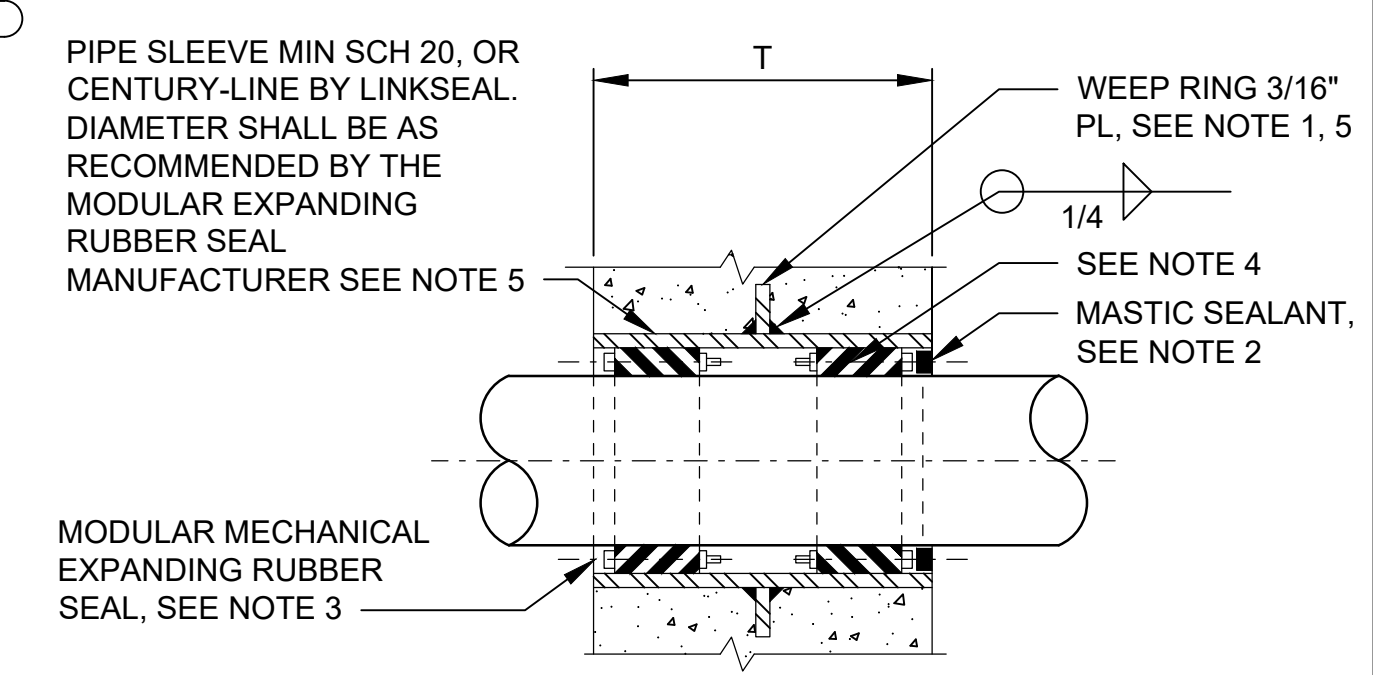
**B SECTION**  
M-001 SCALE: 3/8" = 1'-0"



**C SECTION**  
M-001 SCALE: 3/8" = 1'-0"



**D SECTION**  
M-001 SCALE: 3/8" = 1'-0"



- NOTES:**
1. WEEP RING SHALL HAVE A MINIMUM DIAMETER 3 INCHES GREATER THAN THE OUTSIDE PIPE DIAMETER OF SLEEVE.
  2. WHERE FACE OF WALL OR FLOOR IS EXPOSED TO LIQUID, EARTH, OR AN EXPLOSION HAZARD AREA, SEAL ANNULAR SPACE WITH MASTIC SEALANT.
  3. WHERE USED WITH COPPER PIPE, PROVIDE GLASS REINFORCED NYLON PRESSURE PLATES. OTHERWISE, PROVIDE STAINLESS ATTACHMENT HARDWARE.
  4. FOR WALL OR FLOOR THICKNESS, T, GREATER THAN OR EQUAL TO 12 INCHES, PROVIDE MODULAR EXPANDING RUBBER SEAL ON BOTH ENDS OF PIPE PENETRATION.
  5. WHERE PIPE PENETRATES EXISTING WALLS OR FLOORS, OMIT SLEEVE AND WEEP RING, CORE DRILL HOLE THROUGH EXISTING WALL OR FLOOR.

**1 PIPE PENETRATION**  
M-002 SCALE: NTS

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

**SCALES**

0" = 1"  
0" = 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED TS  
DRAWN WAS  
CHECKED LS

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**METERING VAULT  
SECTIONS AND DETAILS**

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JOB NO 2246059'00  
DATE FEB 2024  
SHEET 29 OF 52  
M-002

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ABBREVIATIONS

Table with 4 columns: Abbreviation, Description, Abbreviation, Description. Includes terms like FOOT, FEET; INCH, INCHES; AMPERE(-S); MANUFACTURER; TIME(-R); etc.

ELECTRICAL NOTES

- 1. THIS IS A GENERALIZED LEGEND SHEET. THIS CONTRACT MAY NOT USE ALL INFORMATION SHOWN.
2. THE INSTALLATION OF ALL EQUIPMENT, RACEWAYS, CONDUCTORS, AND CABLES SHOWN ON THESE DRAWINGS OR DESCRIBED IN THE SPECIFICATIONS SHALL CONFORM TO THE REQUIREMENTS SET FORTH IN THE LATEST EDITIONS OF THE NATIONAL ELECTRICAL CODE AND ALL APPLICABLE LOCAL CODES AND UTILITY COMPANY STANDARDS. IT IS THE CONTRACTOR'S RESPONSIBILITY TO CONTACT THE UTILITY COMPANY AND VERIFY THEIR REQUIREMENTS.
3. ELECTRICAL CONTRACTOR SHALL VISIT THE SITE PRIOR TO BIDDING THE PROJECT TO VERIFY THE SCOPE OF WORK WITH FIELD CONDITIONS. PARTICULAR ATTENTION SHOULD BE GIVEN TO NEW CONDUIT RUNS IN EXISTING BUILDINGS.
4. NOTIFY THE ENGINEER IMMEDIATELY IN WRITING IF CONFLICTS IN EQUIPMENT LOCATIONS ARE DISCOVERED OR IF PROBLEMS ARISE DUE TO FIELD CONDITIONS, LACK OF INFORMATION OR ANY OTHER REASON. NO PAYMENT WILL BE MADE FOR CHANGES WHICH HAVE NOT BEEN FAVORABLY REVIEWED BY THE ENGINEER.
5. CONDUIT ROUTING SHOWN ON PLAN DRAWINGS IS DIAGRAMMATIC ONLY. RACEWAYS SHALL BE INSTALLED IN A MANNER TO PREVENT CONFLICTS WITH EQUIPMENT OR STRUCTURAL CONDITIONS. EXPOSED RACEWAYS SHALL BE INSTALLED PARALLEL OR PERPENDICULAR TO BEAMS AND WALLS. REFER ALSO TO THE CONTRACT SPECIFICATIONS.
6. VERIFY THE EXACT LOCATION OF TERMINAL BOXES AND CONDUIT ENTRANCES TO ALL EQUIPMENT AGAINST APPROVED SHOP DRAWINGS BEFORE STUBBING UP CONDUITS. CONDUIT STUB-UPS SHALL NOT BE MORE THAN 6 INCHES FROM THE CENTERLINE OF TERMINAL BOXES.
7. CONNECTIONS BETWEEN RIGID CONDUIT AND MOTOR TERMINAL BOXES OR SIMILAR EQUIPMENT SUBJECT TO VIBRATION SHALL BE FLEXIBLE LIQUID-TIGHT CONDUIT.
8. CONDUITS SHALL BE TERMINATED SO AS TO PERMIT NEAT CONNECTION TO MOTORS AND OTHER EQUIPMENT.
9. CONDUITS FOR FUTURE EQUIPMENT OR EXTENSIONS SHALL BE TERMINATED AS SHOWN IN THE DETAILS OR AS SPECIFIED.
10. LOCATIONS OF PULLBOXES ARE APPROXIMATE. COORDINATE EXACT LOCATION IN THE FIELD TO ENSURE 6 INCHES (MINIMUM) CLEARANCE FROM MECHANICAL PIPING FLOW LINES.
11. ONLY MAJOR PULLBOXES ARE SHOWN. PROVIDE ADDITIONAL PULLBOXES WHERE REQUIRED TO MAKE A WORKABLE INSTALLATION.
12. PERFORM WORK IN ACCORDANCE WITH THE DETAILS WHETHER OR NOT THEY ARE REFERENCED ON THE DRAWINGS.
13. VERIFY ALL COLOR REQUIREMENTS BEFORE ORDERING MATERIALS.
14. THE WIRING DIAGRAMS, QUANTITY AND SIZE OF WIRES AND CONDUIT REPRESENT A SUGGESTED ARRANGEMENT BASED UPON SELECTED STANDARD COMPONENTS OF ELECTRICAL EQUIPMENT. MODIFICATIONS ACCEPTABLE TO THE ENGINEER MAY BE MADE BY THE CONTRACTOR TO ACCOMMODATE EQUIPMENT ACTUALLY PURCHASED. THE BASIC SEQUENCE AND METHOD OF CONTROL MUST BE MAINTAINED AS INDICATED ON THE DRAWINGS AND/OR SPECIFICATIONS.
15. REFER TO THE MECHANICAL DRAWINGS FOR CERTAIN CONTROL DIAGRAMS, EXACT LOCATIONS OF MECHANICAL EQUIPMENT, AND FOR CERTAIN CONNECTIONS TO BE MADE TO ELECTRICAL CIRCUITS.
16. CONDUIT SIZE AND FILL SHALL BE AS INDICATED ON THE CONDUIT AND CABLE SCHEDULES. WHERE NO SIZE IS SHOWN, THE CONDUIT SHALL BE SIZED IN ACCORDANCE WITH THE LATEST EDITION OF THE NATIONAL ELECTRICAL CODE ADOPTED BY THE AUTHORITY HAVING JURISDICTION. MINIMUM CONDUIT SIZE IS 3/4 INCH, EXCEPT WHERE ENCASED OR BURIED. MINIMUM ENCASED OR BURIED CONDUIT SIZE IS 1 INCH.
17. PROVIDE EXPANSION OR EXPANSION AND DEFLECTION FITTINGS FOR ALL CONDUIT RUNS CROSSING EXPANSION JOINTS. REFER TO THE STRUCTURAL DRAWINGS FOR LOCATIONS OF EXPANSION JOINTS.
18. PROVIDE 3/16 INCH NYLON PULL ROPE IN EACH EMPTY CONDUIT.
19. FOR LIGHTING AND RECEPTACLE SYSTEMS, ONLY CIRCUIT NUMBERS ARE SHOWN. PROVIDE ALL NECESSARY CONDUITS, WIRES, FITTINGS, JUNCTION BOXES AND NECESSARY COMPONENTS SHOWN OR NOT SHOWN ON THE DRAWINGS, TO MAKE THE ELECTRICAL INSTALLATION COMPLETE AND OPERATIONAL. SIZE CONDUITS AND WIRING IN ACCORDANCE WITH THE NATIONAL ELECTRICAL CODE. ALL CONDUIT RUNS SHALL BE CONCEALED UNLESS INDICATED OTHERWISE. CIRCUIT LOADING SHALL BE AS INDICATED IN THE PANEL SCHEDULES. ALL LIGHTING AND RECEPTACLE CIRCUITS SHALL INCLUDE GROUND WIRE.
20. MOUNT LUMINAIRES ACCORDING TO THE MOUNTING HEIGHT GIVEN ON THE DRAWINGS, WITH THE DISTANCE BEING MEASURED FROM THE BOTTOM OF THE LUMINAIRE TO THE FINISHED FLOOR. PROVIDE APPROPRIATE BRACKETS AND HARDWARE FOR MOUNTING.
21. ALL RECEPTACLES IN OUTDOOR AND ANTICIPATED WET AREAS SHALL BE GROUND FAULT CIRCUIT INTERRUPTER RECEPTACLES WITH WEATHERPROOF WHILE IN-USE COVERS.
22. ALL FREE STANDING ELECTRICAL EQUIPMENT AND CONTROL PANELS SHALL BE SET ON CONCRETE HOUSEKEEPING PADS WITH LEVELING CHANNELS EMBEDDED IN THE PAD.
23. ALL PANELBOARDS SHALL BE MOUNTED SO THAT THE DISTANCE FROM THE CENTERLINE OF THE TOP CIRCUIT BREAKER OPERATING HANDLE IN THE UPPERMOST POSITION TO THE FINISHED FLOOR SHALL NOT EXCEED 6'-7".
24. ALL SURFACE MOUNTED PANELS AND PANELBOARDS ON THE INTERIOR OF EXTERIOR WALLS ABOVE GRADE OR IN OTHER LOCATIONS CONSIDERED DAMP OR WET SHALL BE MOUNTED SO AS TO MAINTAIN A 1/4 INCH (MINIMUM) AIR SPACE BETWEEN THE ENCLOSURE AND THE WALL.
25. PROVIDE LOCKOUTS IN STRICT ACCORDANCE WITH OWNER'S REQUIREMENTS.
26. REFER TO THE SINGLE LINE DIAGRAMS, EQUIPMENT ELEVATIONS, PANELBOARD SCHEDULES, AND COMPONENT/DEVICE LABELS IN THE CONTROL SCHEMATICS FOR NAMEPLATE INFORMATION. SEE THE CONTRACT SPECIFICATIONS FOR NAMEPLATE SIZE, COLOR, MATERIAL, AND PLACEMENT REQUIREMENTS.
27. "NORMAL" STATUS OF SWITCHES OR CONTACTS SHOWN IN CONTROL SCHEMATICS IS THE SHELF POSITION.

ELECTRICAL DEMOLITION NOTES

- 1. BIDDING CONTRACTORS SHALL VISIT THE SITE TO ASSESS THE SCOPE OF DEMOLITION, REMOVAL AND MODIFICATION WORK.
2. ELECTRICAL CONTRACTOR AND THE OWNER SHALL DE-ENERGIZE ALL WIRING PRIOR TO REMOVAL OF EQUIPMENT, DEVICES, MOTORS INSTRUMENTATION, CONTROL PANELS, ETC. CONTRACTOR SHALL OBTAIN PRIOR APPROVAL FROM THE OWNER.
3. EXPOSED RACEWAYS: REMOVE CONDUIT, WIRES, AND BOXES. PATCH TO MATCH EXISTING. FINISH ALL OPENINGS LEFT IN WALLS AND FLOORS.
4. CONCEALED CONDUITS IN THE SLAB: REMOVE EXISTING WIRES TO THE EXTENT POSSIBLE AND ABANDON CONDUITS IN THE SLAB. CUT CONDUIT FLUSH AND PATCH THE FLOOR TO MATCH EXISTING.
5. CONTROL PANELS: ELECTRICAL CONTRACTOR SHALL DE-ENERGIZE AND REMOVE ALL CONDUIT AND WIRE AS DESCRIBED IN NOTES 3 AND 4. CONTRACTOR SHALL REMOVE PANELS AS NOTED ON THE CONTRACT DRAWINGS.
6. MOTOR CONTROL CENTERS: DISCONNECT AND REMOVE ALL CONDUITS AND WIRING TO EXISTING STARTERS AND/OR BREAKERS, PANELBOARDS, BRANCH CIRCUITS, INTERLOCKS AND STATUS WIRING WITHIN MCC.
7. REFER TO THE CONTRACT SPECIFICATIONS FOR ADDITIONAL ELECTRICAL DEMOLITION AND REMOVAL REQUIREMENTS.

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Table with 2 columns: DESIGNED ZLP, DRAWN VZ, CHECKED ZCD

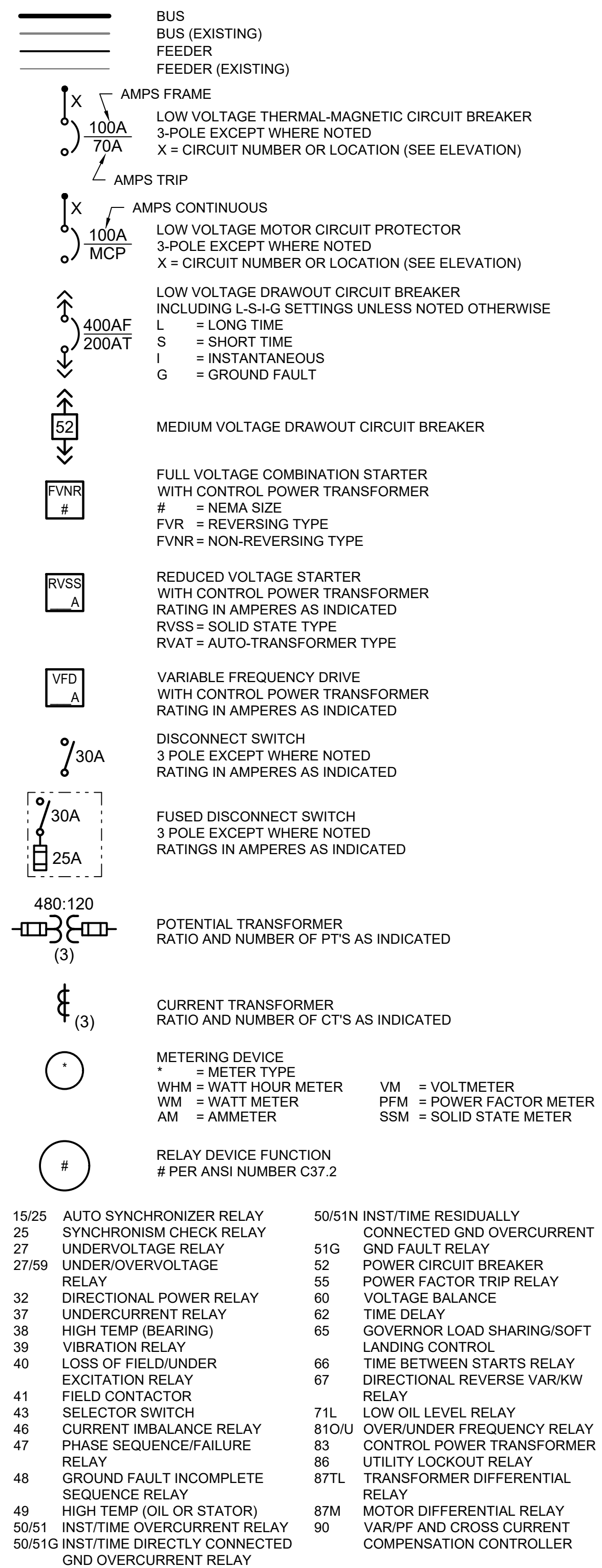
CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11 Kennedy Jenks

SCALE NTS JOB NO 2246059-00 DATE FEB 2024 SHEET 30 OF 52 E-001



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### SINGLE LINE DIAGRAM SYMBOLS



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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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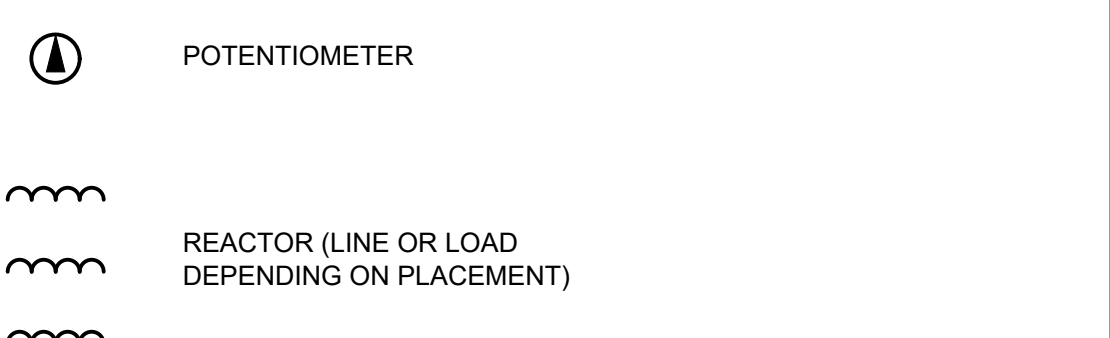
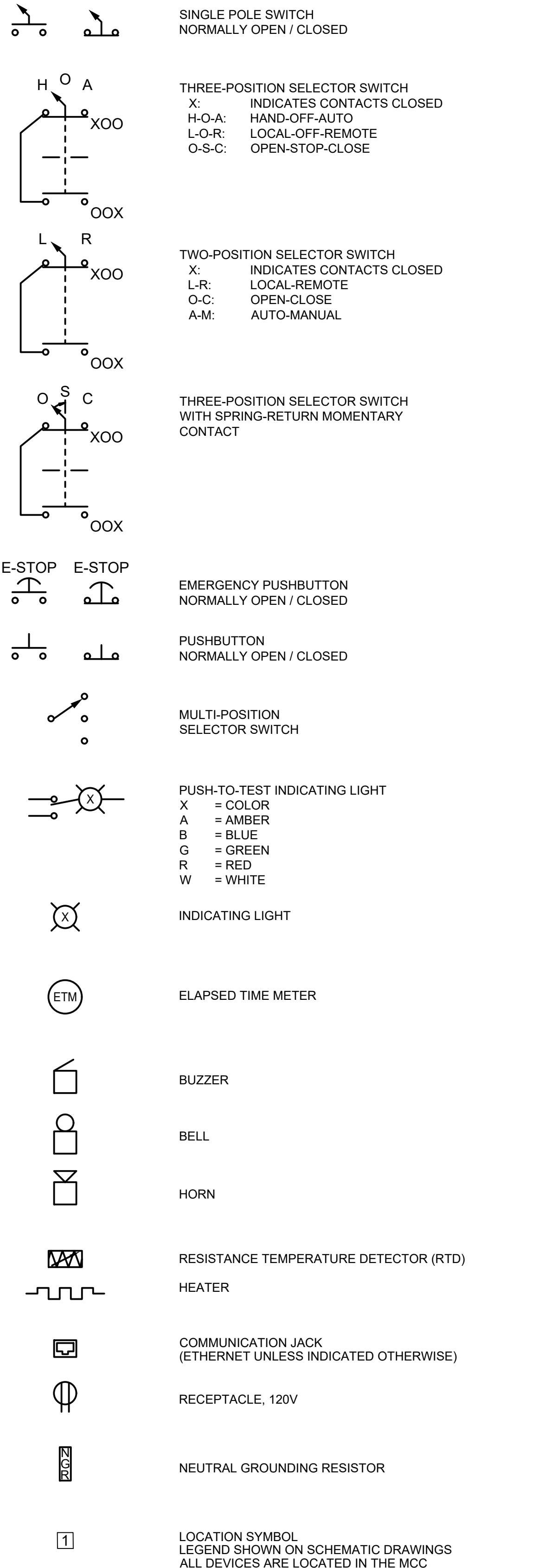
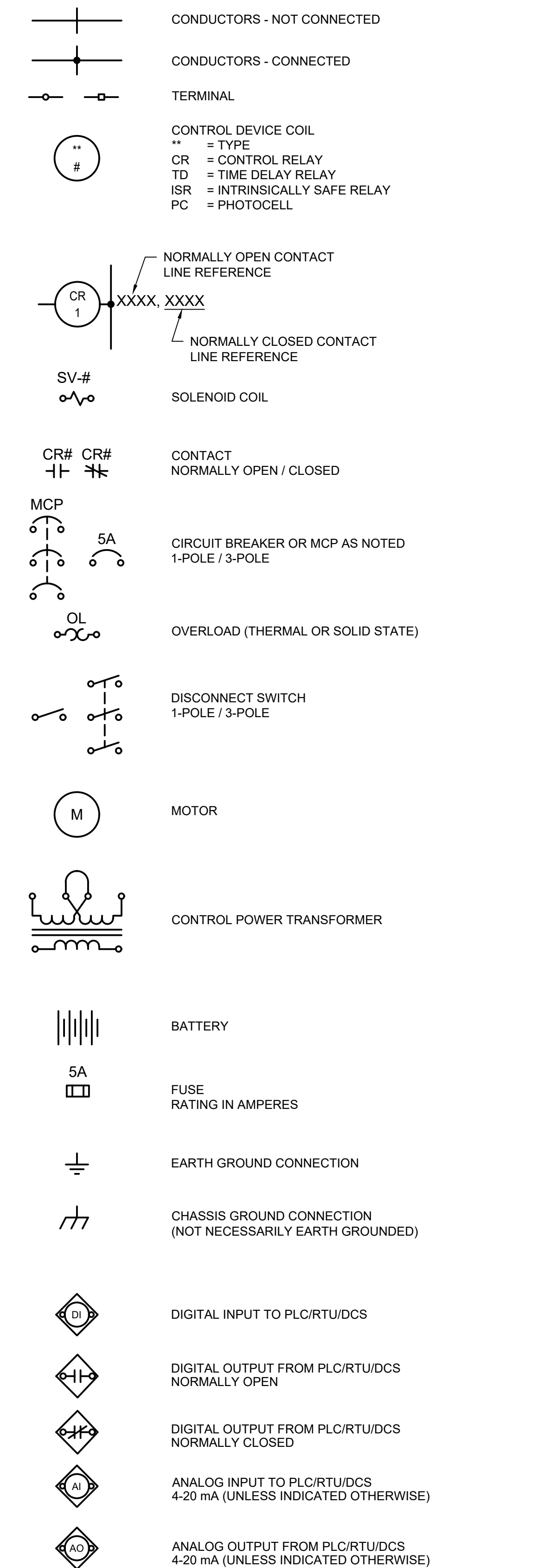
**JAN 2024 - INTERIM 100%**

NOT FOR CONSTRUCTION

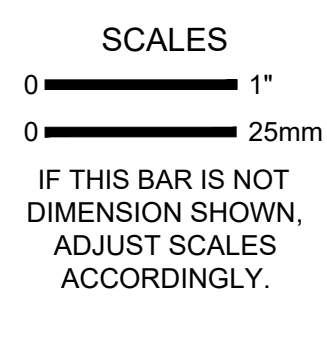
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NO	REVISION	DATE	BY

### CONTROL SCHEMATIC SYMBOLS



CLOSE ON			SENSED VARIABLE
RIISING	FALLING		
FS	FS	FLOW	
LS	LS	LEVEL	
PS	PS	PRESSURE	
TS	TS	TEMPERATURE	
LIMIT SWITCHES			
ZS		NORMALLY OPEN, CLOSE ON REACHING LIMIT	
ZS		NORMALLY CLOSED, OPEN ON REACHING LIMIT	
TORQUE SWITCH			
		NORMALLY CLOSED, OPEN ON INCREASING TORQUE	
TIMED CONTACTS			
SYMBOL	NORMAL	OPEN TO CLOSED	CLOSED TO OPEN
TR	OPEN	DELAYED	INSTANTANEOUS
TR	CLOSED	INSTANTANEOUS	DELAYED
TR	OPEN	INSTANTANEOUS	DELAYED
TR	CLOSED	DELAYED	INSTANTANEOUS



DESIGNED  
ZLP

DRAWN  
VZ

CHECKED  
ZCD

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**LEGEND - I**

SCALE  
NTS

JOB NO  
2246059\*00

DATE  
FEB 2024

SHEET 31 OF 52

E-002



Plot Date: 1/19/2024 2:58 PM

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PLAN SYMBOLS

CONDUIT AND RACEWAYS

CONDUIT - MULTIPLE IN DUCT BANK

MULTIPLE CONDUIT RUN

CONDUIT - ENCASED OR UNDERGROUND

CONDUIT - EXPOSED OR CONCEALED

CALLOUT INDICATING CONDUIT PER SCHEDULE

HOME RUN TO PANELBOARD OR AS INDICATED (3/4" CONDUIT, 2 #12, 1 #12 GND UNLESS INDICATED OTHERWISE)

FLEXIBLE CONDUIT

CONDUIT RUN, CONTINUES ON SAME SHEET OR AS NOTED

CONDUIT - CAPPED OR SEALED

OPEN CIRCLE DENOTES UPWARD CONDUIT RISER

SEMI CIRCLE DENOTES DOWNWARD CONDUIT RISER

JUNCTION BOX

UNDERGROUND RACEWAY HANDHOLE DIMENSIONS AS NOTED

UNDERGROUND RACEWAY MANHOLE DIMENSIONS AS NOTED

EQUIPMENT

MOTOR

PANEL OR CABINET - AS LABELED SWBD, SWGR, MCC, LP, PNLBD, PLC, ETC

GROUNDING

BARE COPPER GROUND TO GROUND WIRE IN SLAB, OR UNDERGROUND GROUND GRID, SIZE AS NOTED

GROUND CONNECTION - BOLTED

GROUND CONNECTION - EXOTHERMICALLY WELDED

GROUND ROD - IN WELL WITH BOX

GROUND ROD - BURIED

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City of Arvada, Colorado

CITY ENGINEER      DATE      JOB NUMBER

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LIGHTING

LUMINAIRE CALLOUT  
A = LUMINAIRE TYPE  
\* = APPROXIMATE MOUNTING HEIGHT AFF  
CLG = CEILING MOUNT  
(SEE LUMINAIRE SCHEDULE FOR MORE DETAILS)

LUMINAIRE - STRIP OR TROFFER TYPE (SWITCHED/UNSWITCHED)  
X = LIGHTING PANEL DESIGNATION  
# = CIRCUIT NUMBER  
a = SWITCH DESIGNATION

WALL MOUNTED LUMINAIRE (SWITCHED/UNSWITCHED)

PENDANT/CEILING MOUNTED LUMINAIRE (SWITCHED/UNSWITCHED)

POLE, BRACKET, ARM, AND MOUNTED LUMINAIRE

RECESSED CAN LUMINAIRE (SWITCHED/UNSWITCHED)

EMERGENCY LUMINAIRE WITH SELF CONTAINED BATTERY

WALL/CEILING MOUNTED EXIT LIGHT DIRECTIONAL ARROW WHERE INDICATED, SHADED AREA INDICATES ILLUMINATED FACE

LIGHT SWITCH  
X = LIGHTING PANEL DESIGNATION  
# = CIRCUIT NUMBER  
a = SWITCH DESIGNATION  
\* = SWITCH TYPE  
1 1 WAY  
3 3 WAY  
4 4 WAY  
D DIMMER

MOTION SENSOR

OCCUPANCY SENSOR

PHOTOCELL

TIME CLOCK

RECEPTACLES

DUPLEX RECEPTACLE, 120V, WALL MOUNT NEMA 5-20R CONFIGURATION  
X = LIGHTING PANEL DESIGNATION  
# = CIRCUIT NUMBER  
\* = RECEPTACLE TYPE  
WP WEATHERPROOF  
XP EXPLOSION PROOF  
GFCI GROUND FAULT CIRCUIT INTERRUPTER

DUPLEX RECEPTACLE, 120V, FLOOR MOUNT NEMA 5-20R CONFIGURATION

SINGLE SPECIAL RECEPTACLE, 208V OR 240V, 1-PHASE  
X = PANEL DESIGNATION  
# = CIRCUIT NUMBER  
A = AMPERAGE

SINGLE SPECIAL/WELDING RECEPTACLE, 208V OR 240V, 3-PHASE  
X = PANEL DESIGNATION  
# = CIRCUIT NUMBER  
A = AMPERAGE

SINGLE SPECIAL RECEPTACLE, 480V, 3-PHASE  
X = PANEL DESIGNATION  
# = CIRCUIT NUMBER  
A = AMPERAGE

SECURITY AND COMMUNICATION

ANTENNA

VIDEO CAMERA  
\* = TYPE  
F FIXED  
PTZ PAN-TILT-ZOOM  
360 360 DEGREE FIXED

SECURITY ACCESS DEVICE  
\* = TYPE  
CR CARD READER  
KS KEY SWITCH  
KP KEYPAD  
RF RADIO FREQUENCY ID

TELEPHONE OUTLET WALL MOUNTED/FLOOR MOUNTED

DATA OUTLET WALL MOUNTED/FLOOR MOUNTED

TELEPHONE/DATA COMBINATION OUTLET WALL MOUNTED/FLOOR MOUNTED

TELEVISION ANTENNA/CABLE OUTLET

MISCELLANEOUS

DISCONNECT SAFETY SWITCH

INSTRUMENT

SWITCH - SPECIAL PURPOSE  
X = LIGHTING PANEL DESIGNATION  
# = CIRCUIT NUMBER  
\* = SWITCH TYPE  
M MOTOR RATED  
K KEY OPERATED  
T TIMER

THERMOSTAT

CLASS I, DIVISION 1 HAZARDOUS AREA BOUNDARY (LABEL APPEARS IN CLASSIFIED AREA)

CLASS I, DIVISION 2 HAZARDOUS AREA BOUNDARY (LABEL APPEARS IN CLASSIFIED AREA)

FIRE PROTECTION

FIRE ALARM PULL STATION

FIRE ALARM STROBE

FIRE ALARM HORN

FIRE ALARM HORN/STROBE

SMOKE DETECTOR

HEAT DETECTOR

NO	REVISION	DATE	BY

SCALES

0 1" = 1"

0 25mm = 1"

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED	ZLP
DRAWN	VZ
CHECKED	ZCD

CITY OF ARVADA

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

LEGEND - II

SCALE NTS

JOB NO 2246059\*00

DATE FEB 2024

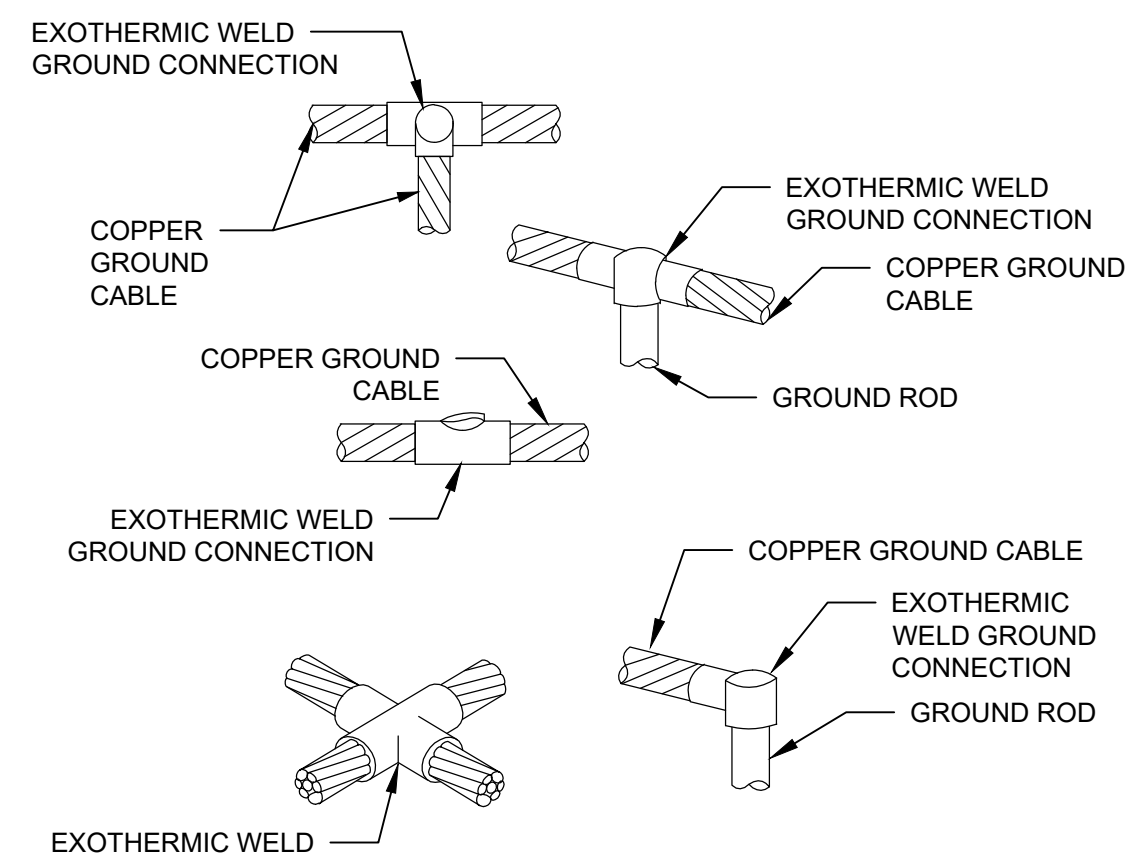
SHEET 32 OF 52

E-003

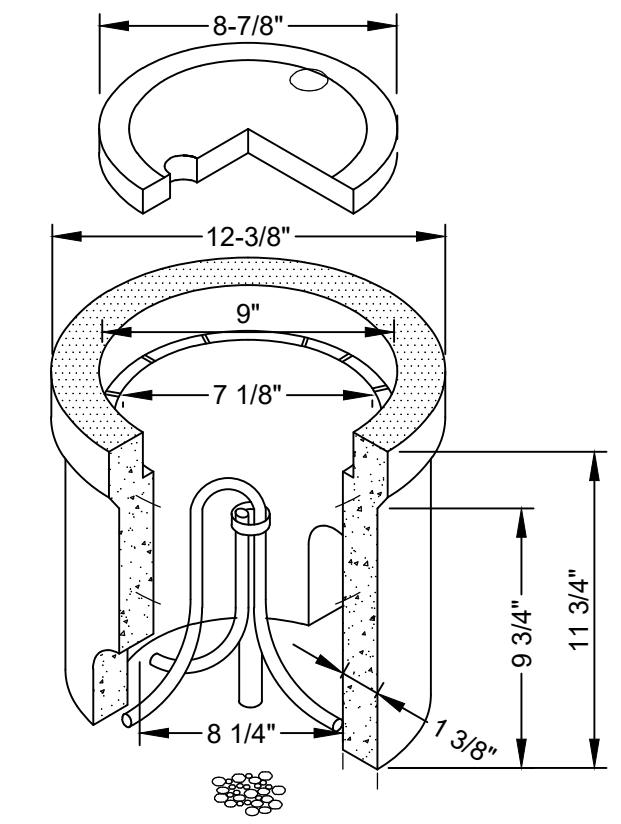


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User: ZACHARY PYLE

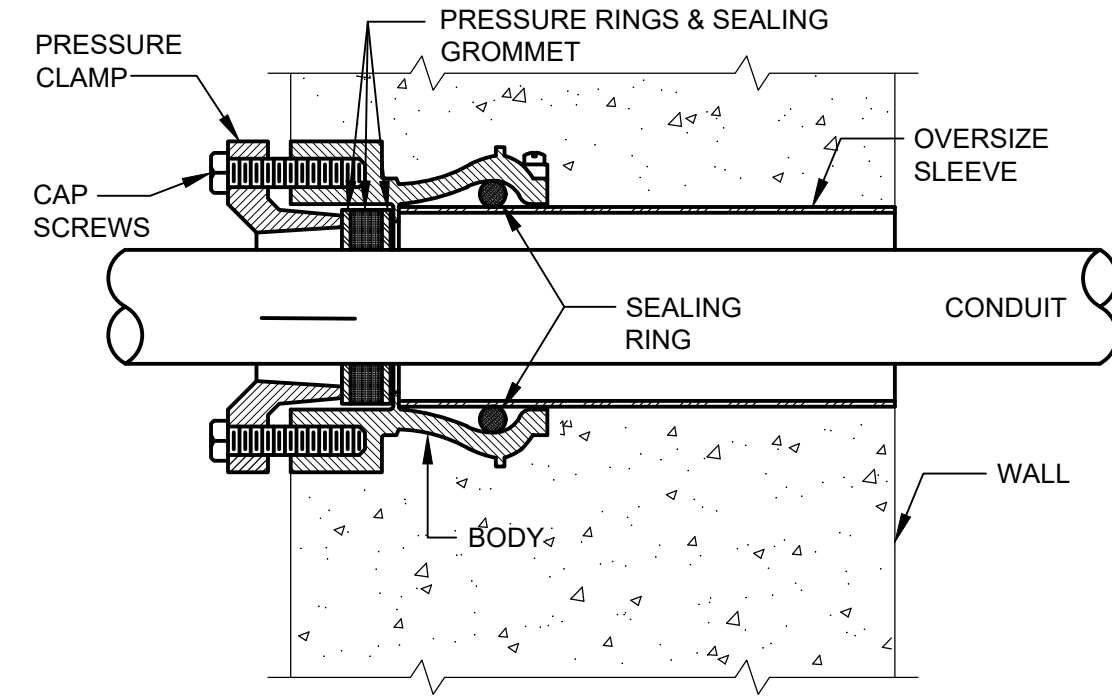
**GENERAL SHEET NOTES**  
A. ALL DETAILS SHOWN ARE TYPICAL. DETAILS SHALL BE USED THROUGHOUT THE PROJECT AS APPLICABLE.



**1 EXOTHERMIC WELDS**  
SCALE: NTS

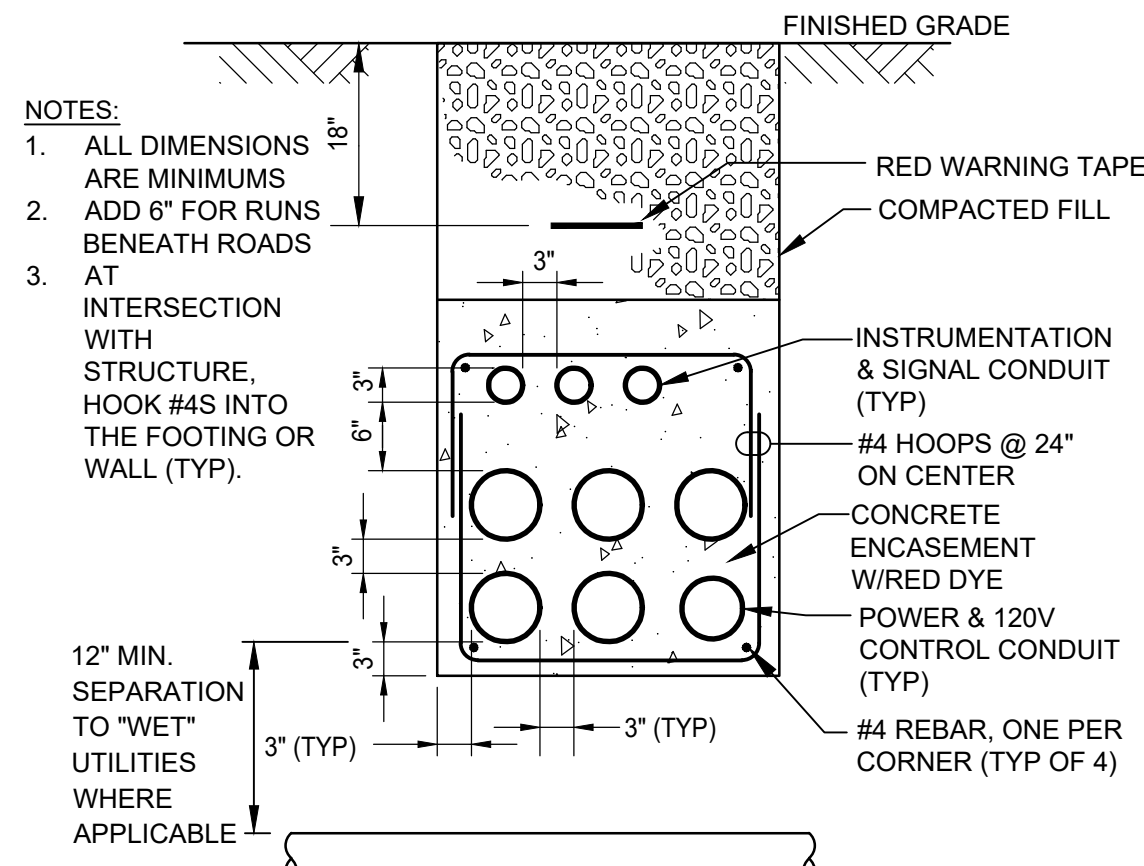


**2 CONC GROUNDING ELECTRODE BOX**  
SCALE: NTS

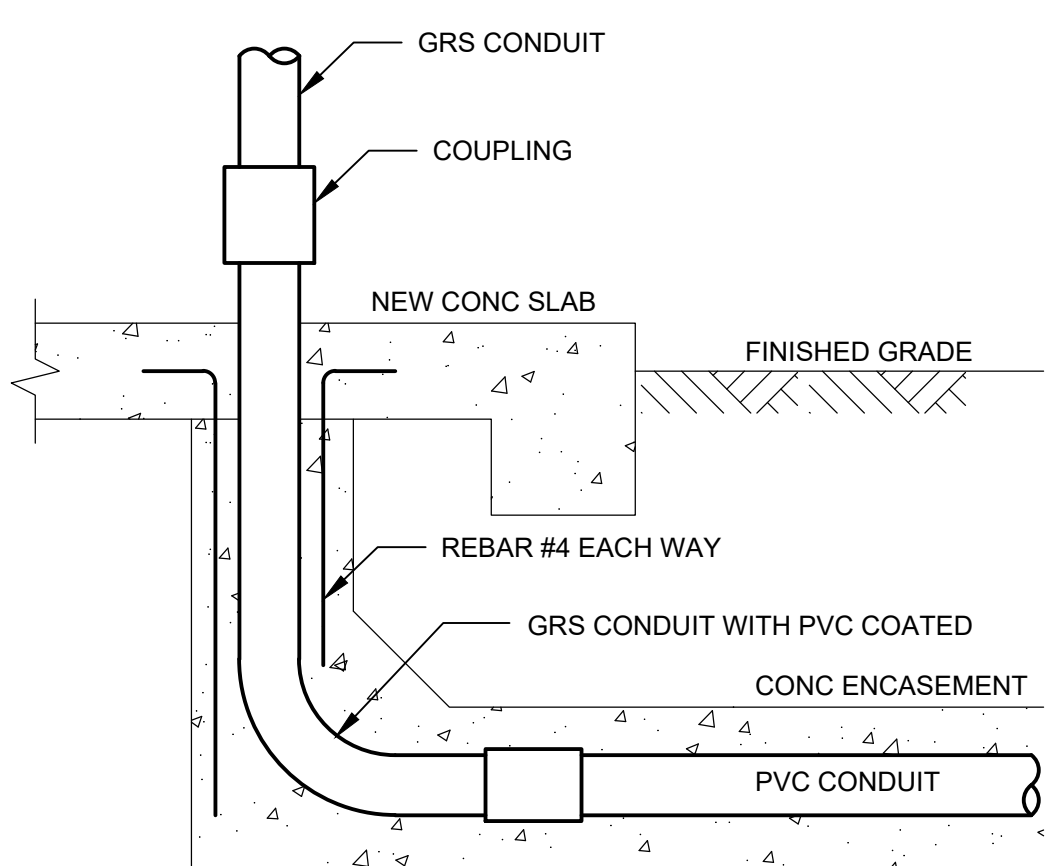


**3 CONDUIT SEAL**  
SCALE: NTS

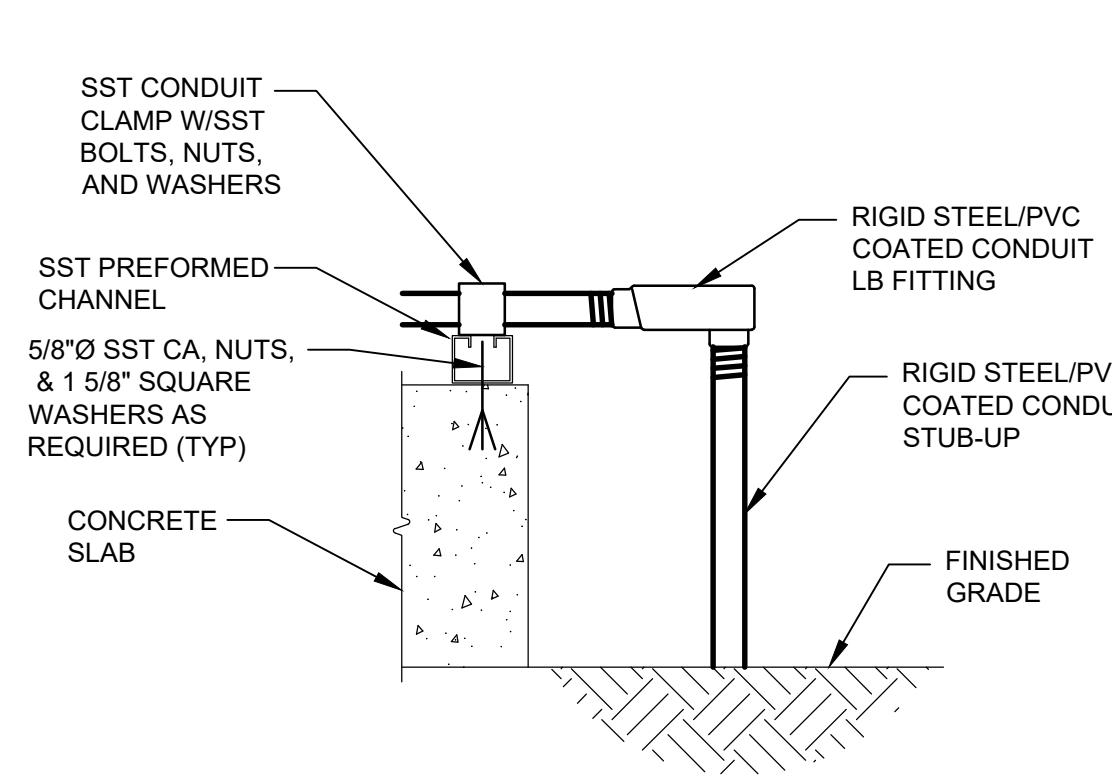
NOTES:  
PROVIDE CONDUIT SEAL IN WALL AND FLOOR WHERE PENETRATION ARE BELOW GRADE OR GROUND WATER LEVEL AND ENTERING INTO WATER CONTAINMENT RESERVOIR.  
MFR: O-Z/GEDNEY, TYPE FSK



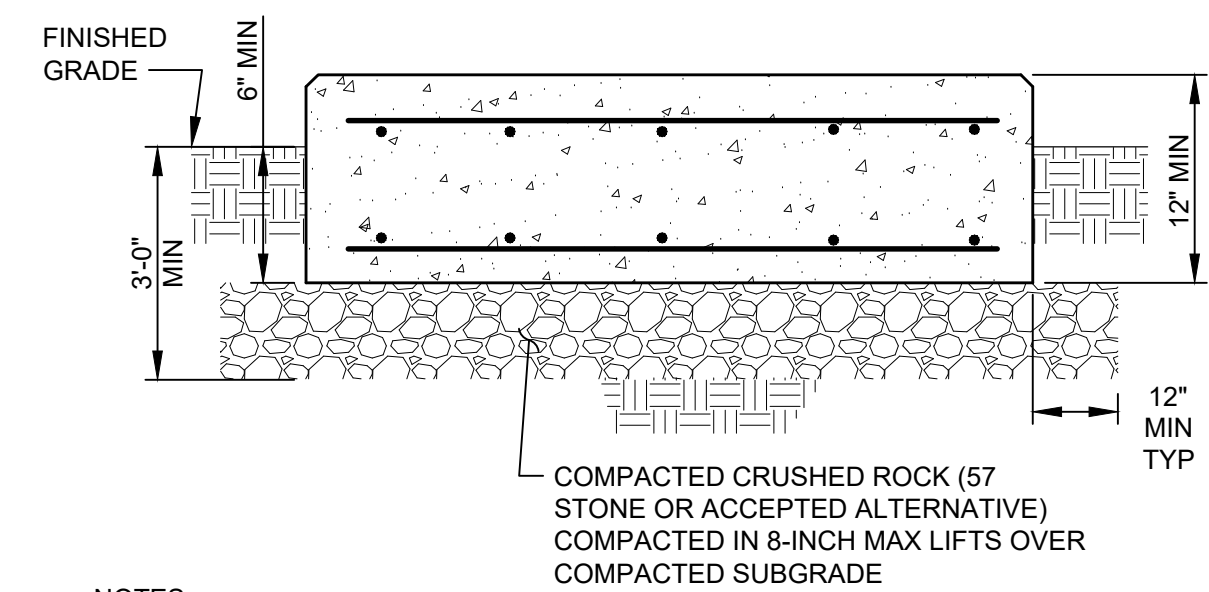
**4 REINFORCED DUCT BANK**  
SCALE: NTS



**5 CONDUIT TRANSITION CONCRETE ENCASEMENT**  
SCALE: NTS



**6 CONDUIT STUB-UP**  
SCALE: NTS



**7 EQUIPMENT PAD ON GRADE**  
SCALE: NTS

NOTES:  
1. SEE HVAC AND ELECTRICAL DRAWINGS FOR ADDITIONAL INFORMATION.  
2. REINF #5@12" EACH WAY TOP AND BOTTOM  
3. PROVIDE 3/4" ISOLATION JOINT WHERE ADJACENT TO BLDG OR OTHER SLABS FILLED WITH PRE-MOLDED JOINT FILLER AND SEALANT AT EXPOSED SURFACES.  
4. CONTRACTOR TO COORDINATE PLAN DIMENSIONS OF PAD WITH FAVORABLE REVIEW OF EQUIPMENT SHOP DRAWINGS.

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

**SCALES**  
0 = 1"  
0 = 25mm  
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DESIGNED	ZLP
DRAWN	VZ
CHECKED	ZCD

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

SCALE	NTS
JOB NO	2246059*00
DATE	FEB 2024
SHEET	33 OF 52
	E-004

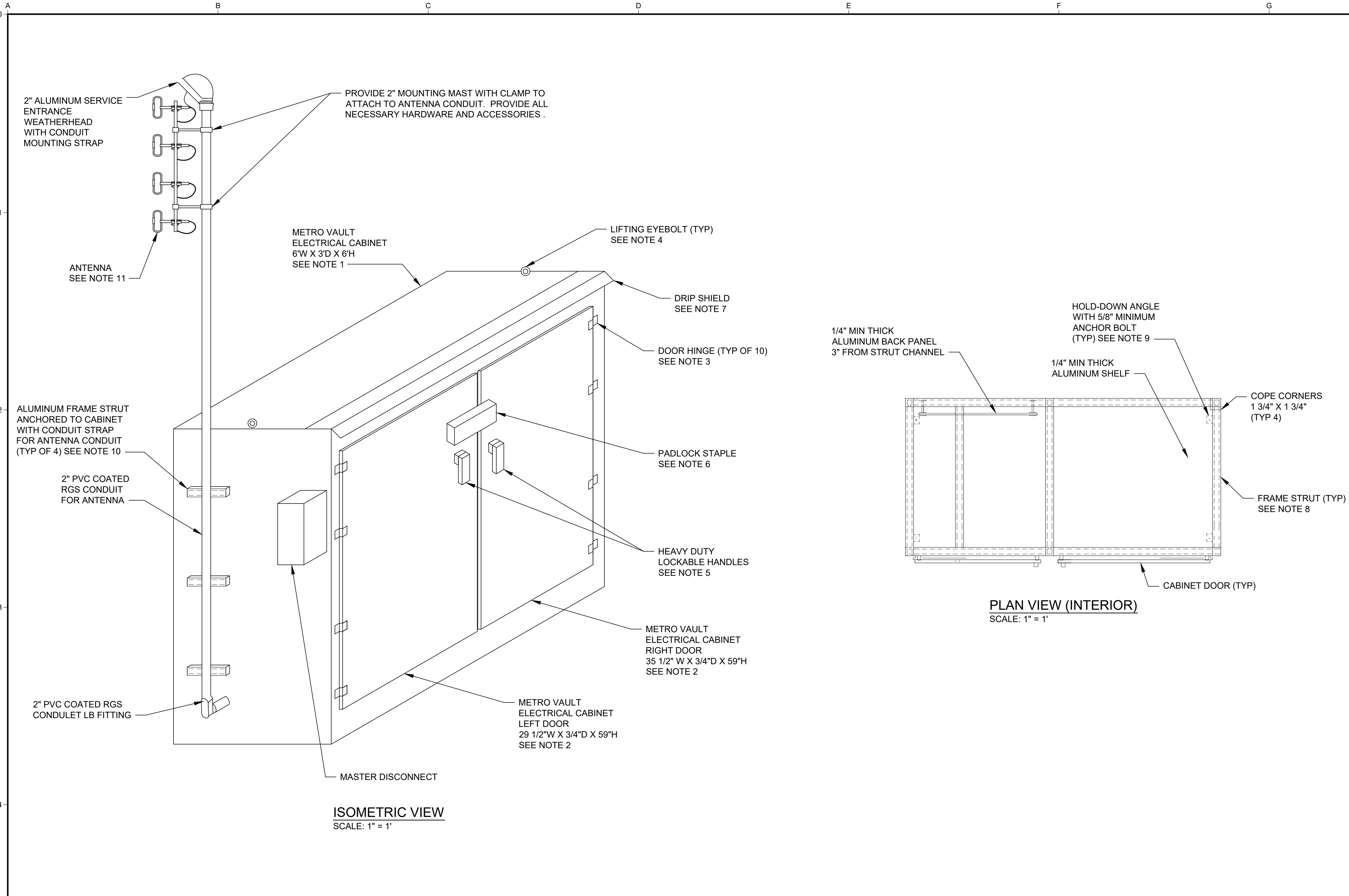
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- GENERAL SHEET NOTES**
- METRO VAULT ELECTRICAL CABINET REQUIREMENTS:
    - THE ELECTRICAL CABINET SHALL ADHERE TO THE FOLLOWING SPECIFICATIONS:
      - CABINET MATERIAL: 12-GAUGE STEEL
      - BACKBOARD MATERIAL: ALUMINUM PLATE
      - SURFACE FINISH: ALL STEEL SURFACES MUST UNDERGO SHOP PRIMING, FOLLOWED BY TWO COATS OF SEMI-GLOSS ENAMEL.
      - PAINT COLOR: THE SPECIFIED COLOR IS GLIDDEN PAINT "FEDERAL GREEN" (14056)
      - INTERNAL BRACING: THE CABINET DESIGN SHOULD INCORPORATE INTERNAL BRACING TO SUPPORT THE DISCONNECT SWITCHES.
      - DESIGN CONSTRAINTS: THE CABINET DESIGN MUST COMPLY WITH THE FOLLOWING CONSTRAINTS: WIND SPEED: 90 MPH, EXPOSURE C, GROUND SNOW LOAD: 30 PSF, & SEISMIC DESIGN: CATEGORY B
    - CABINET MANUFACTURER TO COORDINATE WITH ELECTRICIAN REGARDING CONDUIT PENETRATIONS AND SUPPORT LOCATIONS.
    - CONTRACTOR TO SUBMIT A SUBMITTAL TO THE ENGINEER FOR APPROVAL FOR THE ENTIRE CABINET, INCLUDING ALL COMPONENTS LOCATED INTERNALLY AS WELL AS EXTERNALLY. THE CABINET SHALL BE UL LABELED.
  - THE ELECTRICAL CABINET DOORS SHALL BE PROVIDED WITH 1/4" X 3/4" NEOPRENE DOOR SEALS ATTACHED WITH SILICONE ADHESIVE. A DOORSTOP SHALL BE INCLUDED ON EACH DOOR.
  - DOOR HINGES SHALL BE 5" X 5" STAINLESS STEEL, FULL MORTISE, STANDARD WEIGHT, PLAIN BEARING HINGE. THE PIN LOCATED ON THE HINGE SHALL BE NON-REMOVABLE. MANUFACTURER AND MAKE SHALL BE HAGER SERIES 1191 OR ENGINEER-APPROVED EQUAL.
  - LIFTING EYE SHALL BE 5/8" TYPE 2 SHOULDER PATTERN EYEBOLT, STAINLESS STEEL.
  - DOOR HANDLES SHALL OPERATE AS A 3-POINT LATCHING SYSTEM AND BE PADLOCKABLE. EACH DOOR HANDLE SHALL INCLUDE A KIT WITH THE HANDLE, LATCH, LATCH RODS, ADJUSTABLE ROD GUIDES, AND ALL NECESSARY HARDWARE FOR A FUNCTIONAL SYSTEM. MANUFACTURER SHALL BE NVENT (HOFFMAN) OR ENGINEER-APPROVED EQUAL.
  - PADLOCK STAPLE SHALL BE INCLUDED WITH A STEEL SHROUD TO GUARD THE PADLOCK FROM TAMPERING.
  - DRIP SHIELD SHALL BE INCLUDED TO PROTECT THE ENCLOSURE.
  - REFER TO ELECTRICAL SPECIFICATIONS FOR SPECIFICATIONS REGARDING FRAME STRUT.
  - HOLD DOWN ANGLES SHALL BE TYPE 90 DEGREES, 12 GAUGE. REFER TO ELECTRICAL SPECIFICATIONS FOR SPECIFICATIONS REGARDING FRAME STRUT.
  - PROVIDE ADDITIONAL SUPPORTS AS NECESSARY TO MOUNT THE ANTENNA TO THE SIDE OF THE METRO VAULT ELECTRICAL CABINET.
  - REFER TO DIVISION 17 SPECIFICATIONS FOR REQUIREMENTS REGARDING THE ANTENNA.

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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**1 METRO VAULT ELECTRICAL CABINET DETAILS - I**  
SCALE: NTS

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NO	REVISION	DATE	BY

**SCALES**

0 — 1" = 1"

0 — 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED: ZLP

DRAWN: VZ

CHECKED: ZCD

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

SCALE: NTS
JOB NO: 2246059*00
DATE: FEB 2024
SHEET 34 OF 52
E-005

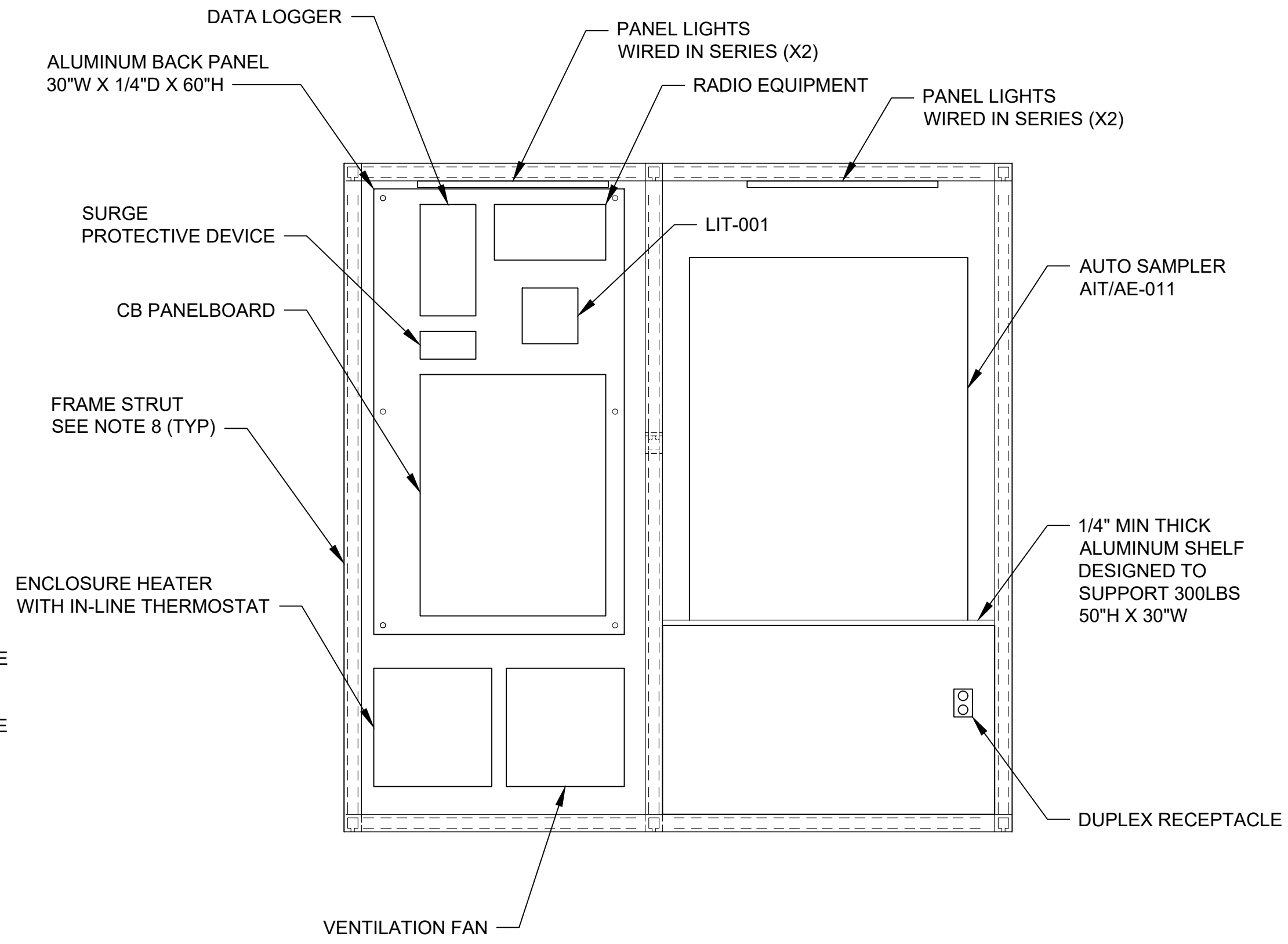
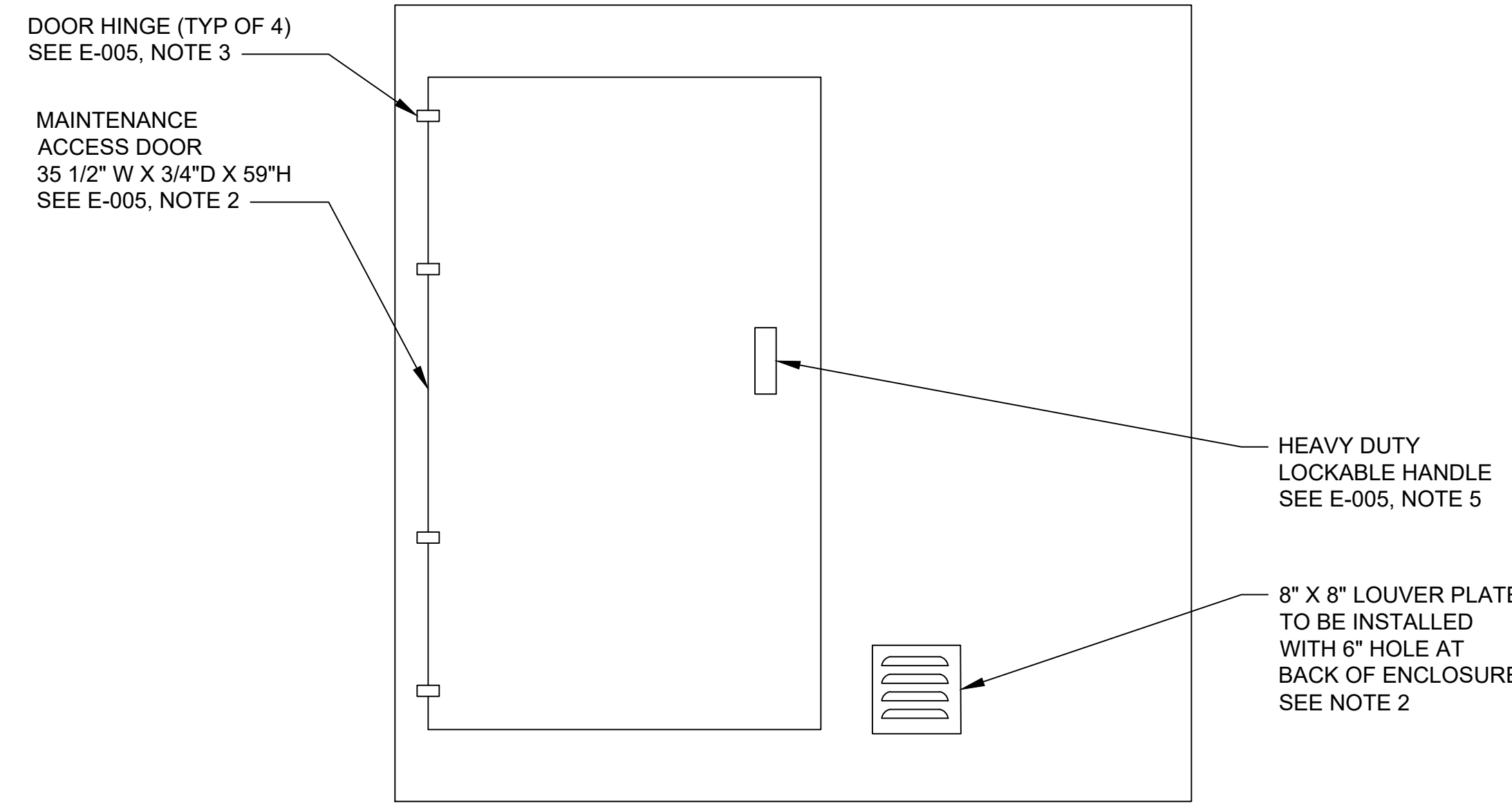


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- GENERAL SHEET NOTES**
- REFER TO ELECTRICAL SPECIFICATIONS FOR SPECIFICATIONS REGARDING FRAME STRUT.
  - LOUVER PLATE TO BE INSTALLED AT THE BACK OF THE ENCLOSURE FOR USE WITH A VENTILATION FAN. COORDINATE THE OPENING OF THE LOUVER PLATE WITH THE VENTILATION FAN CUTSHEET.



**1 METRO VAULT ELECTRICAL CABINET DETAILS - II**  
SCALE: NTS

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City of Arvada, Colorado

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NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**METRO VAULT ELECTRICAL**  
**CABINET DETAILS - II**

SCALE  
NTS

JOB NO  
2246059\*00

DATE  
FEB 2024

SHEET 35 OF 52

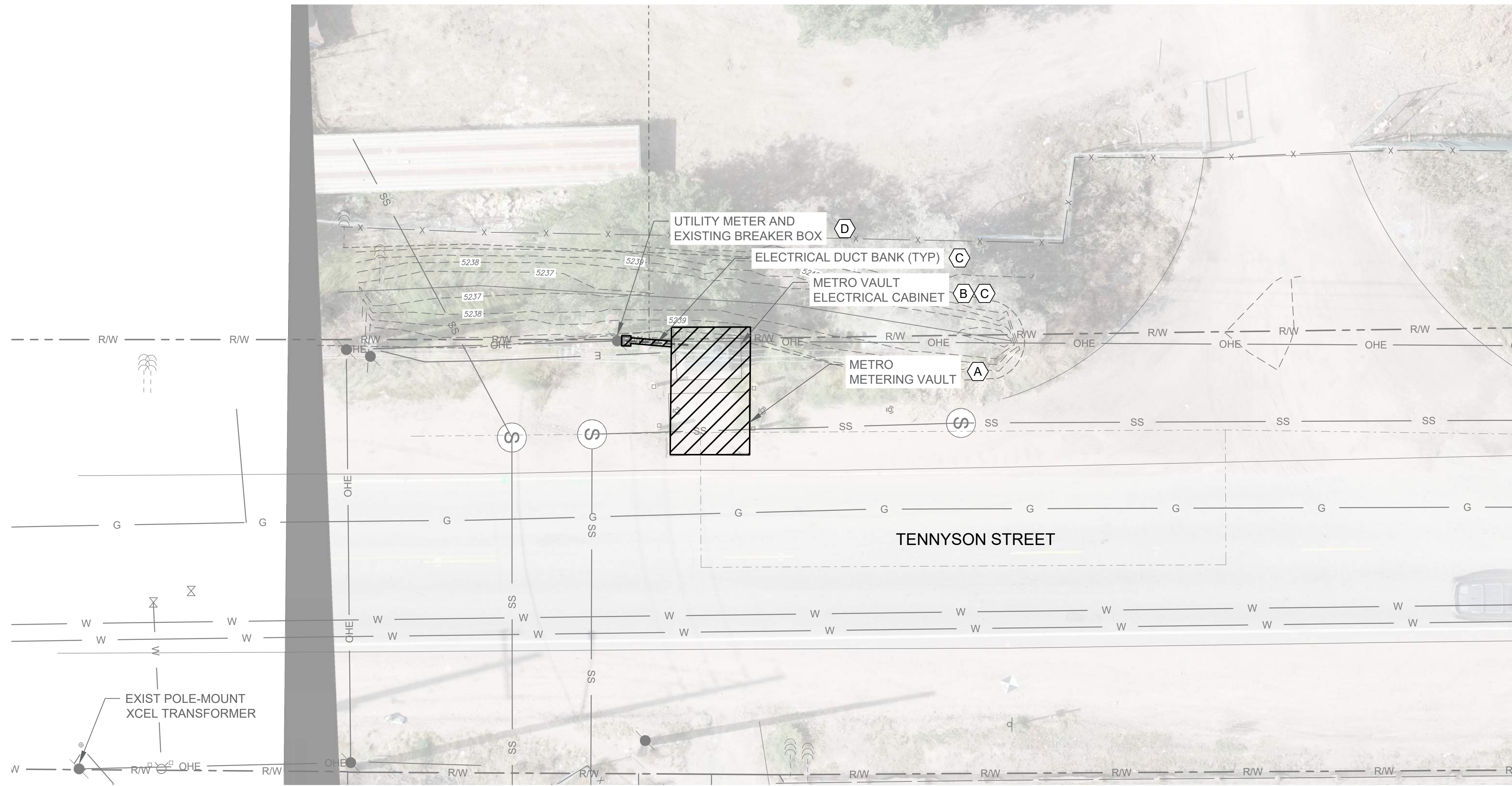
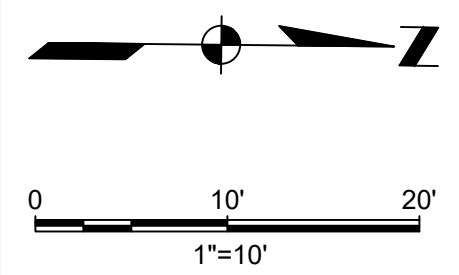
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- GENERAL SHEET NOTES**
- REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF DEMOLITION.
  - COORDINATE WITH THE ELECTRIC UTILITY, ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES**
- EXISTING METRO METERING VAULT TO BE DEMOLISHED.
  - EXISTING METRO VAULT ELECTRICAL CABINET AND ALL CABINET INTERNALS TO BE REMOVED BY METRO.
  - EXISTING CONCRETE HOUSEKEEPING PAD, EXISTING ELECTRICAL DUCTBANK, AND EXISTING CONDUIT STUB-UPS SHALL BE DEMOLISHED
  - EXISTING BREAKER BOX SHALL BE DEMOLISHED.

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City of Arvada, Colorado

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**SCALES**

0 1" = 10'

0 25mm

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ZCD

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**OVERALL DEMOLITION SITE PLAN**

SCALE 1" = 10'

JOB NO 2246059\*00

DATE FEB 2024

SHEET 36 OF 52

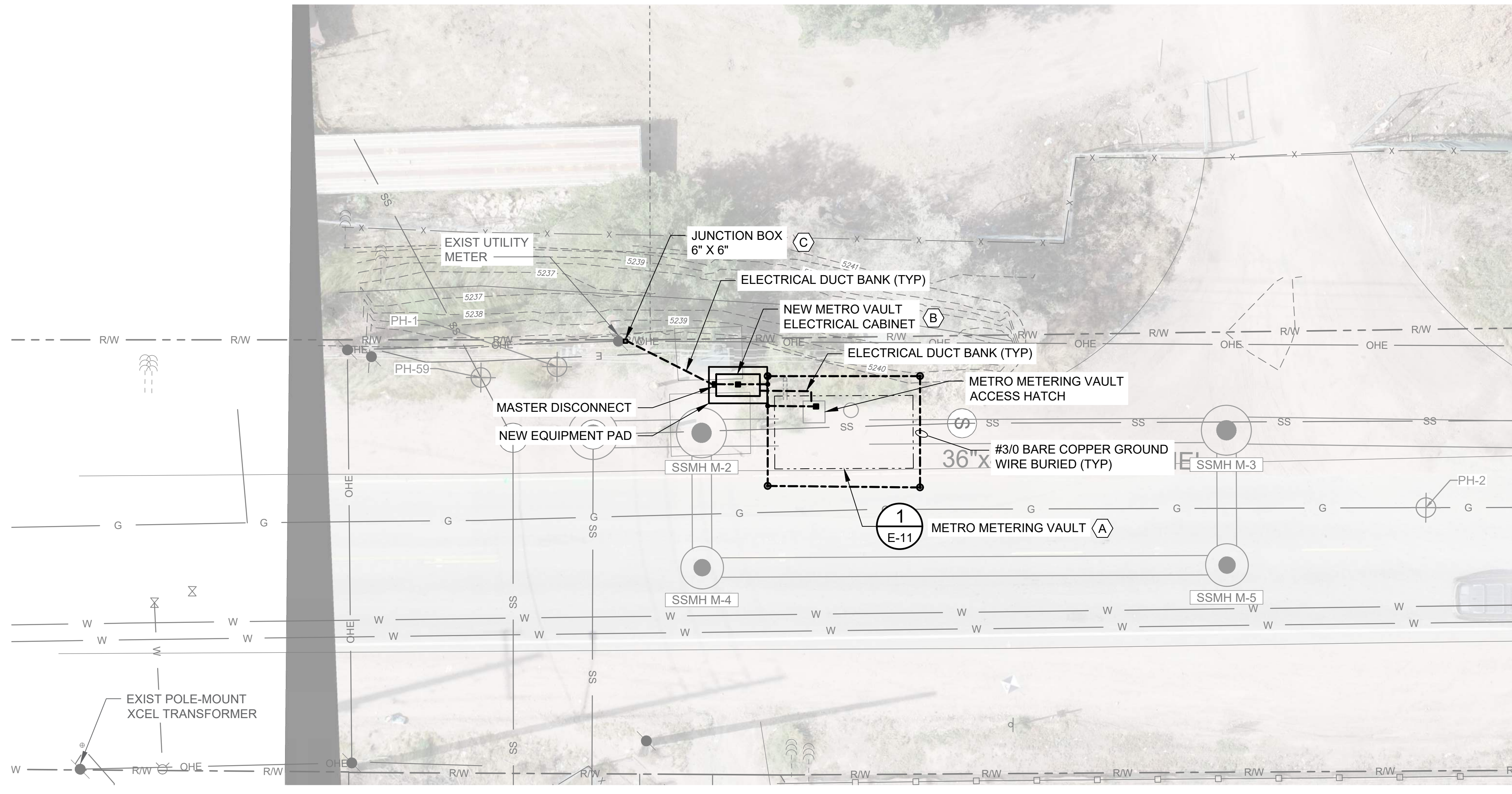
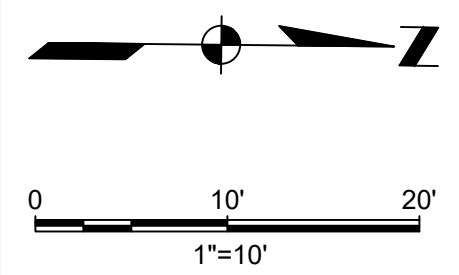
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- GENERAL SHEET NOTES**
- REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF PROPOSED WORK.
  - COORDINATE WITH THE ELECTRIC UTILITY, XCEL ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES**
- ENTIRE SPACE OF METRO METERING VAULT SHALL BE CLASS I, DIVISION I, GROUP D PER NFPA 820.
  - NEW ELECTRICAL EQUIPMENT PAD SHALL BE INSTALLED FOR NEW METRO VAULT ELECTRICAL CABINET.
  - PROVIDE JUNCTION/PULL BOXES AS NECESSARY TO INTERFACE WITH THE EXISTING UTILITY METER.

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

**SCALES**

0" = 1"  
0" = 25mm

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DESIGNED	ZLP
DRAWN	VZ
CHECKED	ZCD

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**OVERALL SITE PLAN**

SCALE	1" = 10'
JOB NO	2246059*00
DATE	FEB 2024
SHEET	37 OF 52
	E-010

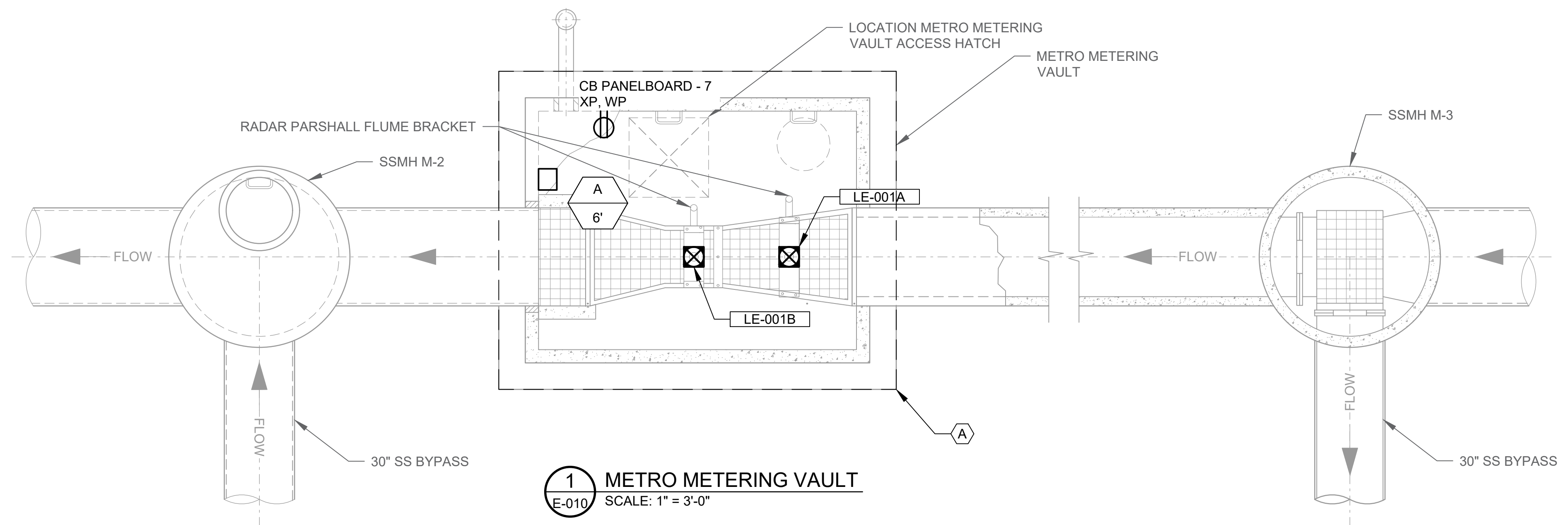


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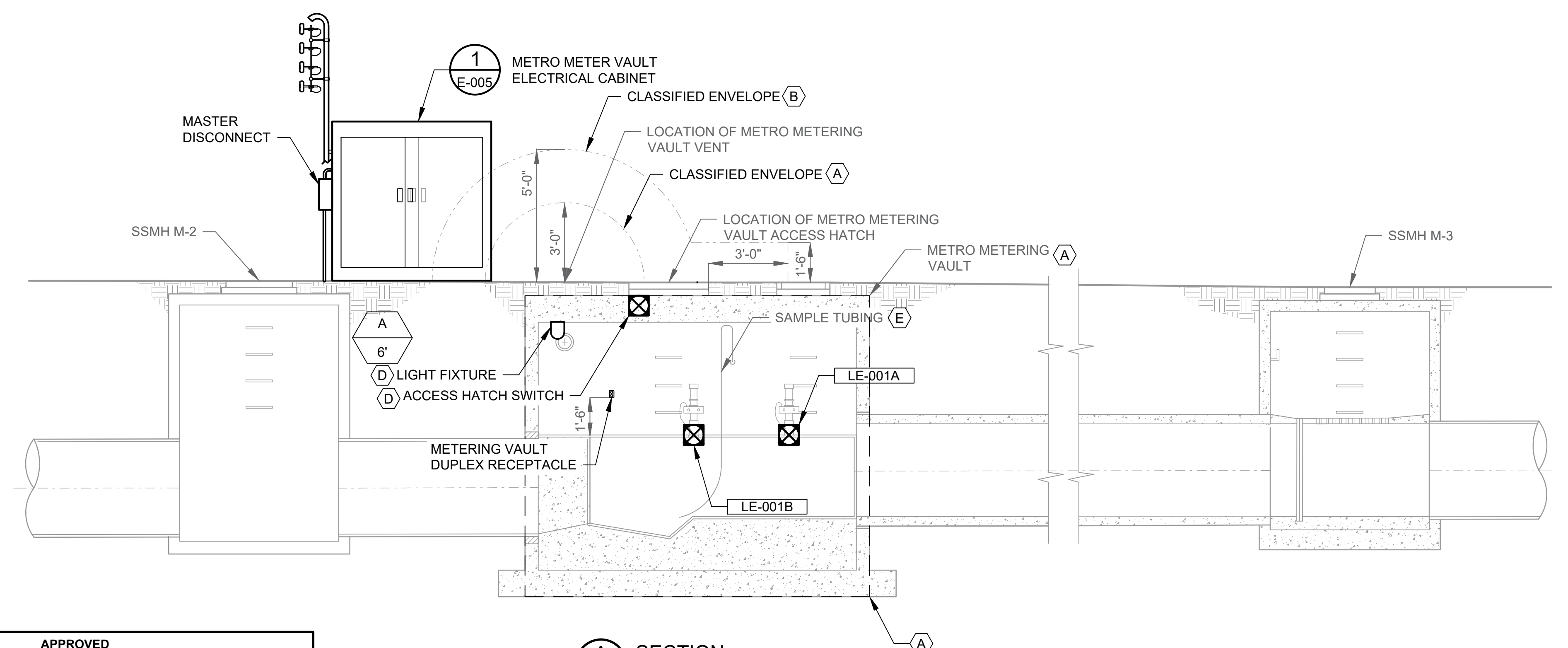
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- GENERAL SHEET NOTES**
- REFER TO CIVIL AND MECHANICAL DRAWINGS FOR ALL NON-ELECTRICAL CALLOUTS AND SCOPE OF PROPOSED WORK..
  - COORDINATE WITH THE ELECTRIC UTILITY, XCEL ENERGY, AS NECESSARY FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES**
- ENTIRE SPACE OF METRO METERING VAULT AND THE RADIUS OF THE ENVELOPE IS CLASS I, DIVISION I, GROUP D PER NFPA 820.
  - ENTIRE SPACE OF METRO METERING VAULT AND THE RADIUS OF THE ENVELOPE IS CLASS I, DIVISION 2, GROUP D PER NFPA 820.
  - MOUNT LEVEL TRANSMITTERS PER INSTRUMENTATION AND MECHANICAL DETAILS.
  - ACCESS HATCH SWITCH SHALL BE WIRED IN SERIES WITH METRO METER VAULT LIGHT.
  - SAMPLE TUBING FROM AUTO-SAMPLER TO BE ROUTED IN THE CONDUIT, SEE CONDUIT AND CONDUCTOR SCHEDULE.



**1 METRO METERING VAULT**  
E-010 SCALE: 1" = 3'-0"



**A SECTION**  
SCALE: 1" = 3'-0"

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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NO	REVISION	DATE	BY

**SCALES**

0 1" = 1"

0 25mm = 1"

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DESIGNED	ZLP
DRAWN	VZ
CHECKED	ZCD

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

SCALE	1" = 3'
JOB NO	2246059*00
DATE	FEB 2024
SHEET	38 OF 52
	E-011

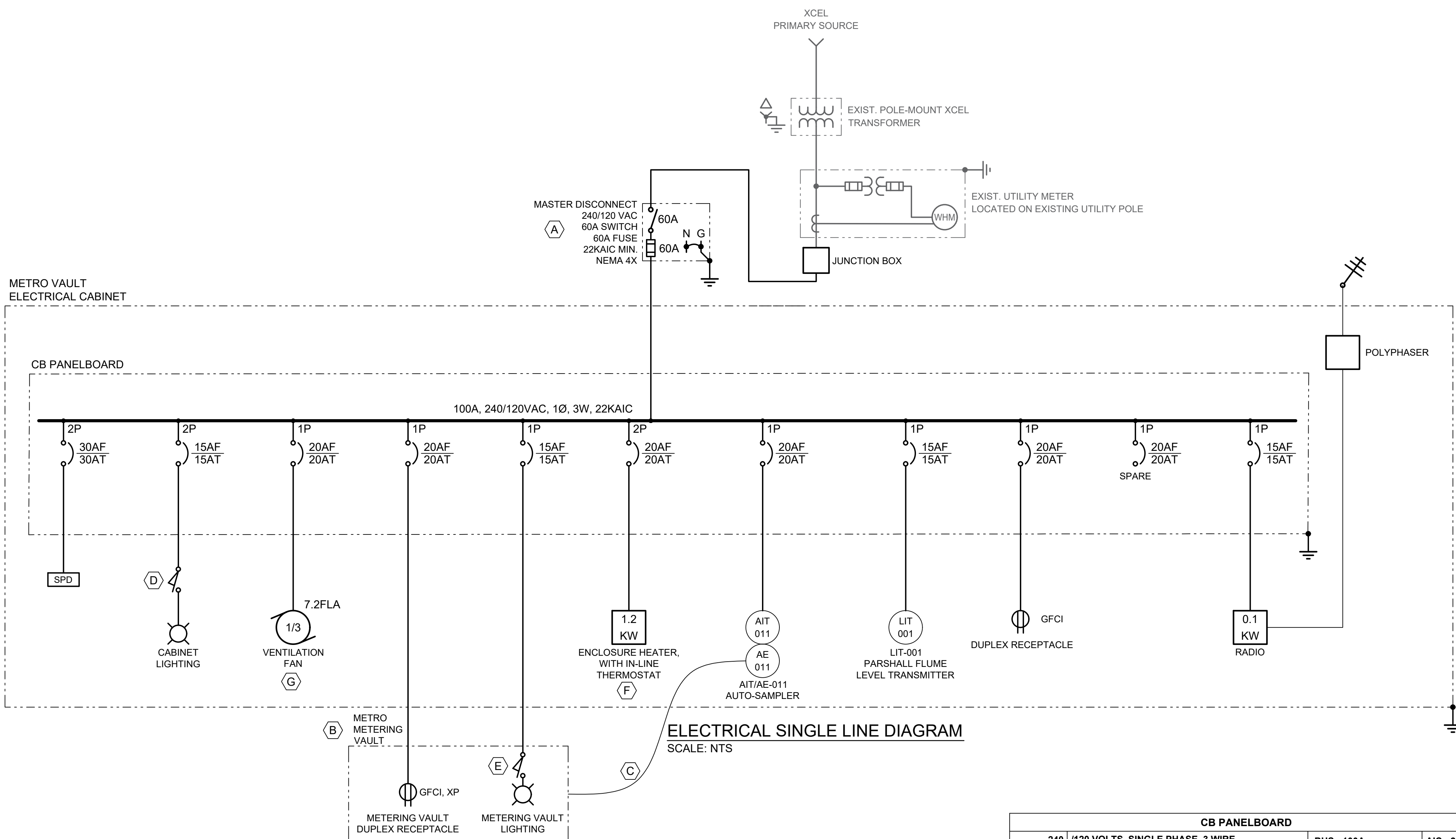


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- GENERAL SHEET NOTES**
- COORDINATE WITH THE ELECTRIC UTILITY, XCEL ENERGY, FOR SHUTDOWN PROCEDURES DURING CONSTRUCTION ACTIVITIES (DEMOLITION, PROPOSED WORK, ETC.).
- SHEET KEYNOTES**
- MOUNT NEW MASTER DISCONNECT ON OUTSIDE OF NEW METRO VAULT ELECTRICAL CABINET.
  - ENTIRE SPACE OF METRO METERING VAULT IS CLASS I, DIVISION I, GROUP D PER NFPA 820.
  - SAMPLE TUBING FROM AUTO-SAMPLER TO BE ROUTED IN CONDUIT, SEE CONDUIT AND CONDUCTOR SCHEDULE.
  - LED STRIP LIGHTS SHALL BE CONTROLLED BY DOOR SWITCHES, SEE LUMINAIRE SCHEDULE, LUMINAIRE TYPE B.
  - LED LIGHT SHALL BE CONTROLLED BY THE HATCH DOOR SWITCH, SEE LUMINAIRE SCHEDULE, LUMINAIRE TYPE A.
  - ENCLOSURE HEATER(S) WITH INLINE THERMOSTAT MUST BE PTC 1200W 130600-00 OR AN EQUIVALENT. THE CONTRACTOR MUST SUBMIT ENCLOSURE HEATER CALCULATIONS TO THE ENGINEER TO DETERMINE THE REQUIRED NUMBER OF HEATERS REQUIRED TO MAINTAIN ABOVE FREEZING TEMPERATURES.
  - VENTILATION FAN SHALL BE GRAINGER ITEM 7C038 WITH THE APPROPRIATE MOTOR.



**ELECTRICAL SINGLE LINE DIAGRAM**  
SCALE: NTS

LUMINAIRE SCHEDULE					
TYPE	DESCRIPTION	LAMPS	WATTS /FIXTURE	MANUFACTURER CATALOG NUMBER	MOUNTING
A	CLASS I, DIVISION I, GROUP D EXPLOSION-PROOF LED, EPOXY POWDER COAT, WALL MOUNT.	LED	56	EATON CROUSE-HINDS, EVLL5LCBX21/UNV1 OR EQUAL	WALL BRACKET, STAINLESS STEEL GUARD
B	240VAC LED ENCLOSURE LIGHT, IP20 RATED, MOUNTING ACCESSORIES INCLUDING DOOR POSITION SWITCH WITH 3M CABLE	LED	6	PHOENIX CONTACT, PLD E 409 W 350 OR EQUAL	SCREW/MAGNET MOUNTING, DOOR SWITCH KIT

**LUMINAIRE SCHEDULE**  
SCALE: NTS

CB PANELBOARD				FED FROM: MASTER DISCONNECT		
240 /120 VOLTS, SINGLE PHASE, 3 WIRE		BUS: 100A	AIC: 22KA	MAIN: MLO		MOUNTING: SURFACE
CKT. NO.	DESCRIPTION	CONNECTED KVA		TRIP AMPS/ POLES	CKT. NO.	DESCRIPTION
		A	B			
1	CABINET LIGHTING	0.1		15/2	2	ENCLOSURE HEATER WITH IN-LINE THERMOSTAT
3			0.1		4	
5	VENTILATION FAN	0.9		20/1	6	AIT-011 AUTO-SAMPLER
7	METERING VAULT DUPLEX RECEPTACLE		0.2	20/1	8	LIT-001 PARSHALL FLUME LEVEL TRANSMITTER
9	METERING VAULT LIGHTING	0.1		15/1	10	RADIO
11	DUPLEX RECEPTACLE		0.2	20/1	12	SPACE
13	SPARE	0.0		20/1	14	SPACE
15					16	SPACE
17	EXTERNAL SURGE PROTECTION DEVICE	0.0	0.0	30/2	18	SPACE
PHASE SUBTOTALS (KVA):		1.0	0.4			
PHASE TOTALS (KVA):						2.9 2.6
TOTAL KVA:						6.9 KVA
TOTAL AMPERES:						29 A

**CB PANELBOARD SCHEDULE**  
SCALE: NTS

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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CITY OF ARVADA

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

SCALE: NTS

JOB NO: 2246059\*00

DATE: FEB 2024

SHEET 39 OF 52

**E-020**



CONDUIT AND CABLE SCHEDULE							
NUMBER	FROM	TO	SIZE (")	POWER	CONTROL	SIGNAL	COMMENTS
P-001	EXISTING UTILITY METER	JUNCTION BOX	1"	3-#6, #8 GND.			RE-USE EXISTING CONDUIT
P-002	JUNCTION BOX	MASTER DISCONNECT	1"	3-#6, #8 GND.			
P-003	MASTER DISCONNECT	CB PANELBOARD	1"	3-#6, #8 GND.			
P-004	CB PANELBOARD	ENCLOSURE HEATER, WITH IN-LINE THERMOSTAT	3/4"	2-#12, #12GND.			
P-005	CB PANELBOARD	CABINET LIGHTING	3/4"	2-#12, #12GND.			
P-006	CB PANELBOARD	VENTILATION FAN	3/4"	2-#12, #12GND.			
P-007	CB PANELBOARD	AIT-011 AUTO-SAMPLER	3/4"	2-#12, #12GND.			
P-008	CB PANELBOARD	LEVEL TRANSMITTER LIT-001	3/4"	2-#12, #12GND.			
P-009	CB PANELBOARD	RADIO	3/4"	2-#12, #12GND.			
P-010	CB PANELBOARD	METERING VAULT LIGHTING	1"	2-#12, #12GND.			IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)
P-011	CB PANELBOARD	METERING VAULT DUPLEX RECEPTACLE	1"	2-#12, #12GND.			IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)
P-012	CB PANELBOARD	DUPLEX RECEPTACLE	3/4"	2-#12, #12GND.			
P-013	CB PANELBOARD	EXTERNAL SURGE PROTECTIVE DEVICE	3/4"	3-#10, #10GND			
S-001	DATA LOGGER	RADIO	3/4"			1-CAT6	
S-002	RADIO	POLYPHASER	3/4"			COAX	
S-003	POLYPHASER	ANTENNA	2"			COAX	
S-004	DATA LOGGER	LIT-001	3/4"			1-2/C #16(SH)	
S-005	LIT-001	LE-001A, LE-001B	1"			2-MFR CABLE	IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)
C-001	DATA LOGGER	AIT-011	3/4"		8-#14, #14GND.		
M-001	AUTOSAMPLER AIT-011	PARSHALL FLUME SAMPLING POINT	2"				CONTAINS 3/8" PVC SA SAMPLE TUBING IN DUCT BANK, PROVIDE CONDUIT SEALS PER NEC (CLASSIFIED AREA)

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City of Arvada, Colorado

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**CITY OF ARVADA**  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11  
 Kennedy Jenks

**CONDUIT AND CABLE SCHEDULE**

SCALE  
NTS

JOB NO  
2246059\*00

DATE  
FEB 2024

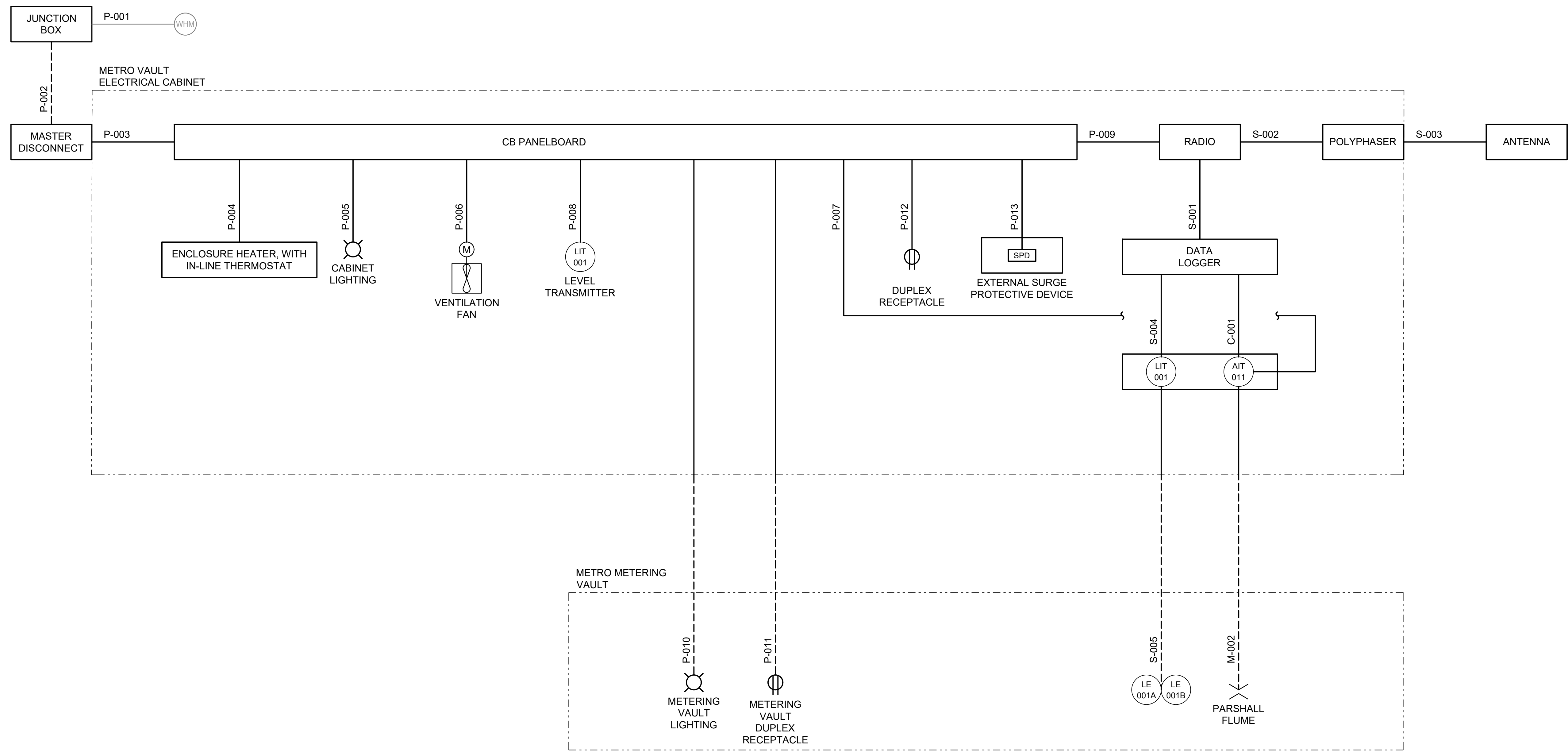
SHEET 40 OF 52  
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**CITY OF ARVADA**  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11  
**Kennedy Jenks**

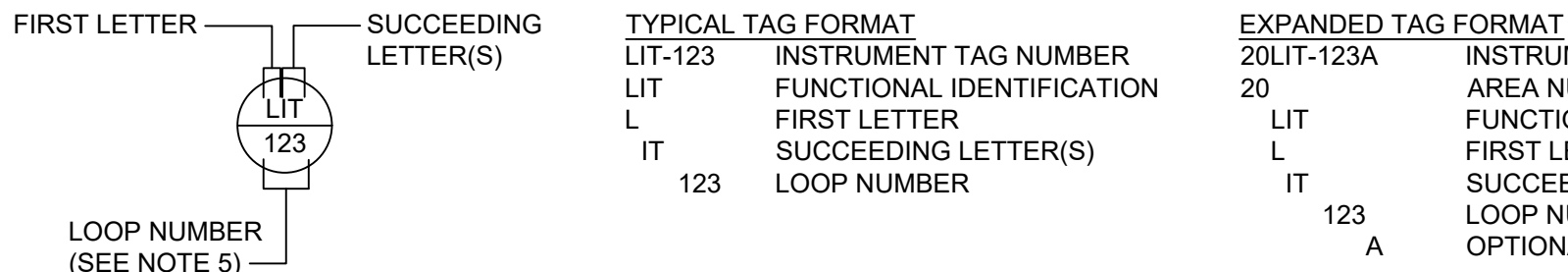
**CONDUIT BLOCK ROUTING DIAGRAM**

SCALE	NTS
JOB NO	2246059*00
DATE	FEB 2024
SHEET	41 OF 52
	E-040



Plot Date: 1/19/2024 3:05 PM  
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# INSTRUMENT CALLOUTS AND TAG SCHEMA



**TYPICAL TAG FORMAT**  
LIT-123 INSTRUMENT TAG NUMBER  
LIT FUNCTIONAL IDENTIFICATION  
LIT 123 SUCCEEDING LETTER(S)  
LIT 123 LOOP NUMBER

**EXPANDED TAG FORMAT**  
20LIT-123A INSTRUMENT TAG NUMBER  
20 AREA NUMBER  
LIT FUNCTIONAL IDENTIFICATION  
LIT 123 SUCCEEDING LETTER(S)  
LIT 123 A LOOP NUMBER  
A OPTIONAL SUFFIX

FIRST LETTER (1)	SUCCEEDING LETTERS (15)			
MEASURED OR INITIATING VARIABLE	MODIFIER	READOUT OR PASSIVE FUNCTION	OUTPUT FUNCTION	MODIFIER
A ANALYSIS (2)(3)(4)		ALARM		
B BURNER, COMBUSTION (2)		USER'S CHOICE (5)	USER'S CHOICE (5)	USER'S CHOICE (5)
C USER'S CHOICE (3a)(5)			CONTROL (23a)(23e)	CLOSED (27b)
D DENSITY	DIFFERENTIAL	DAMPER		
E VOLTAGE (2)		SENSOR (PRIMARY ELEMENT)		
F FLOW, FLOW RATE (2)	RATIO (FRACTION) (2b)			
G USER'S CHOICE		GLASS, VIEWING DEVICE (16)		
H HAND (2)				HIGH (27A)(28A)(29)
I CURRENT (ELECTRICAL)(2)		INDICATE (17)		
J POWER (2)		SCAN (18)		
K TIME, TIME SCHEDULE (2)	TIME RATE OF CHANGE (12c)(13)		CONTROL STATION (24)	
L LEVEL (2)		LIGHT (19)		LOW (27b)(28)(29)
M MOISTURE	MOMENTARY			MIDDLE, INTERMEDIATE
N USER'S CHOICE (5)		USER'S CHOICE (5)	USER'S CHOICE (5)	
O USER'S CHOICE (5)		ORIFICE, RESTRICTION		OPEN (27a)
P PRESSURE, VACUUM (2)		POINT (TEST) CONNECTION		
Q QUANTITY (2)	INTEGRATE, TOTALIZE	INTEGRATE, TOTALIZE		
R RADIATION (2)		RECORD (20)		RUN
S SPEED, FREQUENCY (2)	SAFETY (14)		SWITCH (23b)	STOP
T TEMPERATURE (2)			TRANSMIT	
U MULTI VARIABLE (2)(6)		MULTIFUNCTION (21)	MULTIFUNCTION (21)	MULTIFUNCTION (21)
V VIBRATION, MECHANICAL ANALYSIS (2)(4)(7)			VALVE, DAMPER, OR LOUVER (23c)(23e)	
W WEIGHT, FORCE (2)		WELL, PROBE		
X UNCLASSIFIED (8)	X AXIS (11c)	ACCESSORY DEVICES (22) UNCLASSIFIED (8)	UNCLASSIFIED (8)	UNCLASSIFIED (8)
Y EVENT, STATE, PRESENCE (2)(9)	Y AXIS (11c)		RELAY, COMPUTE, CONVERT	
Z POSITION, DIMENSION (2)	Z AXIS (11c), SAFETY INSTRUMENTED SYSTEM (30)		DRIVER, ACTUATOR, UNCLASSIFIED FINAL CONTROL ELEMENT	

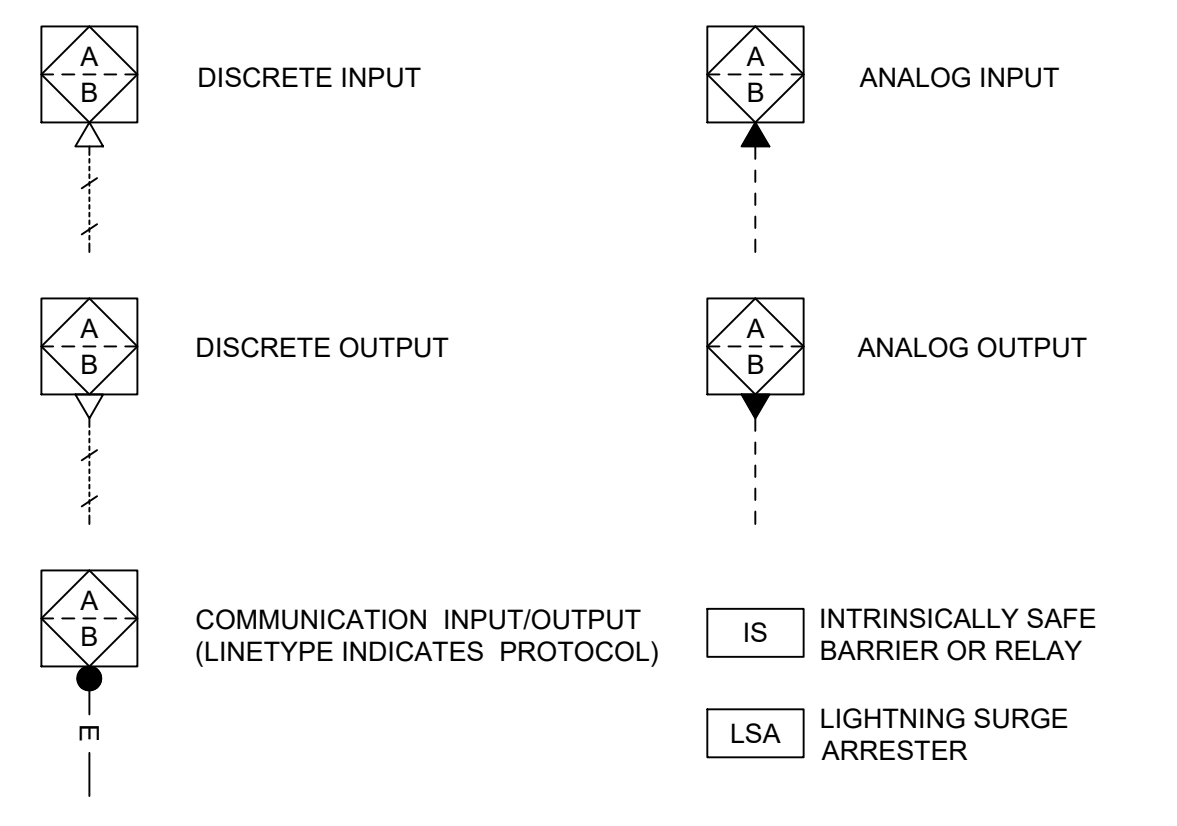
NOTE: NUMBERS IN PARENTHESES REFER TO EXPLANATORY NOTES IN ANSI/ISA-5.1-2009, SECTION 4.2

	LOCATED IN FIELD VISIBLE AT LOCATION OPERATOR ACCESSIBLE	LOCATED ON MAIN PANEL VISIBLE ON PANEL FRONT OPERATOR ACCESSIBLE	LOCATED IN MAIN PANEL CABINET NOT VISIBLE ON PANEL FRONT NOT OPERATOR ACCESSIBLE	LOCATED ON SECONDARY PANEL VISIBLE ON PANEL FRONT OPERATOR ACCESSIBLE	LOCATED IN SECONDARY PANEL CABINET NOT VISIBLE ON PANEL FRONT NOT OPERATOR ACCESSIBLE
SHARED DISPLAY SHARED CONTROL					
PROGRAMMABLE LOGIC CONTROL					
COMPUTER FUNCTION					
INSTRUMENT					
PILOT LIGHT					

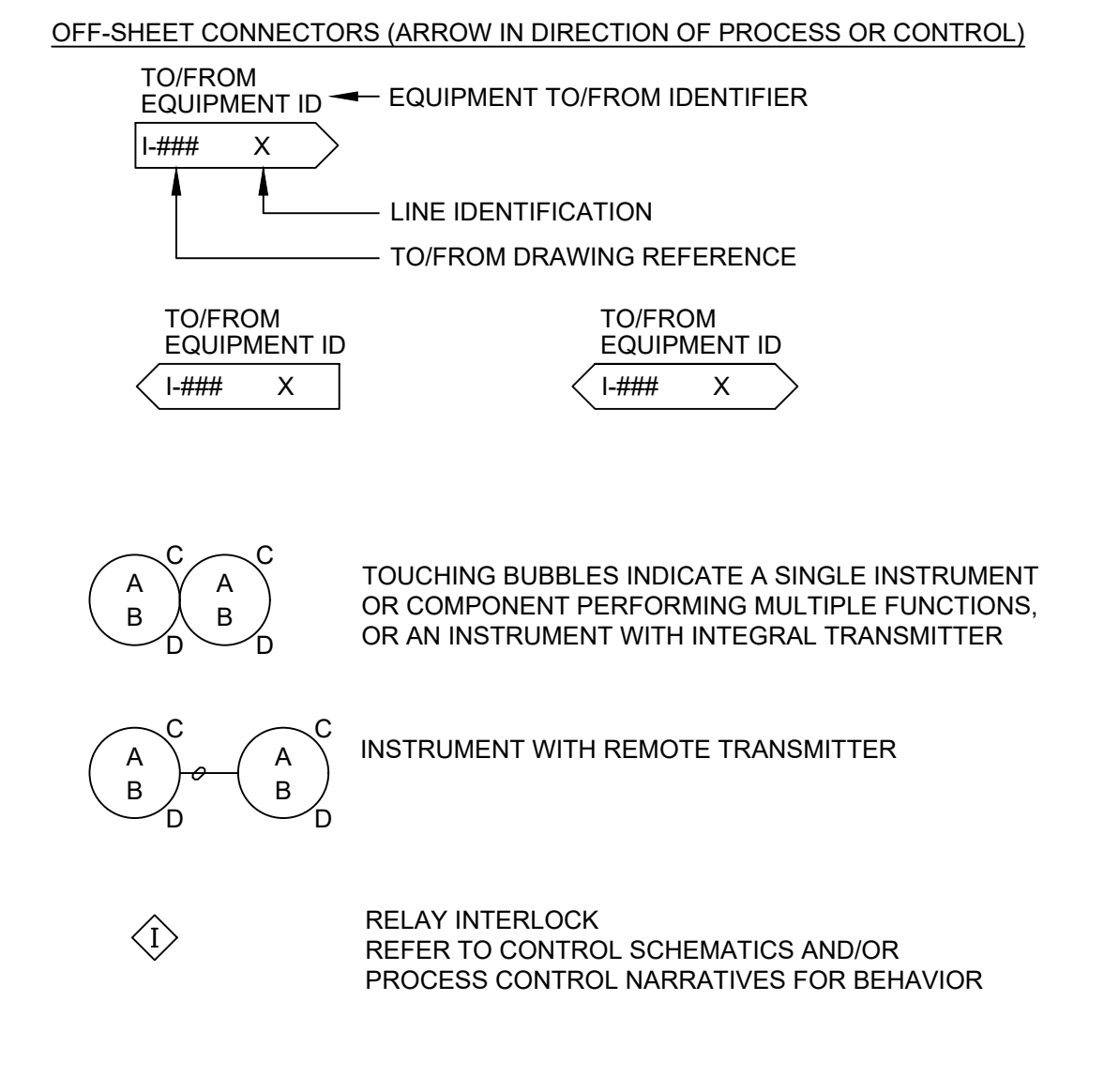
**LETTER MAPPING:**  
A: IDENTIFICATION LETTERS (SEE TABLE OR REFER TO ANSI/ISA-5.1-2009; TABLE 4.1)  
B: LOOP NUMBER  
C: USER DESCRIPTOR/FUNCTION DESIGNATION (SEE LIST THIS SHEET)  
D: MEASUREMENT (REFER TO ANSI/ISA-5.1-2009; TABLE 5.2.2)  
E: PROCESS CONTROL DESCRIPTOR LINE 1  
F: PROCESS CONTROL DESCRIPTOR LINE 2  
G: PROCESS CONTROL DESCRIPTOR LINE 3

DISPLAY AND CONTROL SYMBOLS FOR ANALOG MEASURED VARIABLES MAY ALSO INDICATE THE PRESENCE OF DERIVED SETPOINTS USED FOR ALARM GENERATION

# PLC I/O



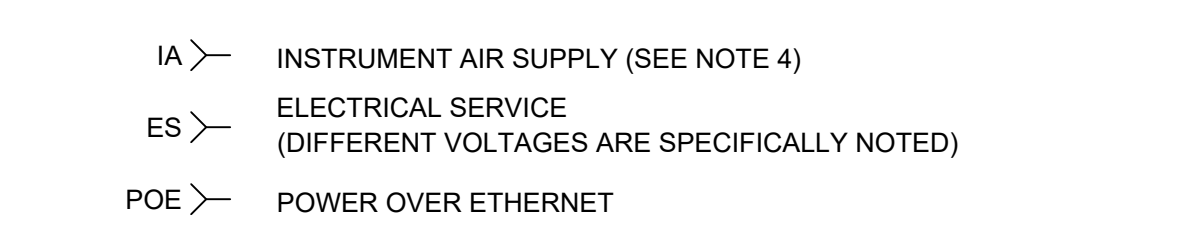
# MISCELLANEOUS



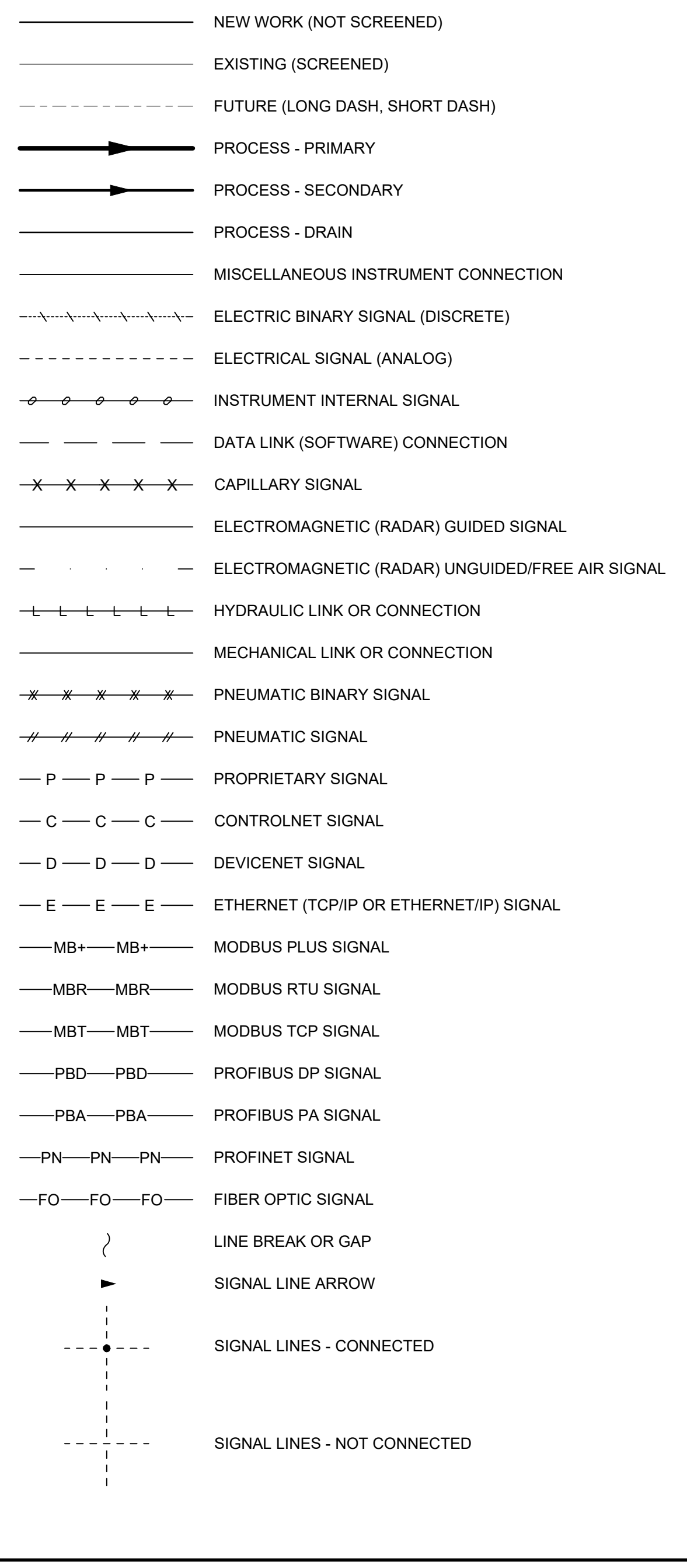
# FUNCTION DESIGNATIONS

SWITCHES	ANALYTICAL INSTRUMENTS
A/M AUTO-MANUAL	ALK ALKALINITY
ESTOP EMERGENCY STOP	CL2* CHLORINE CONCENTRATION
F-R FORWARD-REVERSE	CO CARBON MONOXIDE
HOA HAND-OFF-AUTO	CO2 CARBON DIOXIDE
HOR HAND-OFF-REMOTE	COMB COMBUSTIBLE GAS
LJR LOCAL-REMOTE	COND CONDUCTIVITY
LOR LOCAL-OFF-REMOTE	COND COMBUSTIBLE GAS
O/C OPEN-CLOSE	DO DISSOLVED OXYGEN
OCA OPEN-CLOSE-AUTO	H2S HYDROGEN SULFIDE
O-O ON-OFF	HUM HUMIDITY
OSC OPEN-STOP-CLOSE	NO3 NITRATE
POT POTENTIOMETER	O2 OXYGEN CONCENTRATION
RST RESET	O3 OZONE
S-S START-STOP	ORP OXIDATION REDUCTION POTENTIAL
	PH PH
	SO2 SULFUR DIOXIDE
	TH TOTAL HARDNESS
	TURB TURBIDITY
	UV ULTRAVIOLET TRANSMITTANCE OR INTENSITY
	* NOTED AS TOTAL OR FREE

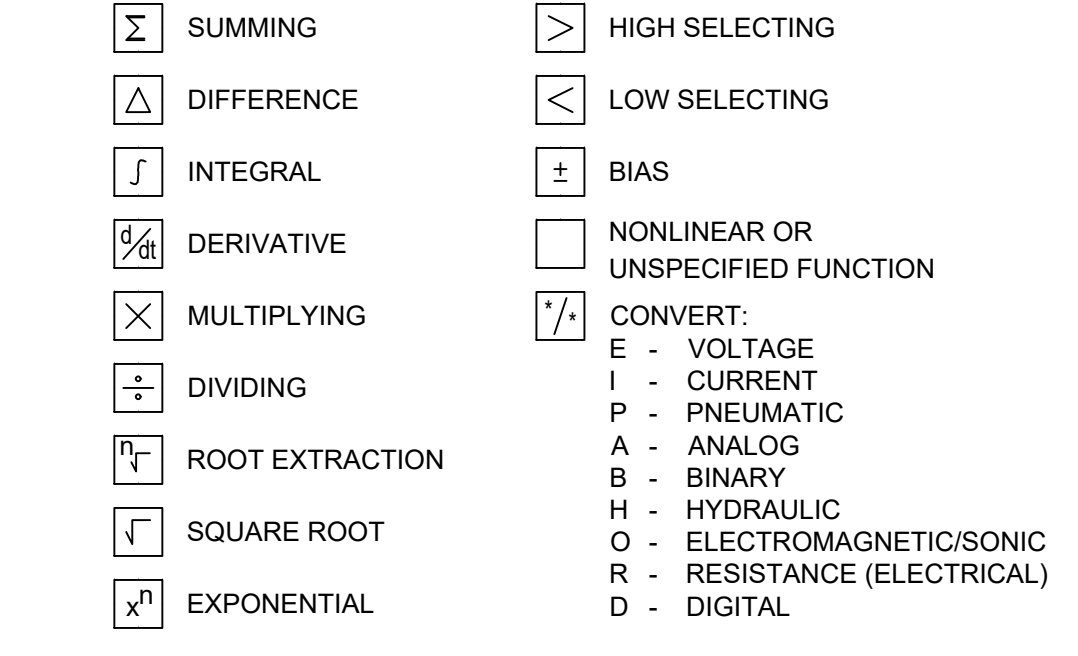
# INSTRUMENT AND EQUIPMENT SERVICES



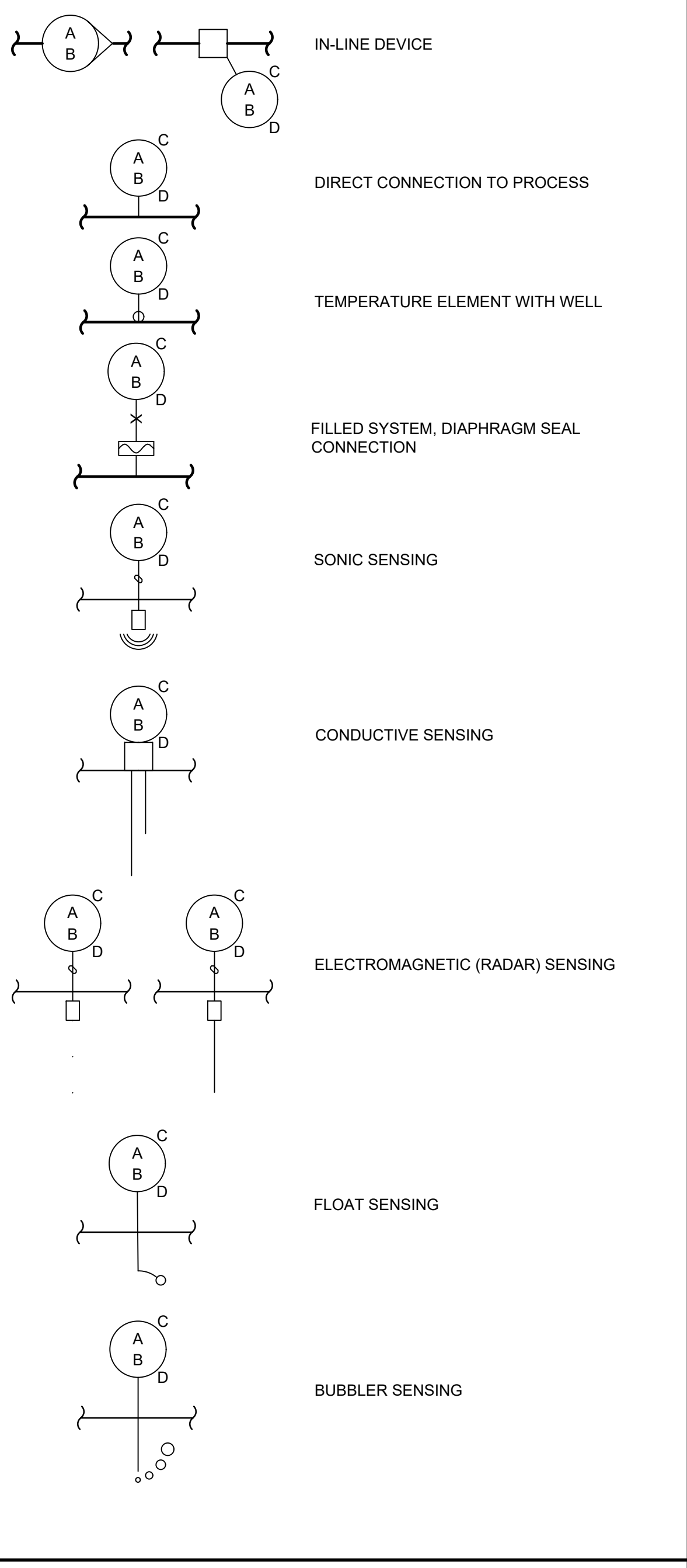
# LINE SYMBOLOLOGY



# SIGNAL PROCESSING FUNCTIONS



# TYPICAL CONNECTIONS



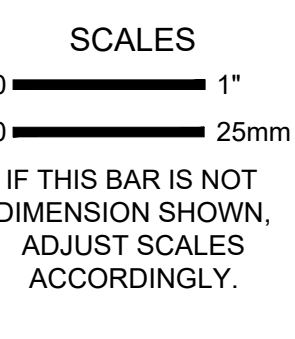
# NOTES

- SEE THE GENERAL AND ELECTRICAL DISCIPLINE DRAWINGS FOR ADDITIONAL SYMBOLS AND ABBREVIATIONS.
- SEE THE GENERAL DISCIPLINE DRAWINGS FOR EQUIPMENT DESIGNATIONS AND PROCESS IDENTIFICATION CODES.
- THIS IS A GENERALIZED LEGEND SHEET. SEE ALSO ISA S5.1, S5.3 AND S7.3.
- FOR INSTRUMENT AIR QUALITY STANDARDS, REFER TO ISA RP7.7.
- WHERE LOOP NUMBERS EXCEED THE LENGTH AVAILABLE WITHIN A BUBBLE, THE LOWER HALF OF THE BUBBLE MAY APPEAR BROKEN TO ALLOW SPACE FOR THE LOOP NUMBER.
- SEE SPECIFICATION 17010 FOR COMPLETE DETAILS OF LOOP DRAWING AND INTERCONNECTION DRAWING SUBMITTAL REQUIREMENTS.
- POWER SUPPLIES FOR INSTRUMENT LOOPS OR SYSTEMS SHALL BE PROVIDED BY THE INSTRUMENTATION SUPPLIER TO MEET THE VOLTAGE AND CURRENT REQUIREMENTS OF THE COMPONENTS IN EACH LOOP OR SYSTEM.
- FIELD SWITCHES FOR ELECTRICAL MOTOR OPERATION SHALL BE SUPPLIED BY THE ELECTRICAL CONTRACTOR UNLESS THEY ARE PART OF A VENDOR PACKAGE.

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Kennedy Jenks

SCALE
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DATE FEB 2024
SHEET 42 OF 52
I-001



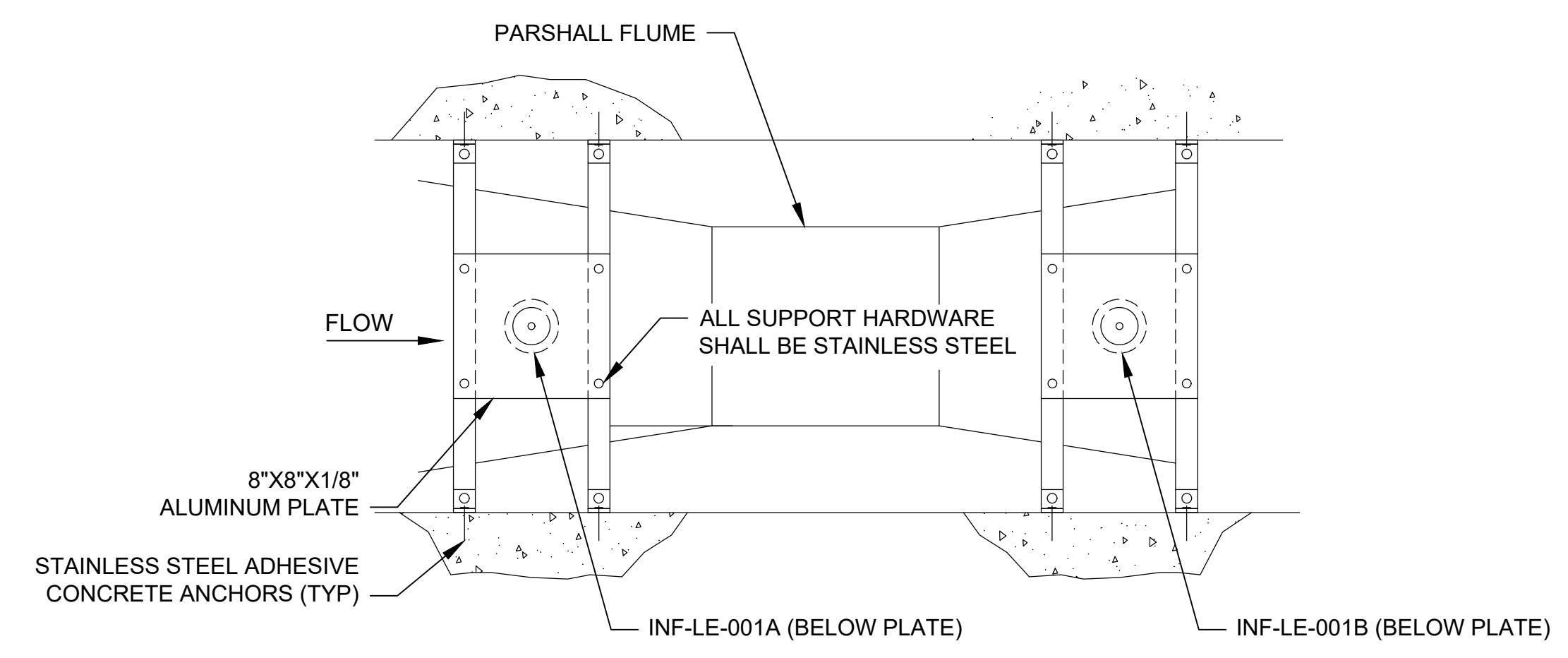
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**GENERAL SHEET NOTES**

1. ALL DETAILS SHOWN ARE TYPICAL. DETAILS SHALL BE USED THROUGHOUT THE PROJECT AS APPLICABLE.



**PARSHALL FLUME TRANSMITTER MOUNTING DETAIL** I-0001  
 SCALE: NTS  
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 City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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**SCALES**

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DESIGNED	ZLP
DRAWN	VZ
CHECKED	ZCD

**CITY OF ARVADA**  
**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**  
**Kennedy Jenks**

**STANDARD DETAILS**

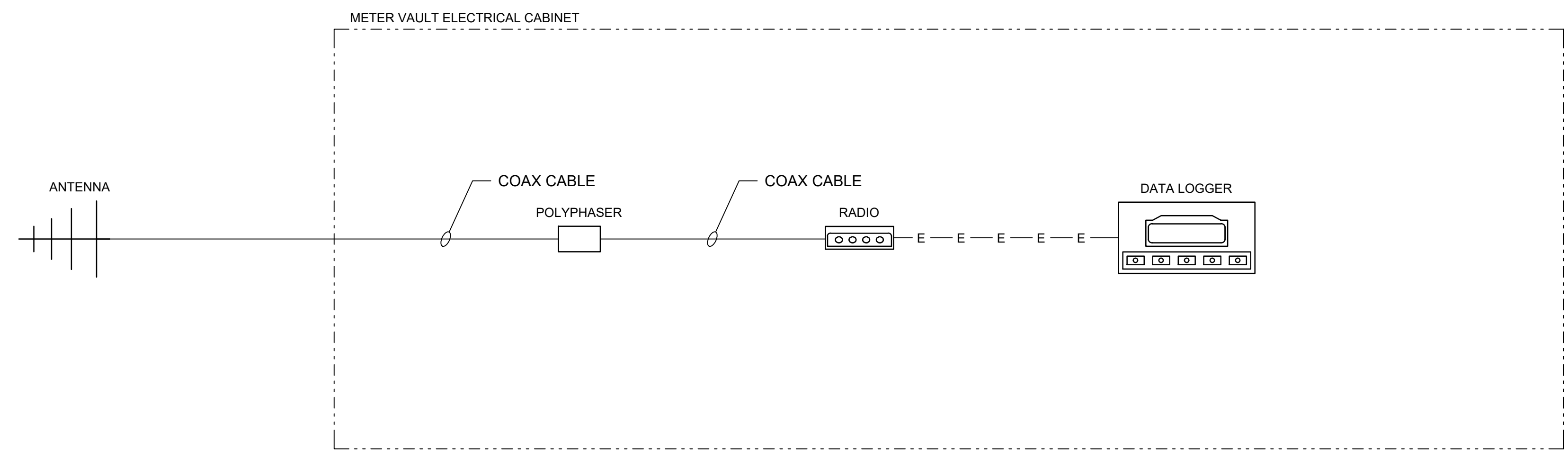
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**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**NETWORK DIAGRAM**

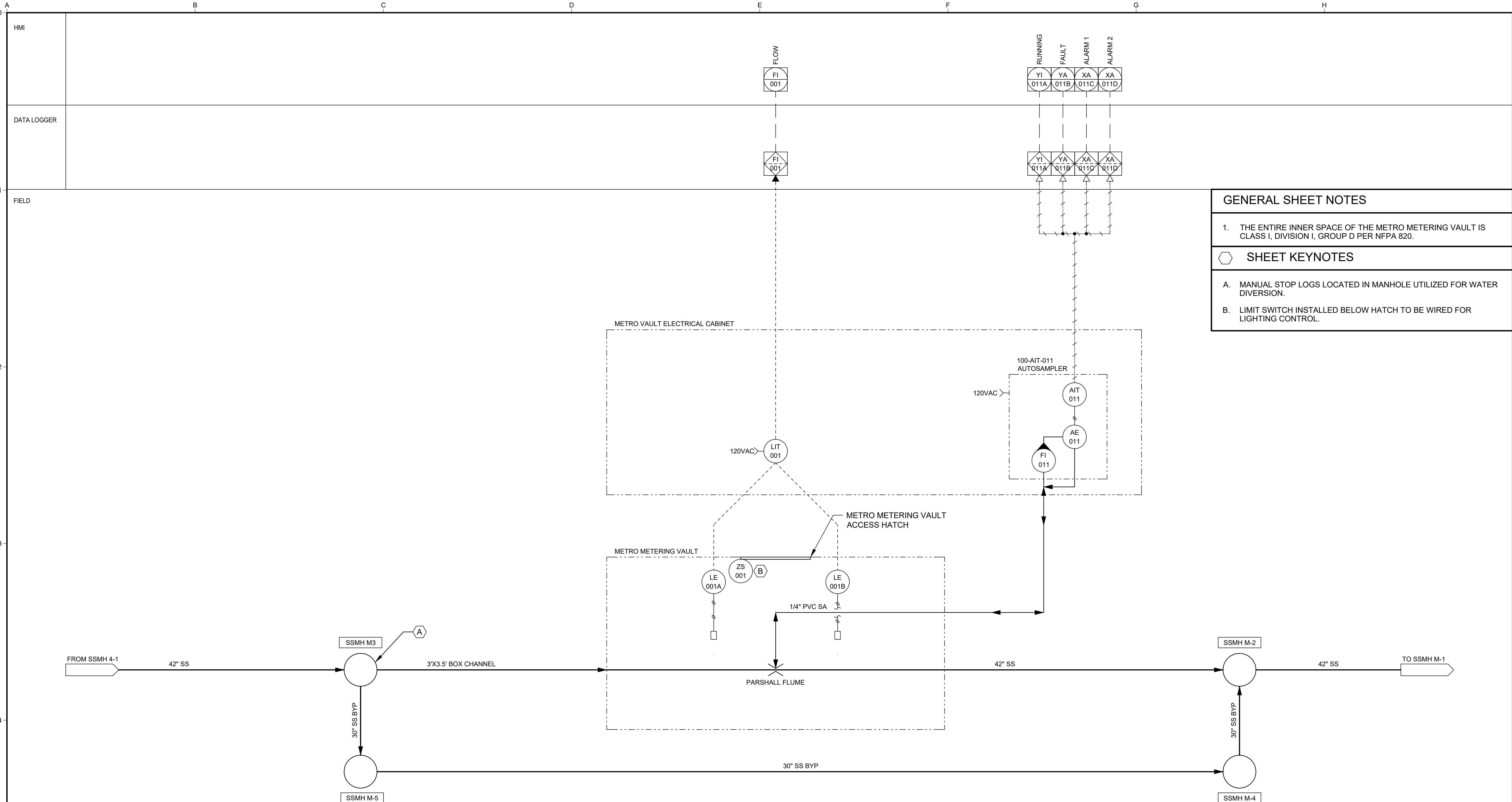
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- GENERAL SHEET NOTES**
- THE ENTIRE INNER SPACE OF THE METRO METERING VAULT IS CLASS I, DIVISION I, GROUP D PER NFPA 820.
- SHEET KEYNOTES**
- MANUAL STOP LOGS LOCATED IN MANHOLE UTILIZED FOR WATER DIVERSION.
  - LIMIT SWITCH INSTALLED BELOW HATCH TO BE WIRED FOR LIGHTING CONTROL.

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CITY OF ARVADA  
**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**  
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**PARSHALL FLUME**  
**PROCESS AND INSTRUMENTATION DIAGRAM**

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I-011







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SC-5

Rock Sock (RS)

Rock Sock (RS)

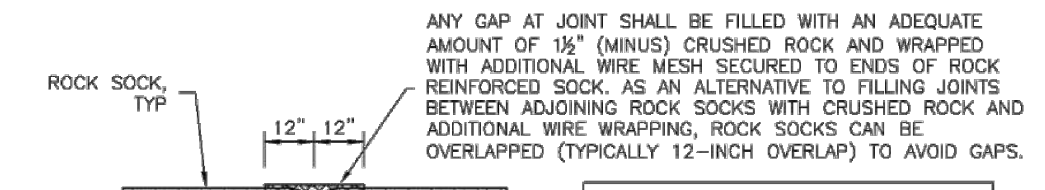
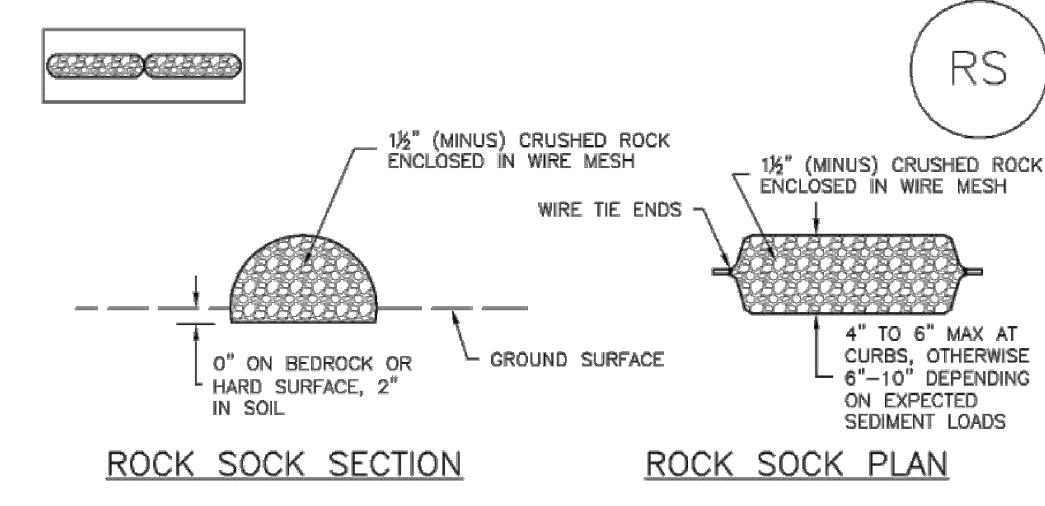
SC-5

Concrete Washout Area (CWA)

MM-1

MM-1

Concrete Washout Area (CWA)



**GRADATION TABLE**

SILOE SIZE	MASS PERCENT PASSING SQUARE MESH SIEVES
NO. 4	
2"	100
1 1/2"	90 - 100
1"	20 - 55
3/4"	0 - 15
3/8"	0 - 5

MATCHES SPECIFICATIONS FOR NO. 4 COARSE AGGREGATE FOR CONCRETE PER AASHTO M4.3. ALL ROCK SHALL BE FRACTURED FACE, ALL SIDES.

- ROCK SOCK INSTALLATION NOTES**
- SEE PLAN VIEW FOR: -LOCATION(S) OF ROCK SOCKS.
  - CRUSHED ROCK SHALL BE 1/2" (MINUS) IN SIZE WITH A FRACTURED FACE (ALL SIDES) AND SHALL COMPLY WITH GRADATION SHOWN ON THIS SHEET (1/2" MINUS).
  - WIRE MESH SHALL BE FABRICATED OF 10 GAGE POULTRY MESH, OR EQUIVALENT, WITH A MAXIMUM OPENING OF 1/2", RECOMMENDED MINIMUM ROLL WIDTH OF 48"
  - WIRE MESH SHALL BE SECURED USING "HOG RINGS" OR WIRE TIES AT 6" CENTERS ALONG ALL JOINTS AND AT 2" CENTERS ON ENDS OF SOCKS.
  - SOME MUNICIPALITIES MAY ALLOW THE USE OF FILTER FABRIC AS AN ALTERNATIVE TO WIRE MESH FOR THE ROCK ENCLOSURE.

RS-1. ROCK SOCK PERIMETER CONTROL

ROCK SOCK

RS-2 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3 November 2010

November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

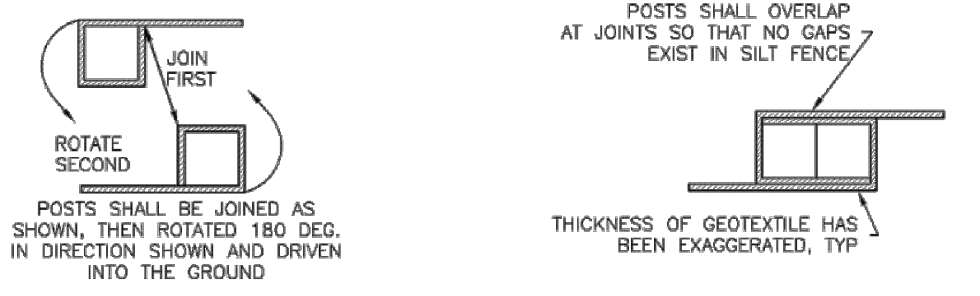
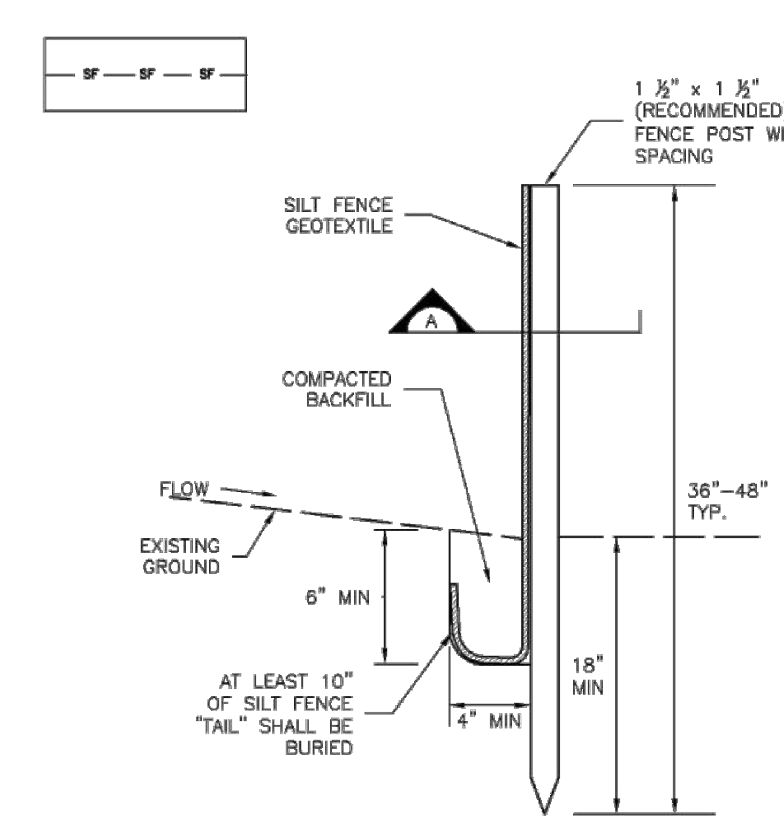
RS-3

Silt Fence (SF)

SC-1

SC-1

Silt Fence (SF)



SECTION A

SF-1. SILT FENCE

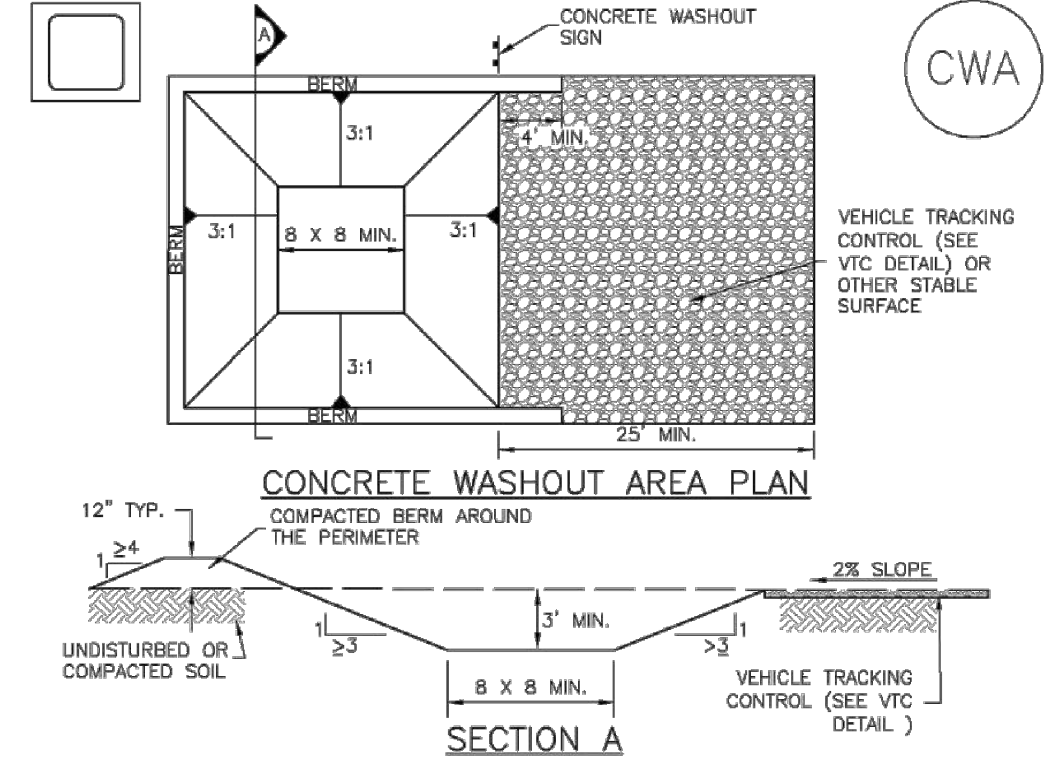
- SILT FENCE INSTALLATION NOTES**
- SILT FENCE MUST BE PLACED AWAY FROM THE TOE OF THE SLOPE TO ALLOW FOR WATER PONDING. SILT FENCE AT THE TOE OF A SLOPE SHOULD BE INSTALLED IN A FLAT LOCATION AT LEAST SEVERAL FEET (2-5 FT) FROM THE TOE OF THE SLOPE TO ALLOW ROOM FOR PONDING AND DEPOSITION.
  - A UNIFORM 6" x 4" ANCHOR TRENCH SHALL BE EXCAVATED USING TRENCHER OR SILT FENCE INSTALLATION DEVICE. NO ROAD GRADERS, BACKHOES, OR SIMILAR EQUIPMENT SHALL BE USED.
  - COMPACT ANCHOR TRENCH BY HAND WITH A "JUMPING JACK" OR BY WHEEL ROLLING. COMPACTOR SHALL BE SUCH THAT SILT FENCE RESISTS BEING PULLED OUT OF ANCHOR TRENCH BY HAND.
  - SILT FENCE SHALL BE PULLED TIGHT AS IT IS ANCHORED TO THE STAKES. THERE SHOULD BE NO NOTICEABLE SAG BETWEEN STAKES AFTER IT HAS BEEN ANCHORED TO THE STAKES.
  - SILT FENCE FABRIC SHALL BE ANCHORED TO THE STAKES USING 1" HEAVY DUTY STAPLES OR NAILS WITH 1" HEADS. STAPLES AND NAILS SHOULD BE PLACED 3" ALONG THE FABRIC DOWN THE STAKE.
  - AT THE END OF A RUN OF SILT FENCE ALONG A CONTOUR, THE SILT FENCE SHOULD BE TURNED PERPENDICULAR TO THE CONTOUR TO CREATE A "U-HOOK," THE "U-HOOK" EXTENDING PERPENDICULAR TO THE CONTOUR SHOULD BE OF SUFFICIENT LENGTH TO KEEP RUNOFF FROM FLOWING AROUND THE END OF THE SILT FENCE (TYPICALLY 10' - 20').
  - SILT FENCE SHALL BE INSTALLED PRIOR TO ANY LAND DISTURBING ACTIVITIES.

- SILT FENCE MAINTENANCE NOTES**
- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
  - FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
  - WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
  - SEDIMENT ACCUMULATED UPSTREAM OF THE SILT FENCE SHALL BE REMOVED AS NEEDED TO MAINTAIN THE FUNCTIONALITY OF THE BMP, TYPICALLY WHEN DEPTH OF ACCUMULATED SEDIMENTS IS APPROXIMATELY 6".
  - REPAIR OR REPLACE SILT FENCE WHEN THERE ARE SIGNS OF WEAR, SUCH AS SAGGING, TEARING, OR COLLAPSE.
  - SILT FENCE IS TO REMAIN IN PLACE UNTIL THE UPSTREAM DISTURBED AREA IS STABILIZED AND APPROVED BY THE LOCAL JURISDICTION, OR IS REPLACED BY AN EQUIVALENT PERIMETER SEDIMENT CONTROL BMP.
  - WHEN SILT FENCE IS REMOVED, ALL DISTURBED AREAS SHALL BE COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED AS APPROVED BY LOCAL JURISDICTION.
- (DETAIL ADAPTED FROM TOWN OF PARKER, COLORADO AND CITY OF AURORA, COLORADO, NOT AVAILABLE IN AUTOCAD)
- NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.

November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

SF-3 SF-4 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3 November 2010

SILT FENCE



CWA-1. CONCRETE WASHOUT AREA

- CWA INSTALLATION NOTES**
- SEE PLAN VIEW FOR: -CWA INSTALLATION LOCATION.
  - DO NOT LOCATE AN UNLINED CWA WITHIN 400' OF ANY NATURAL DRAINAGE PATHWAY OR WATERBODY. DO NOT LOCATE WITHIN 1,000' OF ANY WELLS OR DRINKING WATER SOURCES. IF SITE CONSTRAINTS MAKE THIS INFESIBLE, OR IF HIGHLY PERMEABLE SOILS EXIST ON SITE, THE CWA MUST BE INSTALLED WITH AN IMPERMEABLE LINER (18 MIL. MIN. THICKNESS) OR SURFACE STORAGE ALTERNATIVES USING PREFABRICATED CONCRETE WASHOUT DEVICES OR A LINED ABOVE GROUND STORAGE ARE SHOULD BE USED.
  - THE CWA SHALL BE INSTALLED PRIOR TO CONCRETE PLACEMENT ON SITE.
  - CWA SHALL INCLUDE A FLAT SUBSURFACE PIT THAT IS AT LEAST 8' BY 8' SLOPES LEADING OUT OF THE SUBSURFACE PIT SHALL BE 3:1 OR FLATTER. THE PIT SHALL BE AT LEAST 3' DEEP.
  - BERM SURROUNDING SIDES AND BACK OF THE CWA SHALL HAVE MINIMUM HEIGHT OF 1'.
  - VEHICLE TRACKING PAD SHALL BE SLOPED 2% TOWARDS THE CWA.
  - SIGNS SHALL BE PLACED AT THE CONSTRUCTION ENTRANCE, AT THE CWA, AND ELSEWHERE AS NECESSARY TO CLEARLY INDICATE THE LOCATION OF THE CWA TO OPERATORS OF CONCRETE TRUCKS AND PUMP TRUCKS.
  - USE EXCAVATED MATERIAL FOR PERIMETER BERM CONSTRUCTION.

CONCRETE WASHOUT AREA

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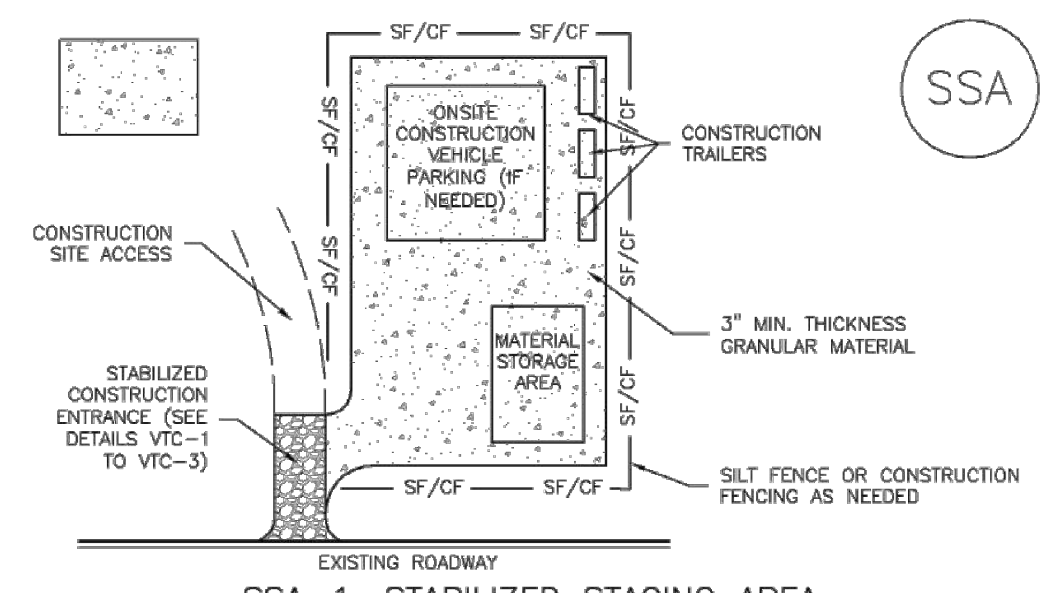
CWA-4 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3 November 2010

Stabilized Staging Area (SSA)

SM-6

SM-6

Stabilized Staging Area (SSA)



- STABILIZED STAGING AREA INSTALLATION NOTES**
- SEE PLAN VIEW FOR: -LOCATION OF STAGING AREA(S). -CONTRACTOR MAY ADJUST LOCATION AND SIZE OF STAGING AREA WITH APPROVAL FROM THE LOCAL JURISDICTION.
  - STABILIZED STAGING AREA SHOULD BE APPROPRIATE FOR THE NEEDS OF THE SITE. OVERSIZING RESULTS IN A LARGER AREA TO STABILIZE FOLLOWING CONSTRUCTION.
  - STAGING AREA SHALL BE STABILIZED PRIOR TO OTHER OPERATIONS ON THE SITE.
  - THE STABILIZED STAGING AREA SHALL CONSIST OF A MINIMUM 3" THICK GRANULAR MATERIAL.
  - UNLESS OTHERWISE SPECIFIED BY LOCAL JURISDICTION, ROCK SHALL CONSIST OF DOT SECT. #703, AASHTO #3 COARSE AGGREGATE OR 6" (MINUS) ROCK.
  - ADDITIONAL PERIMETER BMPs MAY BE REQUIRED INCLUDING BUT NOT LIMITED TO SILT FENCE AND CONSTRUCTION FENCING.
- STABILIZED STAGING AREA MAINTENANCE NOTES**
- INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.
  - FREQUENT OBSERVATIONS AND MAINTENANCE ARE NECESSARY TO MAINTAIN BMPs IN EFFECTIVE OPERATING CONDITION. INSPECTIONS AND CORRECTIVE MEASURES SHOULD BE DOCUMENTED THOROUGHLY.
  - WHERE BMPs HAVE FAILED, REPAIR OR REPLACEMENT SHOULD BE INITIATED UPON DISCOVERY OF THE FAILURE.
  - ROCK SHALL BE REAPPLIED OR REGRADED AS NECESSARY IF RUTTING OCCURS OR UNDERLYING SUBGRADE BECOMES EXPOSED.

- STABILIZED STAGING AREA MAINTENANCE NOTES**
- STABILIZED STAGING AREA SHALL BE ENLARGED IF NECESSARY TO CONTAIN PARKING, STORAGE, AND UNLOADING/LOADING OPERATIONS.
  - THE STABILIZED STAGING AREA SHALL BE REMOVED AT THE END OF CONSTRUCTION. THE GRANULAR MATERIAL SHALL BE REMOVED OR, IF APPROVED BY THE LOCAL JURISDICTION, USED ON SITE AND THE AREA COVERED WITH TOPSOIL, SEEDED AND MULCHED OR OTHERWISE STABILIZED IN A MANNER APPROVED BY LOCAL JURISDICTION.
- NOTE: MANY MUNICIPALITIES PROHIBIT THE USE OF RECYCLED CONCRETE AS GRANULAR MATERIAL FOR STABILIZED STAGING AREAS DUE TO DIFFICULTIES WITH RE-ESTABLISHMENT OF VEGETATION IN AREAS WHERE RECYCLED CONCRETE WAS PLACED.
- NOTE: MANY JURISDICTIONS HAVE BMP DETAILS THAT VARY FROM UDFCD STANDARD DETAILS. CONSULT WITH LOCAL JURISDICTIONS AS TO WHICH DETAIL SHOULD BE USED WHEN DIFFERENCES ARE NOTED.
- (DETAILS ADAPTED FROM DOUGLAS COUNTY, COLORADO, NOT AVAILABLE IN AUTOCAD)

November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3 SSA-3

SSA-4 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3 November 2010

STABILIZED STAGING AREA

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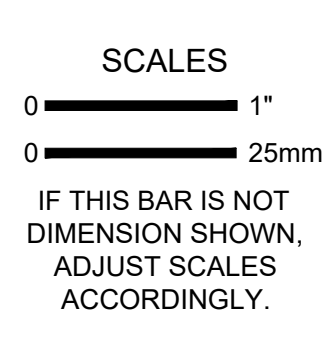
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CITY OF ARVADA

**NORTH TRUNK SEWER IMPROVEMENTS**  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

SCALE NTS

JOB NO 2246059\*00

DATE JAN 2024

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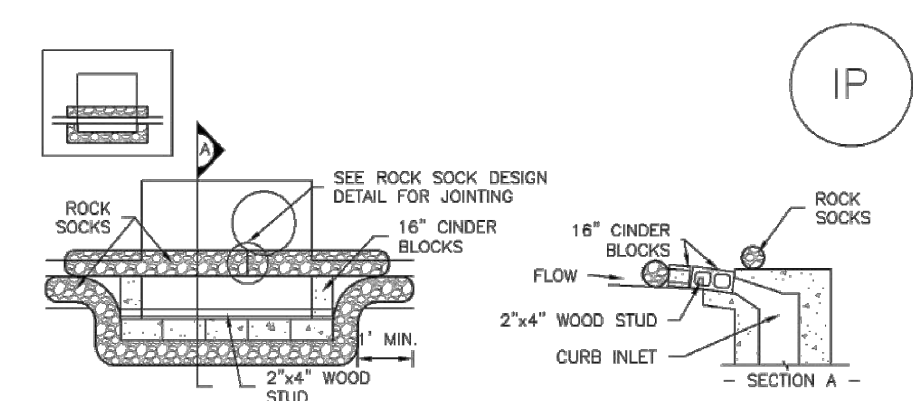


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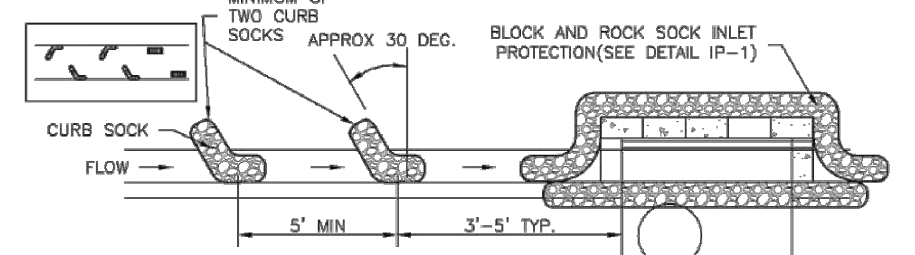
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SC-6 Inlet Protection (IP)



IP-1. BLOCK AND ROCK SOCK SUMP OR ON GRADE INLET PROTECTION

- BLOCK AND CURB SOCK INLET PROTECTION INSTALLATION NOTES
1. SEE ROCK SOCK DESIGN DETAIL FOR INSTALLATION REQUIREMENTS.
2. CONCRETE "CINDER" BLOCKS SHALL BE LAID ON THEIR SIDES AROUND THE INLET IN A SINGLE ROW, ABUTTING ONE ANOTHER WITH THE OPEN END FACING AWAY FROM THE CURB.

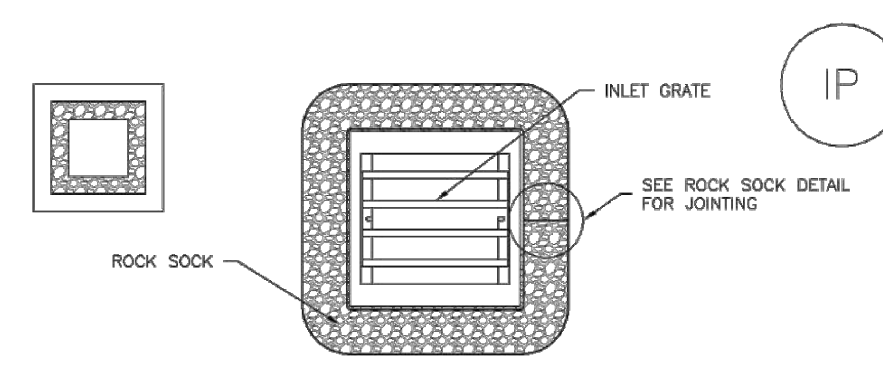


IP-2. CURB ROCK SOCKS UPSTREAM OF INLET PROTECTION

- CURB ROCK SOCK INLET PROTECTION INSTALLATION NOTES
1. SEE ROCK SOCK DESIGN DETAIL INSTALLATION REQUIREMENTS.
2. PLACEMENT OF THE SOCK SHALL BE APPROXIMATELY 30 DEGREES FROM PERPENDICULAR IN THE OPPOSITE DIRECTION OF FLOW.

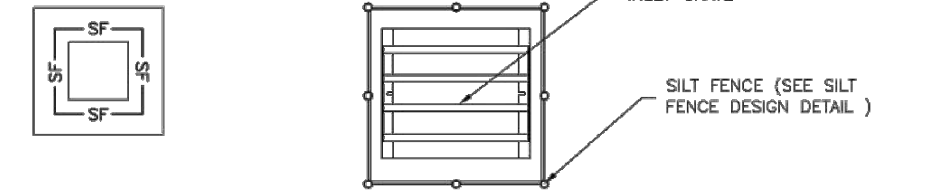
IP-4 Urban Drainage and Flood Control District August 2013
INLET PROTECTION

Inlet Protection (IP) SC-6



IP-3. ROCK SOCK SUMP/AREA INLET PROTECTION

- ROCK SOCK SUMP/AREA INLET PROTECTION INSTALLATION NOTES
1. SEE ROCK SOCK DESIGN DETAIL FOR INSTALLATION REQUIREMENTS.
2. STRAW WATTLES/SEDIMENT CONTROL LOGS MAY BE USED IN PLACE OF ROCK SOCKS FOR INLETS IN PEROUS AREAS. INSTALL PER SEDIMENT CONTROL LOG DETAIL.

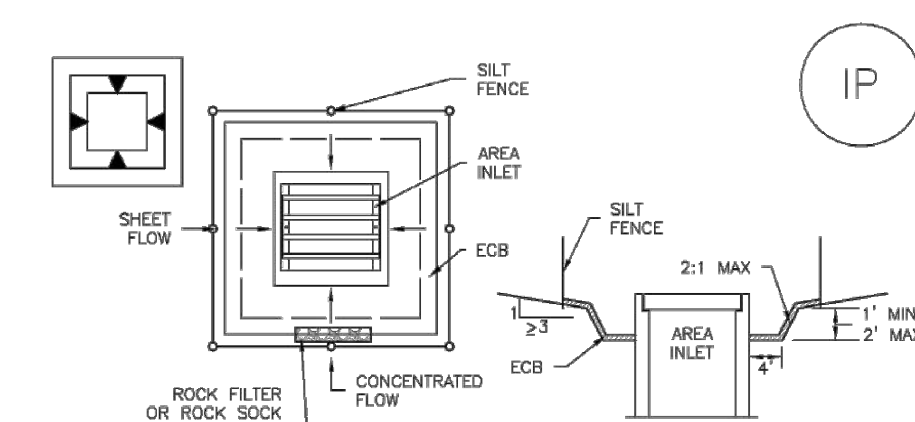


IP-4. SILT FENCE FOR SUMP INLET PROTECTION

- SILT FENCE INLET PROTECTION INSTALLATION NOTES
1. SEE SILT FENCE DESIGN DETAIL FOR INSTALLATION REQUIREMENTS.
2. POSTS SHALL BE PLACED AT EACH CORNER OF THE INLET AND AROUND THE EDGES AT A MAXIMUM SPACING OF 3 FEET.

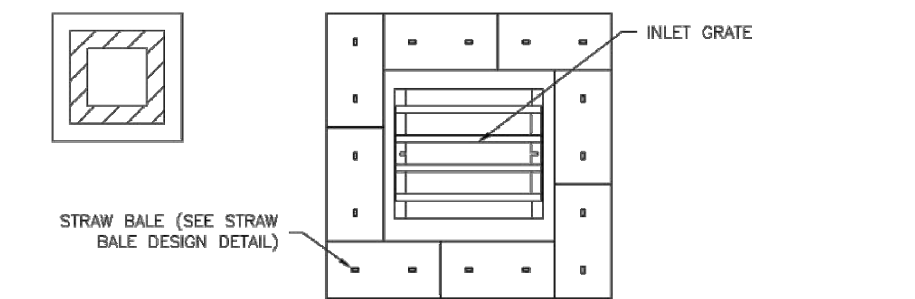
IP-5 Urban Drainage and Flood Control District August 2013
INLET PROTECTION

SC-6 Inlet Protection (IP)



IP-5. OVEREXCAVATION INLET PROTECTION

- OVEREXCAVATION INLET PROTECTION INSTALLATION NOTES
1. THIS FORM OF INLET PROTECTION IS PRIMARILY APPLICABLE FOR SITES THAT HAVE NOT YET REACHED FINAL GRADE AND SHOULD BE USED ONLY FOR INLETS WITH A RELATIVELY SMALL CONTRIBUTING DRAINAGE AREA.

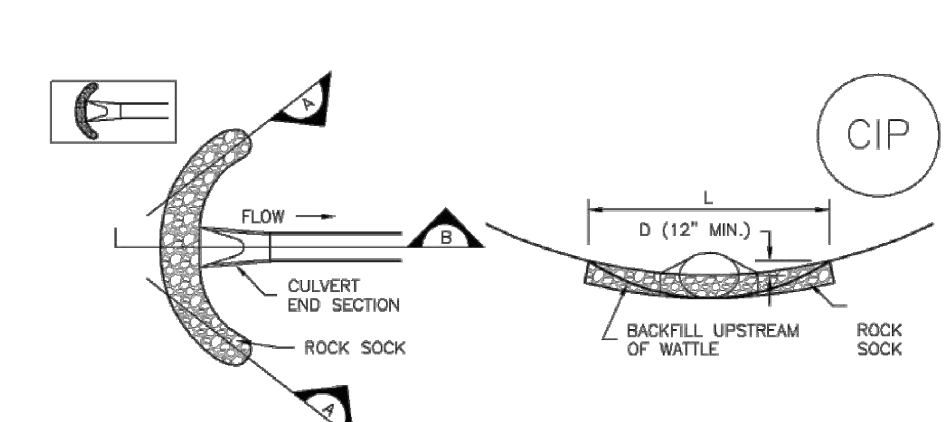


IP-6. STRAW BALE FOR SUMP INLET PROTECTION

- STRAW BALE BARRIER INLET PROTECTION INSTALLATION NOTES
1. SEE STRAW BALE DESIGN DETAIL FOR INSTALLATION REQUIREMENTS.
2. BALES SHALL BE PLACED IN A SINGLE ROW AROUND THE INLET WITH ENDS OF BALES TIGHTLY ABUTTING ONE ANOTHER.

IP-6 Urban Drainage and Flood Control District August 2013
INLET PROTECTION

Inlet Protection (IP) SC-6



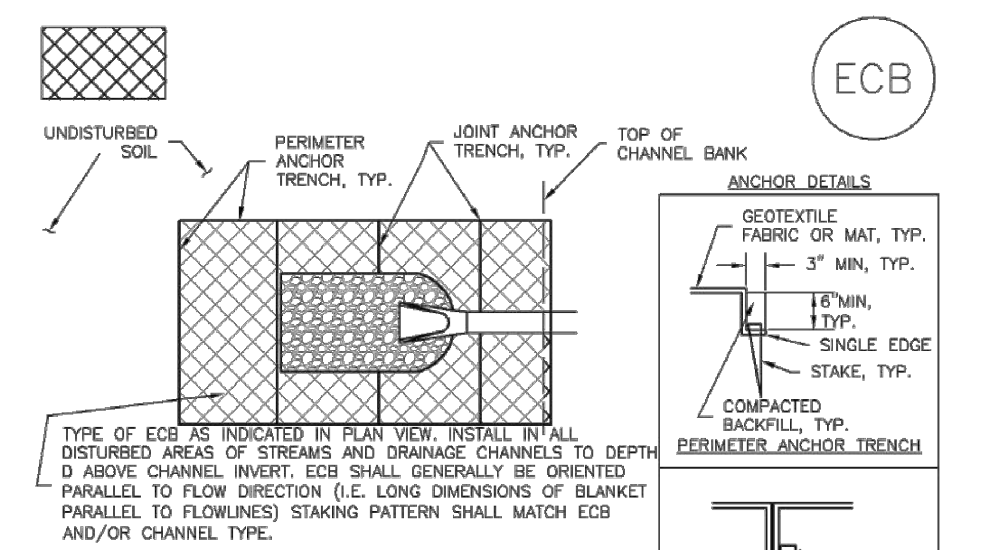
CIP-1. CULVERT INLET PROTECTION

- CULVERT INLET PROTECTION INSTALLATION NOTES
1. SEE PLAN VIEW FOR LOCATION OF CULVERT INLET PROTECTION.
2. SEE ROCK SOCK DESIGN DETAIL FOR ROCK GRADATION REQUIREMENTS AND JOINTING DETAIL.

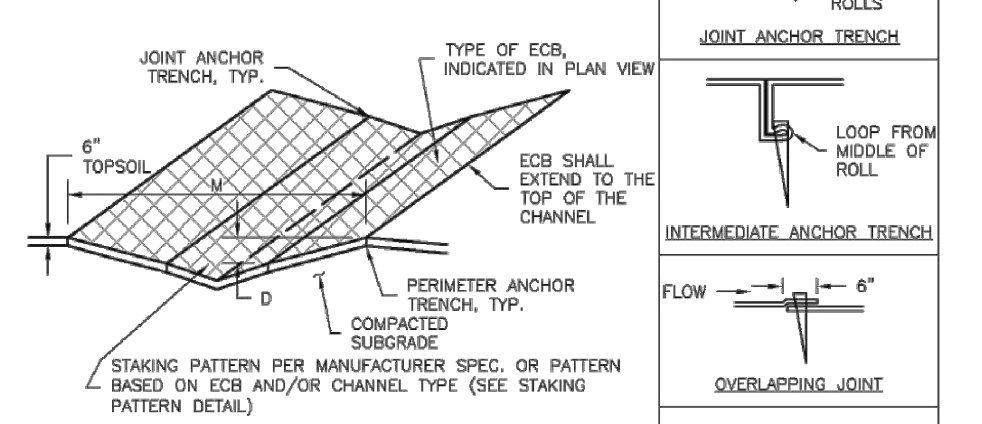
- CULVERT INLET PROTECTION MAINTENANCE NOTES
1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

August 2013 Urban Drainage and Flood Control District August 2013
CULVERT INLET PROTECTION

EC-6 Rolled Erosion Control Products (RECP)



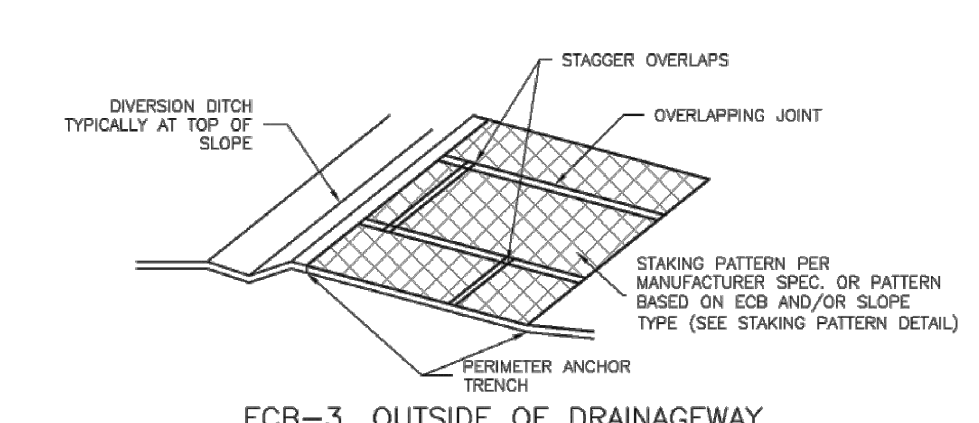
ECB-1. PIPE OUTLET TO DRAINAGEWAY



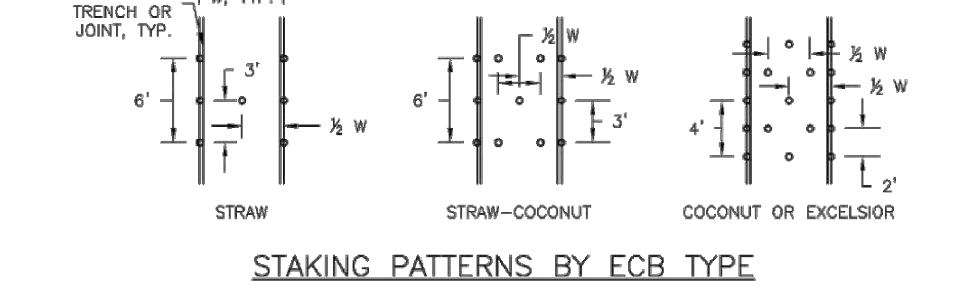
ECB-2. SMALL DITCH OR DRAINAGEWAY

RECP-6 Urban Drainage and Flood Control District November 2010
EROSION CONTROL BLANKET

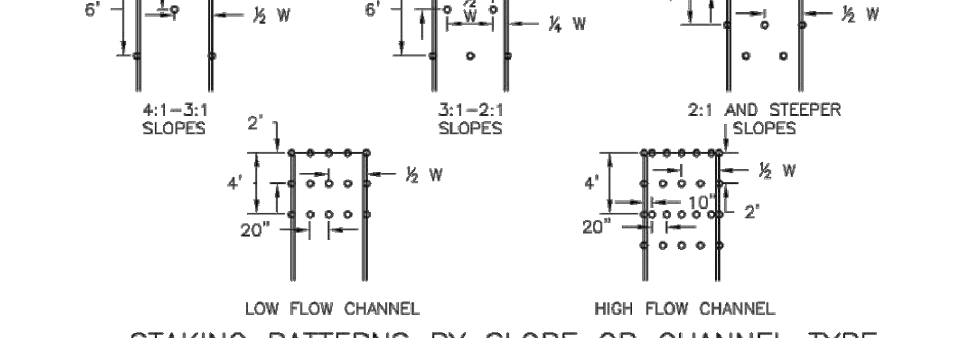
Rolled Erosion Control Products (RECP) EC-6



ECB-3. OUTSIDE OF DRAINAGEWAY



STAKING PATTERNS BY ECB TYPE



STAKING PATTERNS BY SLOPE OR CHANNEL TYPE

RECP-7 Urban Drainage and Flood Control District November 2010
EROSION CONTROL BLANKET

EC-6 Rolled Erosion Control Products (RECP)

- EROSION CONTROL BLANKET INSTALLATION NOTES
1. SEE PLAN VIEW FOR LOCATION OF ECB.
2. 100% NATURAL AND BIODEGRADABLE MATERIALS ARE PREFERRED FOR RECPs, ALTHOUGH SOME JURISDICTIONS MAY ALLOW OTHER MATERIALS IN SOME APPLICATIONS.

EROSION CONTROL BLANKET MAINTENANCE NOTES

Table with 5 columns: TYPE, COCONUT CONTENT, STRAW CONTENT, EXCELSIOR CONTENT, RECOMMENDED NETTING. Rows include STRAW, STRAW-COCONUT, COCONUT, and EXCELSIOR.

RECP-8 Urban Drainage and Flood Control District November 2010
EROSION CONTROL BLANKET

Rolled Erosion Control Products (RECP) EC-6

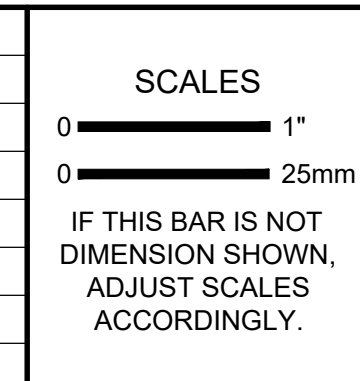
- EROSION CONTROL BLANKET MAINTENANCE NOTES
1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

RECP-9 Urban Drainage and Flood Control District November 2010
EROSION CONTROL BLANKET

APPROVED City of Arvada, Colorado
CITY ENGINEER DATE JOB NUMBER

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Table with 4 columns: NO, REVISION, DATE, BY



DESIGNED TS
DRAWN CLL
CHECKED LS

CITY OF ARVADA
NORTH TRUNK SEWER IMPROVEMENTS
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11
Kennedy Jenks

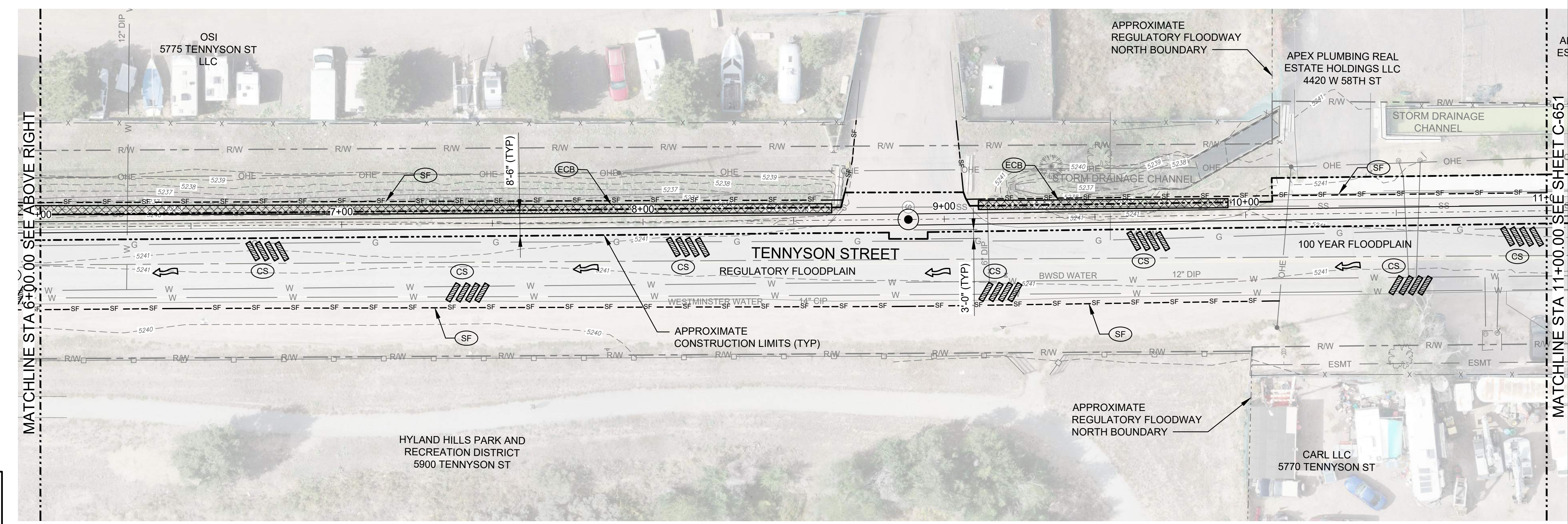
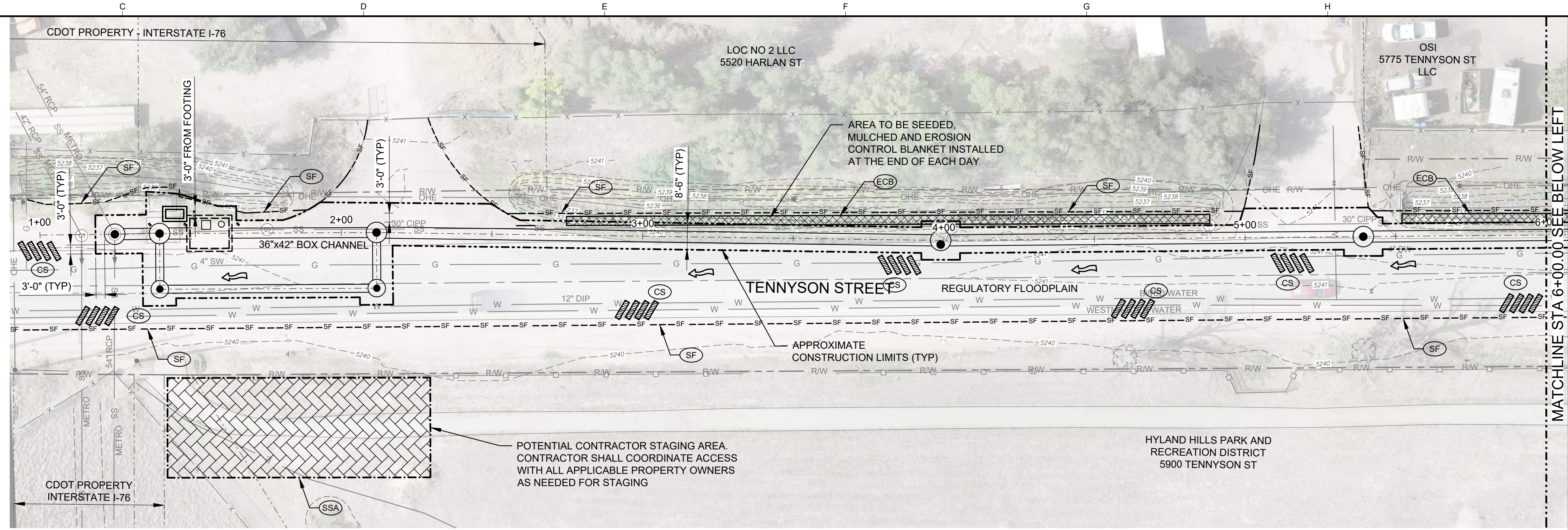
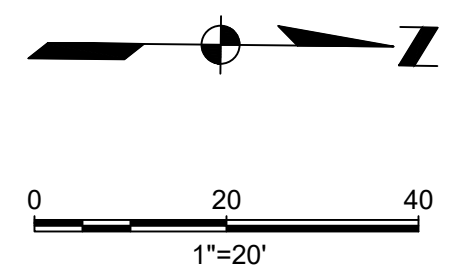
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JOB NO 2246059\*00
DATE JAN 2024
SHEET 48 OF 52
EC-603



Plot Date: 1/23/2024 9:40 AM

User: BRYANT BEHNKE

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City of Arvada, Colorado

CITY ENGINEER	DATE	JOB NUMBER
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**SCALES**  
0 = 1" = 20'  
0 = 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED	TS
DRAWN	WAS
CHECKED	LS

**CITY OF ARVADA**  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11  
**Kennedy Jenks**

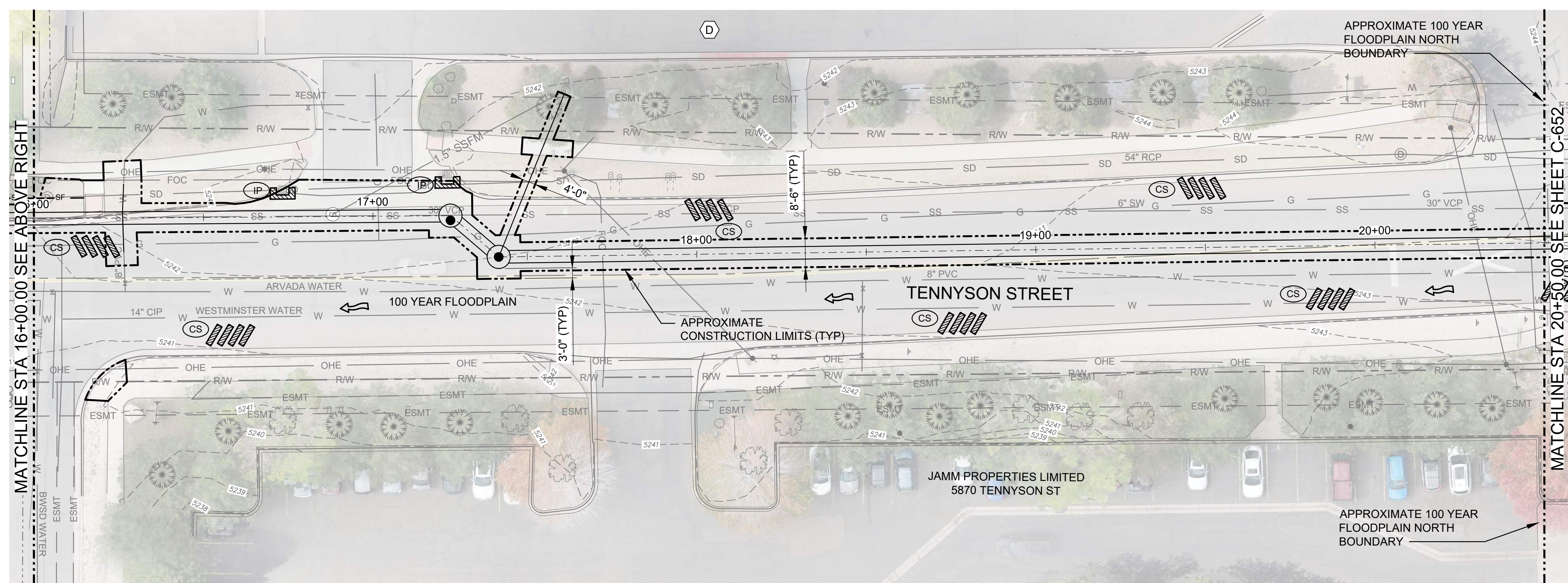
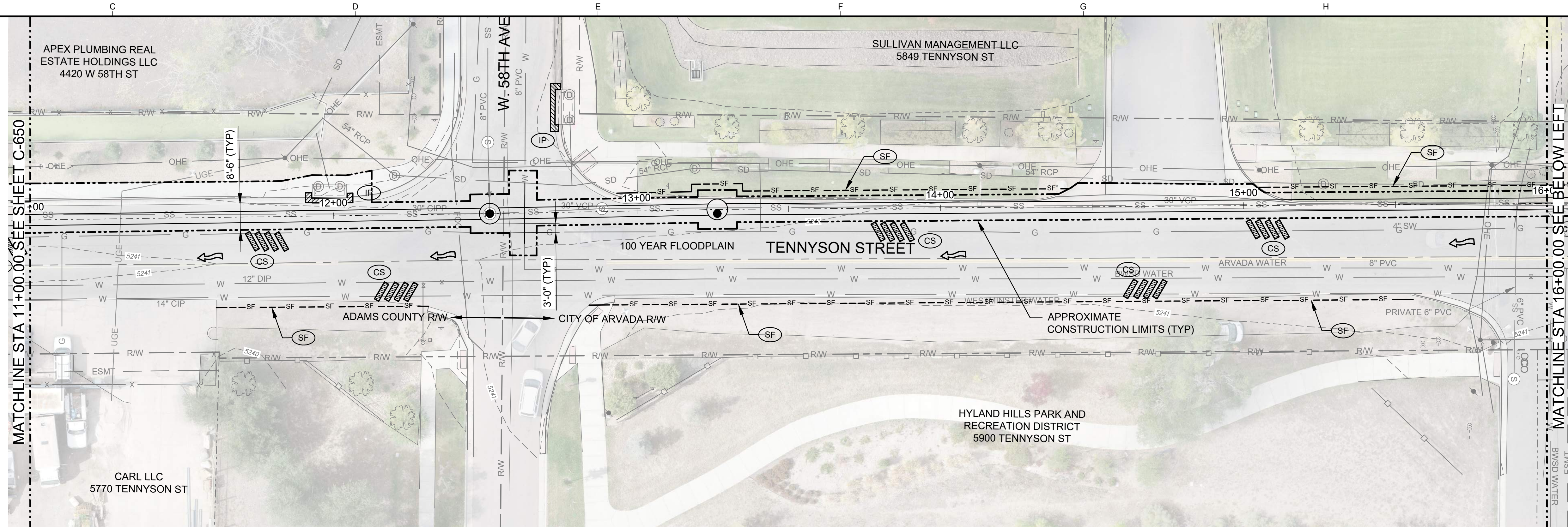
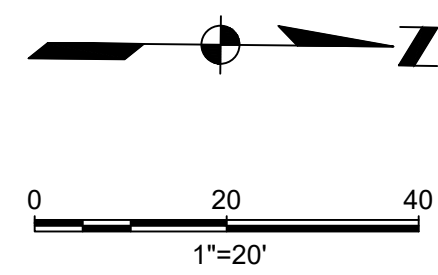
<b>GRADING, EROSION, AND SEDIMENT CONTROL</b> STA 1+00 TO 11+00	SCALE 1" = 20' JOB NO 2246059*00 DATE JAN 2024 SHEET 49 OF 52 EC-650
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Plot Date: 1/23/2024 9:42 AM

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City of Arvada, Colorado

CITY ENGINEER      DATE      JOB NUMBER

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NO	REVISION	DATE	BY

**SCALES**

0 1" = 20'

0 25mm

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DESIGNED TS

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**GRADING, EROSION, AND SEDIMENT CONTROL**  
**STA 11+00 TO 20+50**

SCALE 1" = 20'

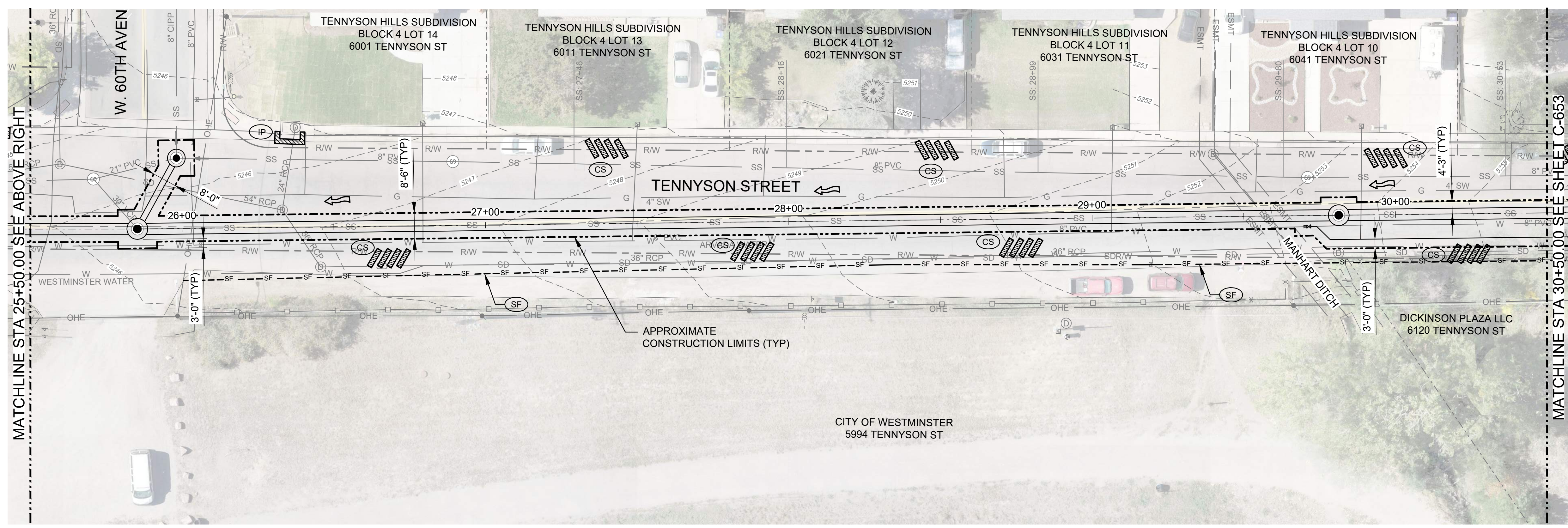
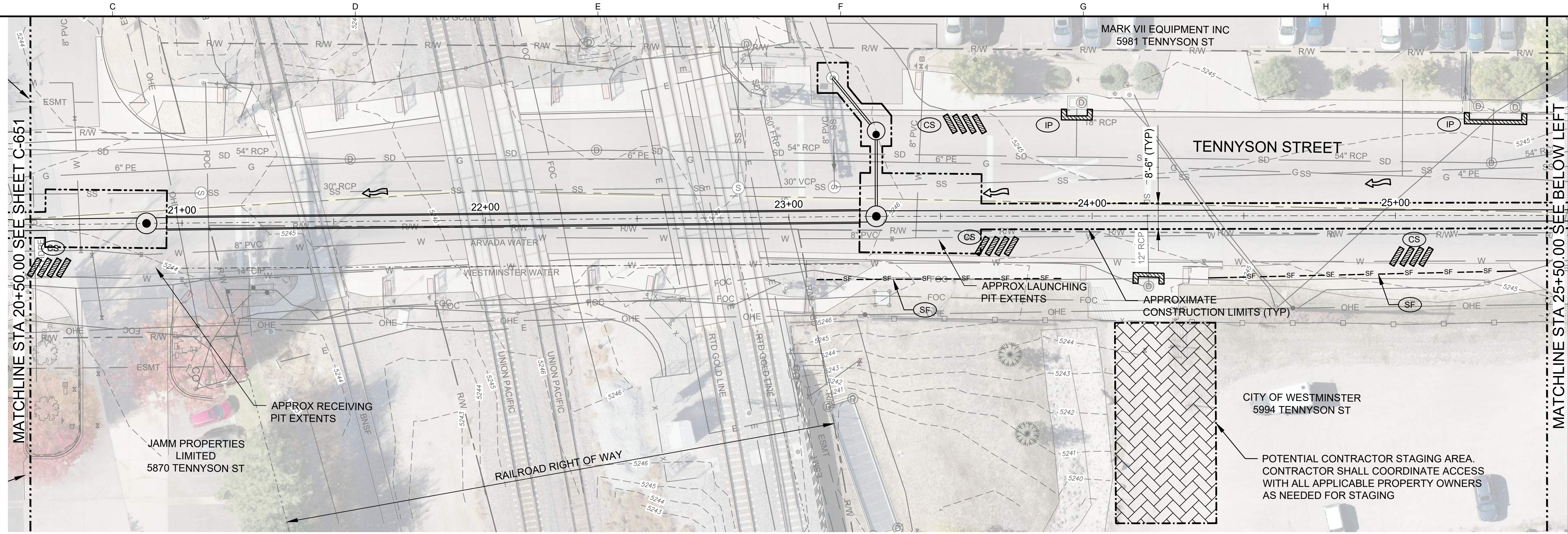
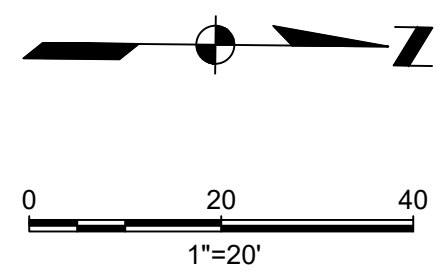
JOB NO 2246059\*00

DATE JAN 2024

SHEET 50 OF 52

EC-651





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**SCALES**

0" = 1"  
0" = 25mm

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**GRADING, EROSION,  
AND SEDIMENT CONTROL  
STA 20+50 TO 30+50**

SCALE  
1" = 20'

JOB NO  
2246059\*00

DATE  
JAN 2024

SHEET  
51 OF 52

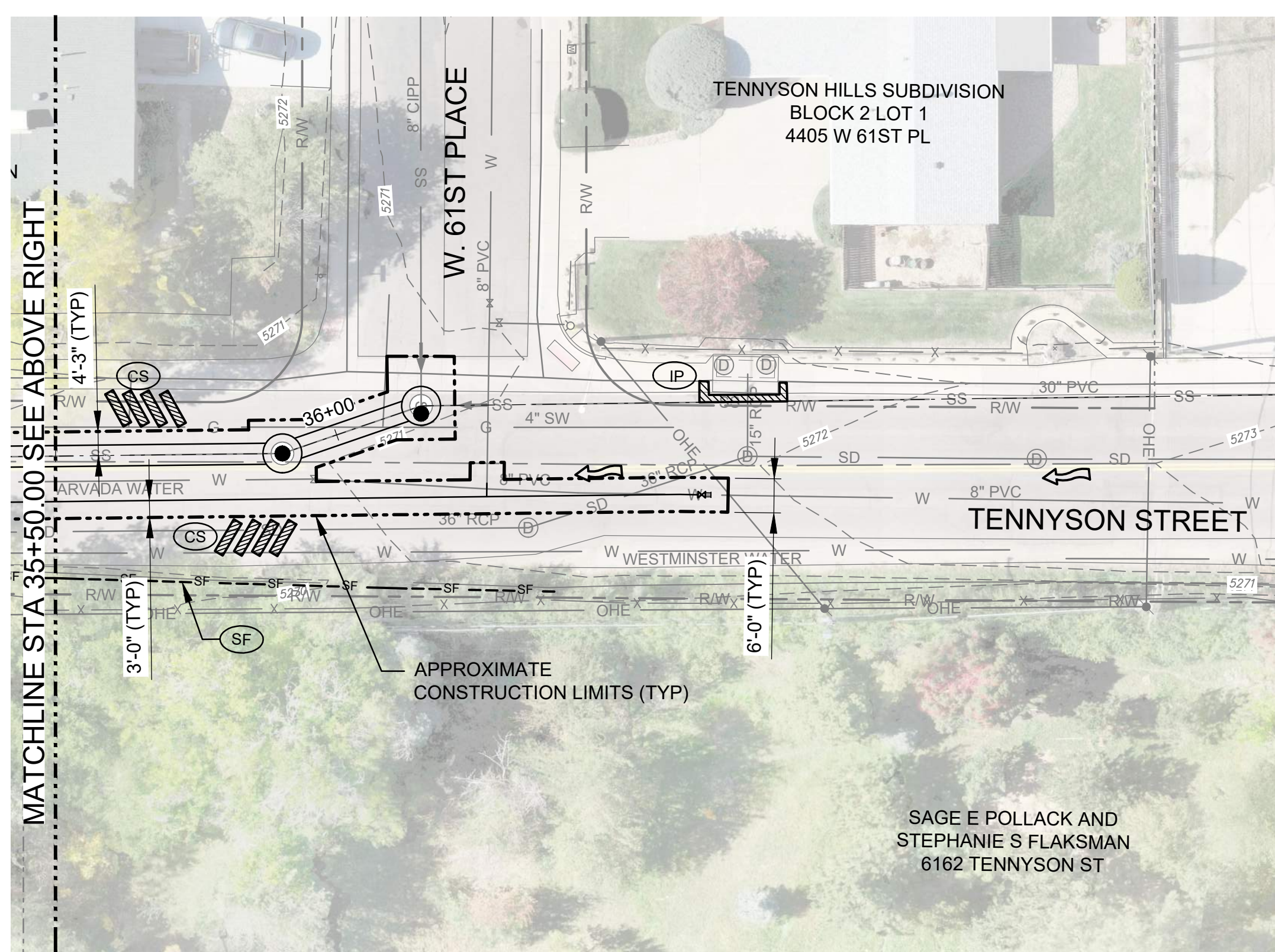
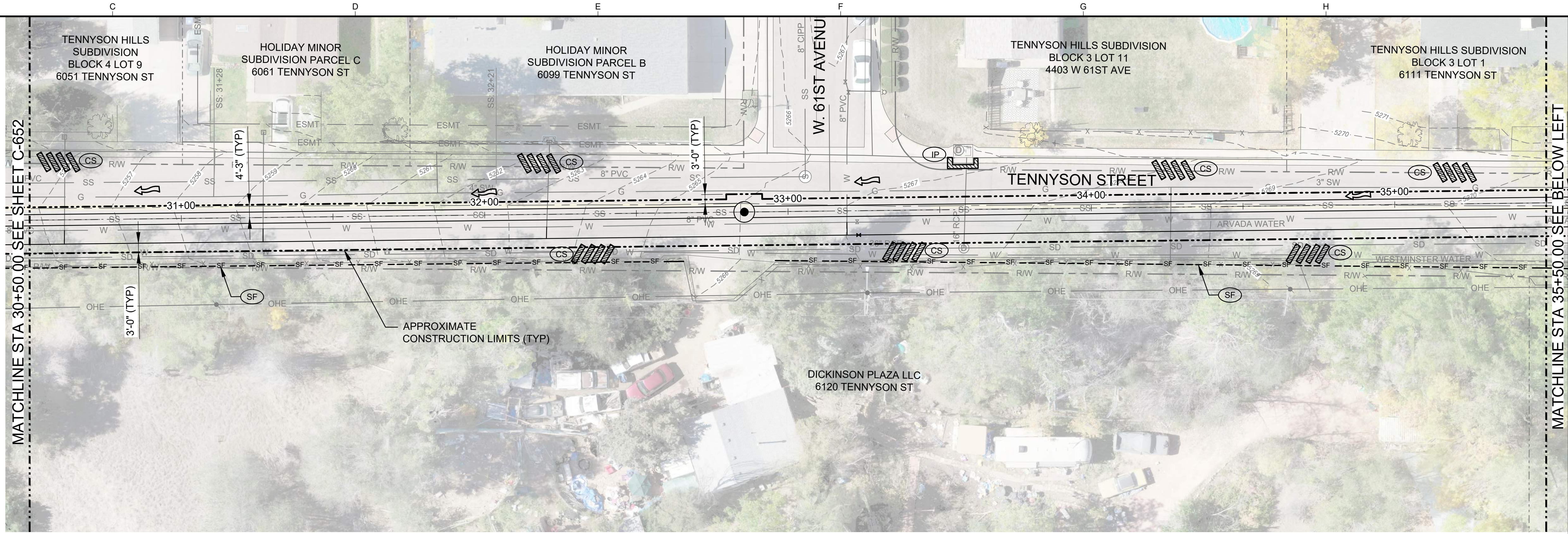
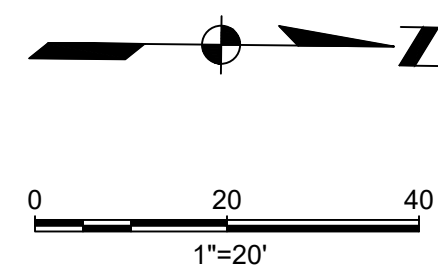
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- GENERAL SHEET NOTES**
- TOTAL AREA OF SITE DISTURBANCE IS APPROXIMATELY 1 ACRE, ALL PHASES.
  - CONTRACTOR RESPONSIBLE FOR COORDINATING ALL NECESSARY SWMP AND STATE STORMWATER PERMIT CERTIFICATIONS. THIS IS TO INCLUDE PROVIDING THE POST-CONSTRUCTION WATER QUALITY EXCEPTION TO THE REQUIRED AGENCIES AS WELL AS A COPY TO THE OWNER.

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**SCALES**

0" = 1"  
0" = 25mm

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**GRADING, EROSION,  
AND SEDIMENT CONTROL  
STA 30+50 TO 37+00**

SCALE 1" = 20'  
JOB NO 2246059\*00  
DATE JAN 2024  
SHEET 52 OF 52  
EC-653



## **Alternate Design Drawings**

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# RAILROAD CORRIDOR - ALTERNATIVE DESIGN



Plot Date: 1/23/2024 9:24 AM

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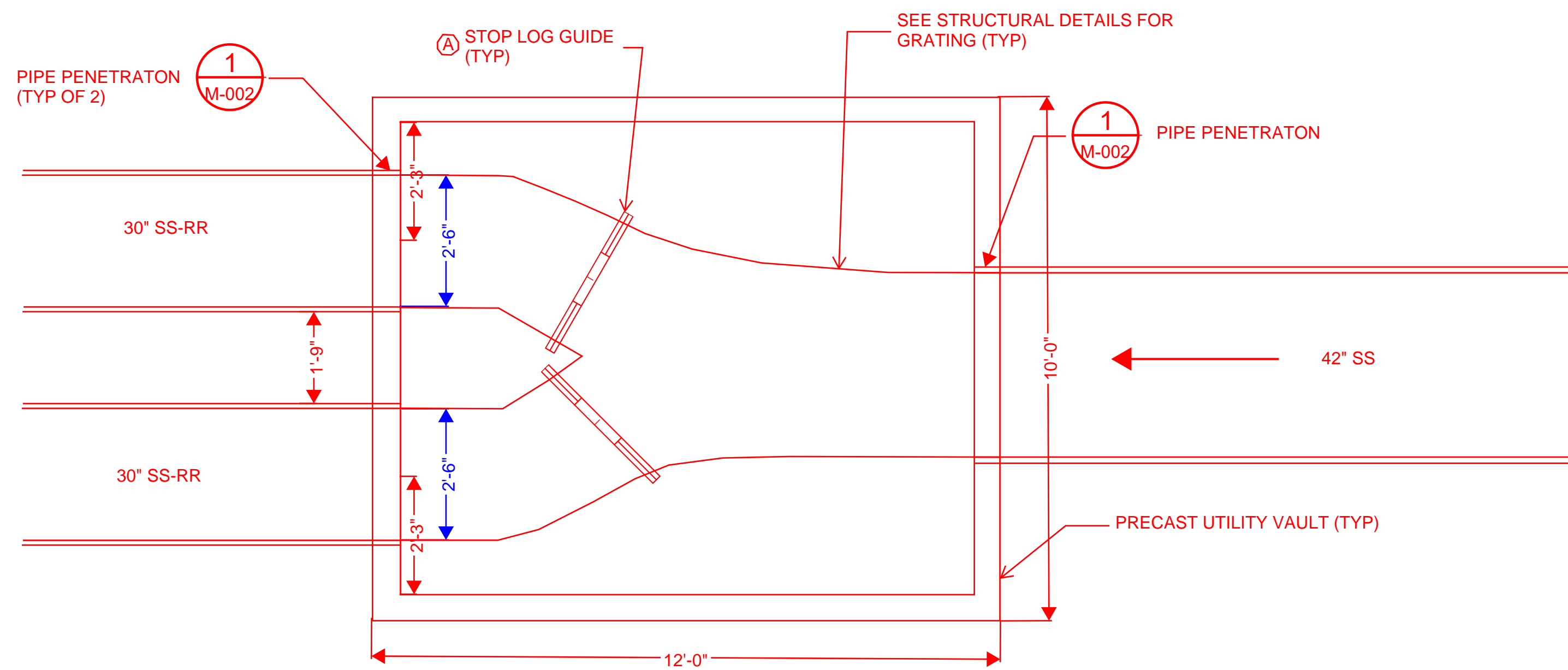
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GENERAL SHEET NOTES

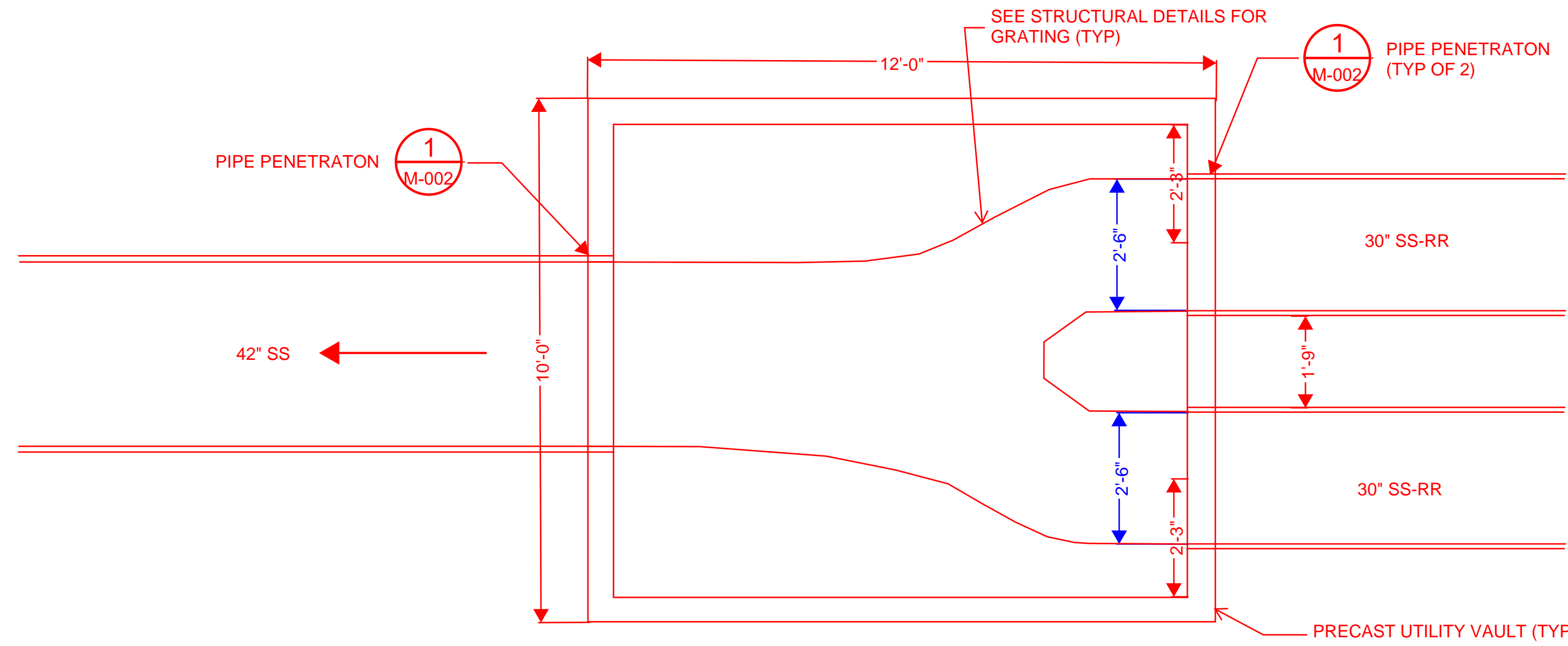
- 1. CHANNELIZATION IS SHOWN SCHEMATICALLY. CONTRACTOR SHALL FIELD GROUT CHANNELS MATCHING THE INVERTS SHOWN ON SHEET C-354. CARE SHALL BE TAKEN TO AVOID UNEVEN SURFACES THAT COULD POTENTIALLY CAUSE A HYDRAULIC JUMP WHEN FLOWING WASTEWATER IS PRESENT.
- 2. CONTRACTOR SHALL COORDINATE VAULT DEPTHS, CHANNEL INVERTS, PIPE PENETRATIONS, DOWELING LOCATIONS, AND ADDITIONAL REQUIREMENTS WITH THE PRECAST VAULT MANUFACTURER. VAULTS SHALL BE SUBMITTED AS A COMPLETE PACKAGE FOR FAVORABLE REVIEW BY THE ENGINEER PRIOR TO DELIVERY.

SHEET KEYNOTES

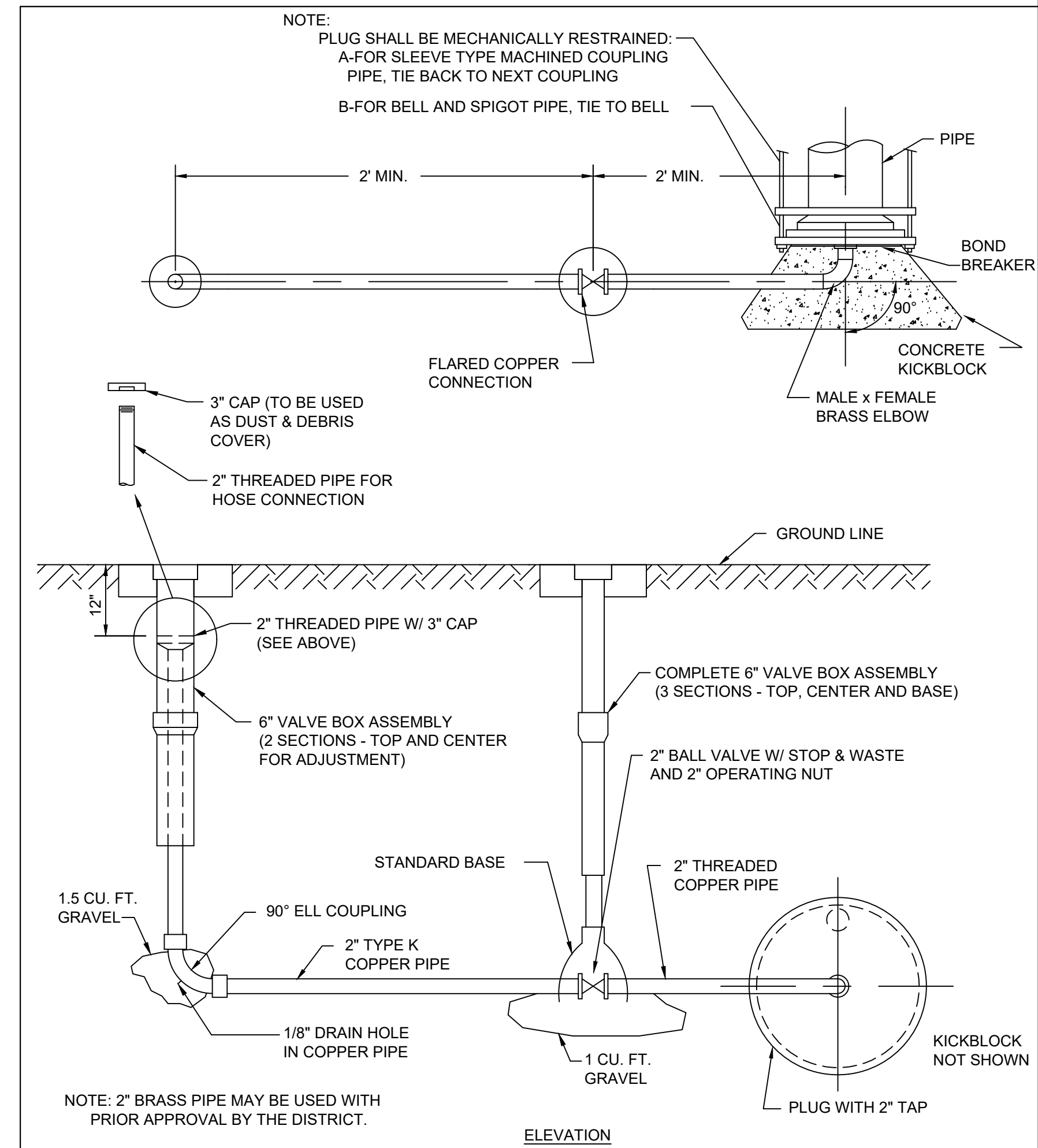
- A. PROVIDE A LEAK TIGHT CONNECTION BETWEEN THE STOP LOGS AND CHANNEL GUIDES. PROPOSED MATERIALS SHALL BE SUITABLE FOR MUNICIPAL WASTEWATER SERVICE. SEE METRO STANDARD DETAIL 40 05 59.1.



FLOW DIVERSION VAULT CHANNEL PLAN - UPSTREAM  
SCALE: 1/2" = 1'-0"



FLOW DIVERSION VAULT CHANNEL PLAN - DOWNSTREAM  
SCALE: 1/2" = 1'-0"



2" BLOW-OFF ASSEMBLY  
FOR USE ON MAINS 12" & SMALLER

DRAWING NO.: CPN-13W DATE: 9/13 PAGE:

..\\d0249927\CPNMD-logo-new-copy.jpg  
Kennedy/Jenks Consultants  
Engineers & Scientists

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

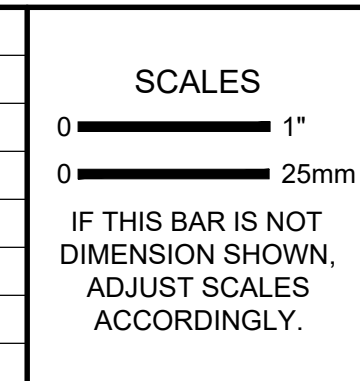
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CITY OF ARVADA

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

Kennedy Jenks

CIVIL DETAILS

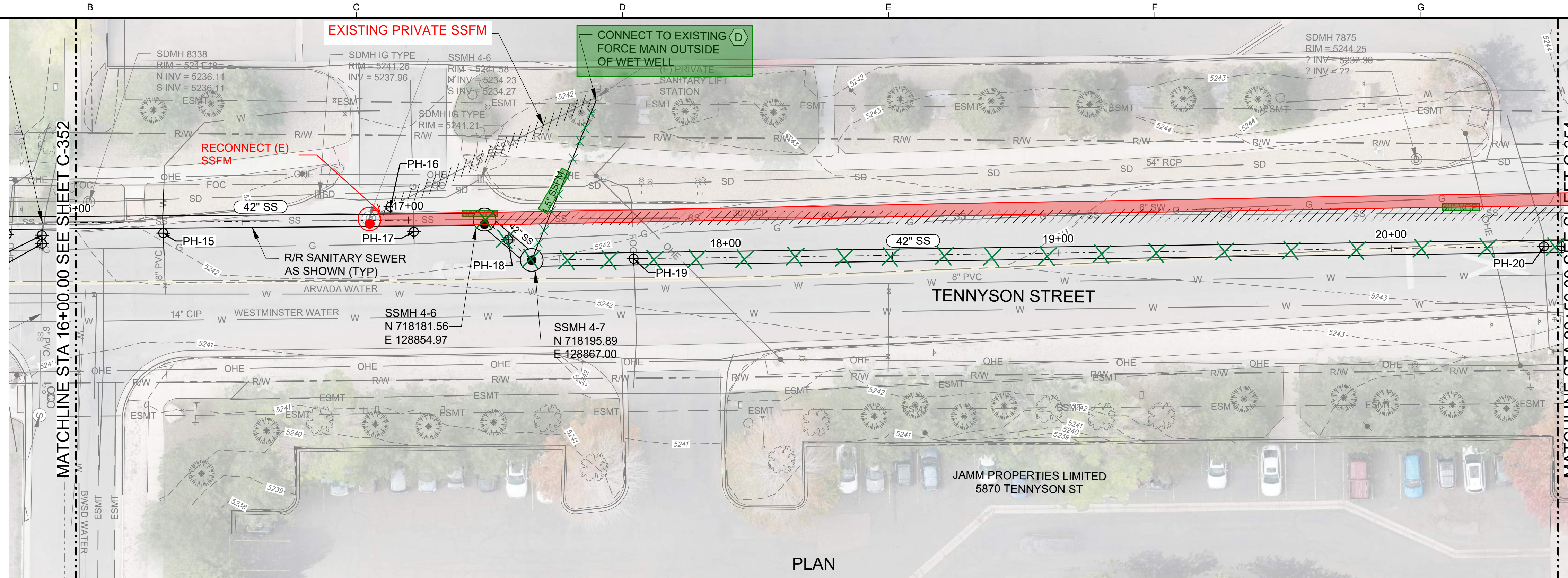
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DATE	JAN 2024
SHEET	7 OF 52
	C-003



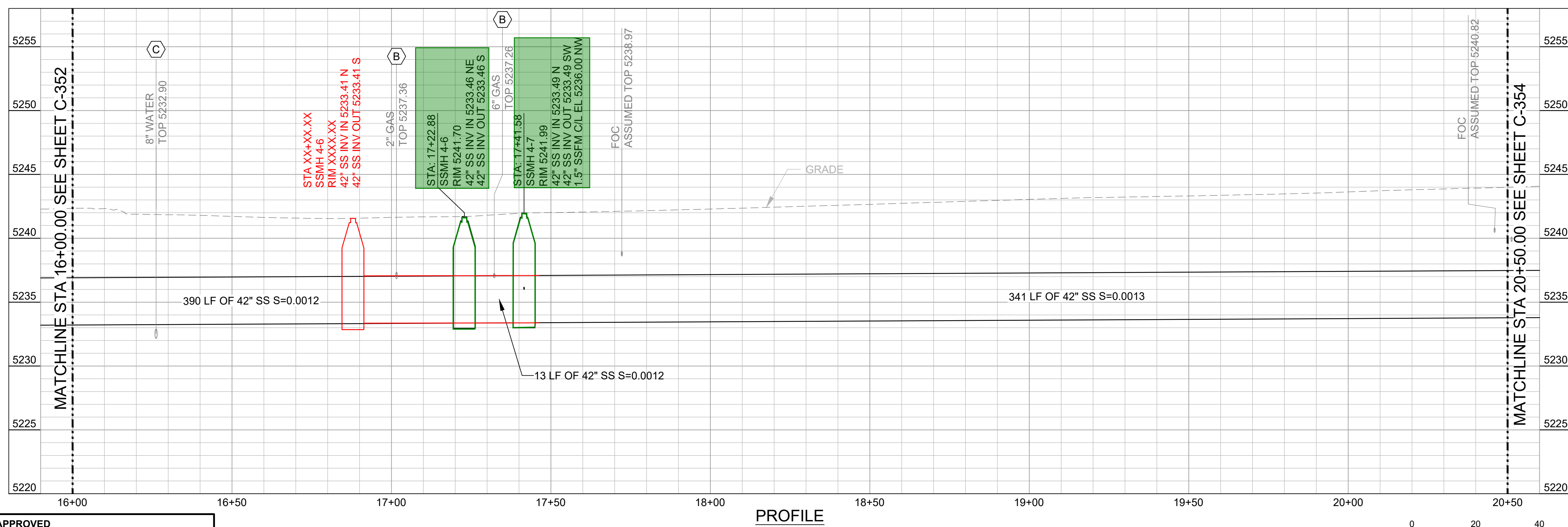
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- ### SHEET KEYNOTES
- A. POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASMENT AS NEEDED FOR VERTICAL CROSSINGS.
  - B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.
  - C. LOWER 8" WATER MAIN AT SEWER CROSSING TO RELOCATE UNDER PROPOSED SEWER AT A MINIMUM OF 18" CLEARANCE. RELOCATE WATER MAIN PER CITY OF ARVADA CROSSING STORM AND SANITARY SEWERS AND OPEN CUT CROSSING BENEATH CONDUITS DETAILS ON C-003.
  - D. CONTRACTOR TO RELOCATE FORCE MAIN TO AVOID EXISTING TREE AND TREE ROOTS WHERE POSSIBLE. IF TREE IS IMPACTED DURING CONSTRUCTION, CONTRACTOR SHALL REMOVE/REPLACE IN KIND.



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NO	REVISION	DATE	BY

**SCALES**

0 1" = 20'

0 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED  
TS

DRAWN  
WAS

CHECKED  
WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
STA 16+00 TO 20+50

SCALE  
1" = 20'

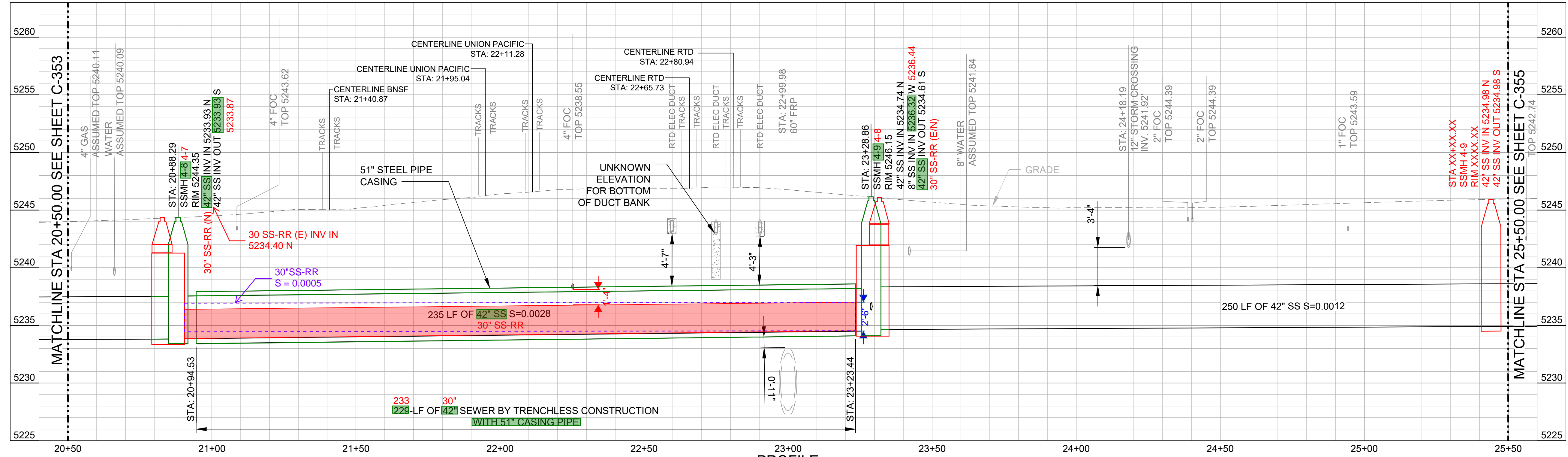
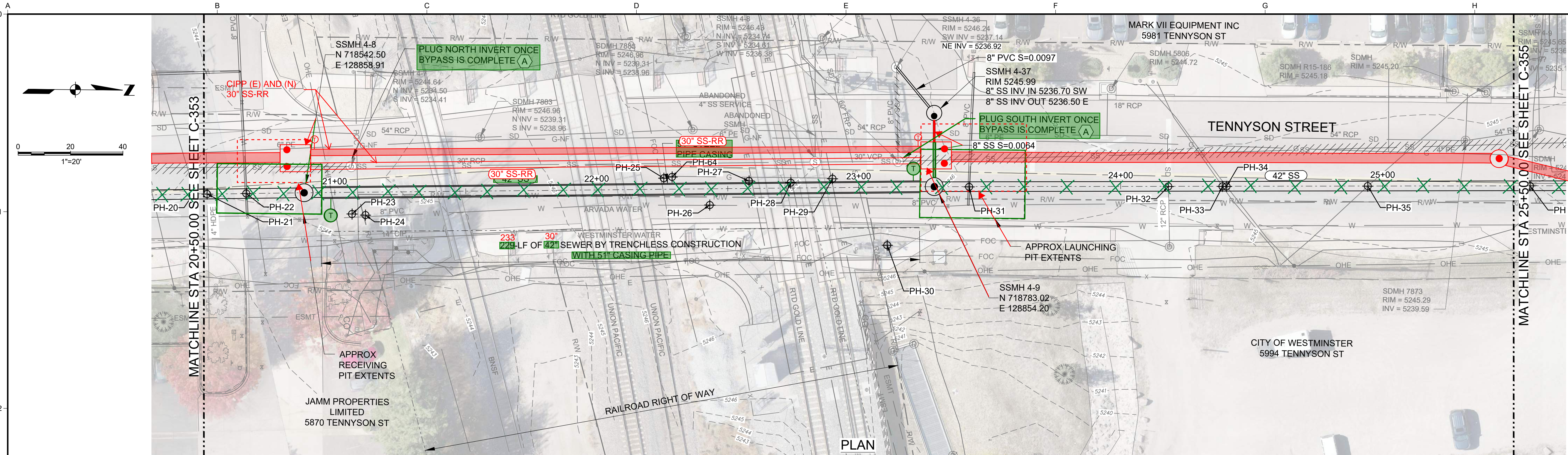
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DATE  
JAN 2024

SHEET 14 OF 52

**C-353**





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NO	REVISION	DATE	BY

**GENERAL SHEET NOTES**

- CONTRACTOR TO VERIFY WITH SURVEY THAT MANHOLES AND TEST STATIONS WILL BE LOCATED OUTSIDE OF RAILROAD R/W.
- CONTRACTOR SHALL PLAN FOR ACTIVE BYPASSING OF THE EXISTING SANITARY PIPE FROM EXISTING SSMH 4-9 TO EXISTING SSMH 4-6 AT A MINIMUM SO THAT CIPP LINING OF THE EXISTING SANITARY PIPE WITHIN THE RAILROAD CORRIDOR CAN PROCEED AHEAD OF TUNNELING WORK. CONTRACTOR TO COORDINATE WITH THE CITY OF ARVADA UTILITIES DEPARTMENT FOR ACCESS TO THE ADJACENT STORMWATER INFRASTRUCTURE FOR ACTIVE BYPASSING PRIOR TO CONSTRUCTION.

**SHEET KEYNOTES**

- A. CONTRACTOR TO FILL THE FIRST 12" INSIDE THE EXISTING 30" SS PIPE WITH LOW STRENGTH GROUT (<200 PSI) FROM THE MANHOLE FACE. CONTRACTOR TO INSTALL ALL TEMP FORMS AS NECESSARY TO RETAIN THE GROUT IN PLACE UNTIL IT HAS FULLY SET.

**SCALES**

0" = 1"  
0" = 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

DRAWN: WAS  
CHECKED: WBG

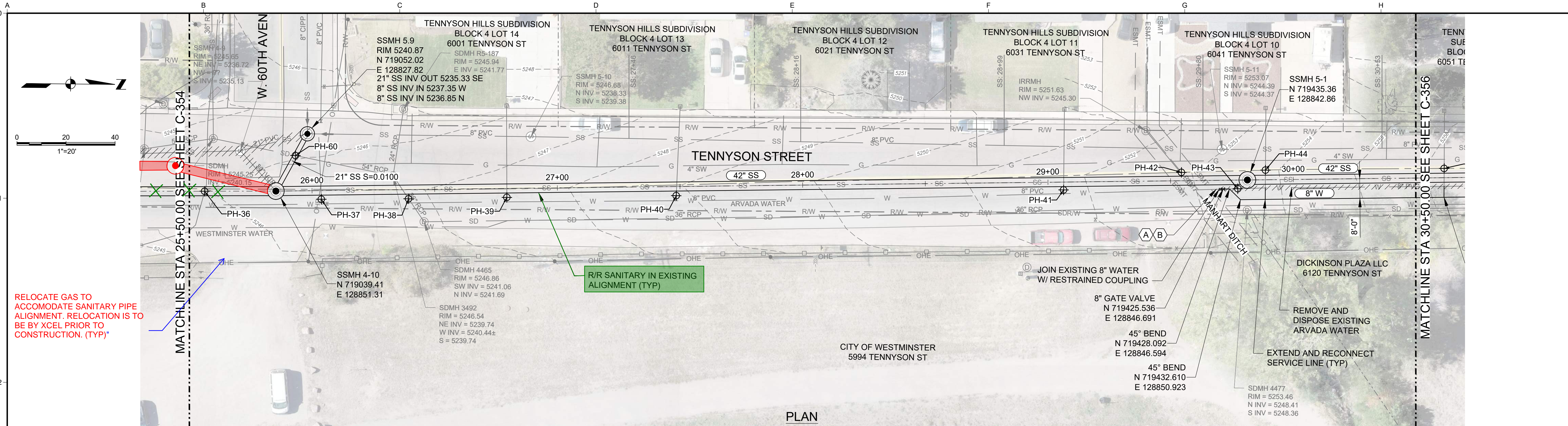
**Kennedy Jenks**

**PLAN AND PROFILE**  
STA 20+50 TO 25+50

SCALE: 1" = 20'

JOB NO: 2246059'00  
DATE: JAN 2024  
SHEET: 15 OF 52  
C-354

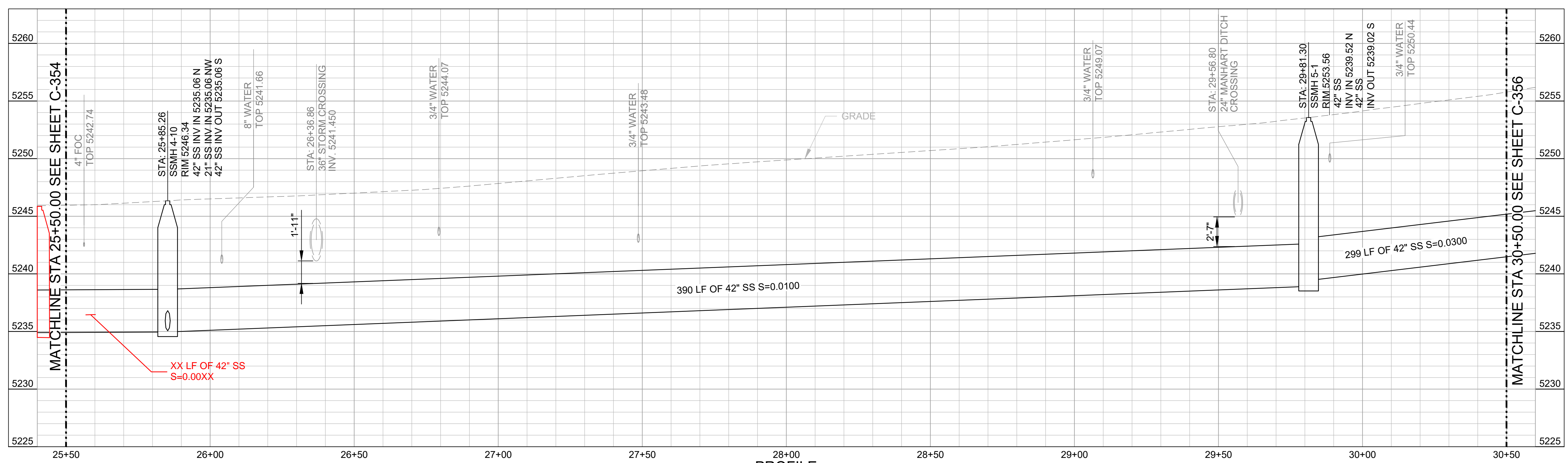




RELOCATE GAS TO ACCOMMODATE SANITARY PIPE ALIGNMENT. RELOCATION IS TO BE BY XCEL PRIOR TO CONSTRUCTION. (TYP)\*

R/R SANITARY IN EXISTING ALIGNMENT (TYP)

PLAN



PROFILE

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City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

**GENERAL SHEET NOTES**

- ALL PORTIONS OF MANHART DITCH BOTTOMS, SIDES, BANKS, FACILITIES, AND ALL AFFECTED PORTIONS OF MANHART'S PROPERTY OR EASEMENTS WHICH ARE DISTURBED SHALL BE RESTORED TO THEIR ORIGINAL CONDITION SO THAT THE FLOW OF WATER IN THE DITCH RUNS AT THE ORIGINAL AMOUNT AND

**GENERAL SHEET NOTES (CONT.)**

VELOCITY, ANY AND ALL FENCING AND OTHER FACILITIES APPURTENANT TO MANHART'S PROPERTY OR EASEMENTS SHALL BE REPLACED IN A CONDITION AT LEAST EQUAL TO THE CONSTITUTION OF SUCH FACILITIES AND APPURTENANCES PRIOR TO CONSTRUCTION.

**WATERLINE POTENTIAL CONSTRUCTION SEQUENCE KEYNOTES**

- INITIATE WATERLINE SHUT DOWN. ISOLATE AND CUT EXISTING 8" WATERLINE TO THE SOUTH.
- CONNECT NEW WATERLINE TO EXISTING WATERLINE AND START SEGMENT 1 INSTALL. INSTALL GATE VALVE AND ENOUGH LINE SEGMENT TO RECHARGE EXISTING WATERLINE TO THE SOUTH.

**JAN 2024 - INTERIM 100%**

NOT FOR CONSTRUCTION

THIS DOCUMENT IS AN INTERIM DOCUMENT AND NOT SUITABLE FOR CONSTRUCTION. AS AN INTERIM DOCUMENT, IT MAY CONTAIN DATA THAT IS POTENTIALLY INACCURATE OR INCOMPLETE AND IS NOT TO BE RELIED UPON WITHOUT THE EXPRESS WRITTEN CONSENT OF THE PREPARER.

NO	REVISION	DATE	BY

**SCALES**

0" = 1"  
0" = 25mm

IF THIS BAR IS NOT DIMENSION SHOWN, ADJUST SCALES ACCORDINGLY.

DESIGNED TS  
DRAWN WAS  
CHECKED WBG

**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

**PLAN AND PROFILE  
STA 25+50 TO 30+50**

SCALE 1" = 20'

JOB NO 2246059'00

DATE JAN 2024

SHEET 16 OF 52

**C-355**



## **Design Specifications**

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**SPECIFICATIONS PACKAGE  
NORTH TRUNK SEWER IMPROVEMENTS PROJECT  
NT10 TENNYSON AND 58<sup>TH</sup>**

CITY OF ARVADA  
COA PROJECT NO. 22-SR-11

January 2024

Engineer of Record – Division 01, and Specifications 02050, 02070, 02072, 02080, 02140, 02200, 02300, 02510, 02516, 02530, 02531, 02721, 02740, 02750, 02951, 03305	Engineer of Record – Specifications 02411, 02430, 02444, 02450, 02470
Engineer of Record – Divisions 05, 08, and Specifications 03300, 03600	Engineer of Record – Divisions 16 & 17

KENNEDY/JENKS CONSULTANTS, INC.  
215 Union Boulevard, Suite 500, Lakewood, Colorado 80228  
(303) 229-1750  
JOB NO. 2246059\*00



# PROJECT MANUAL

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## SECTION 01010

### SUMMARY OF WORK

#### PART 1 - GENERAL

##### 1.01 WORK COVERED BY CONTRACT DOCUMENTS

- A. The project generally consists of replacing approximately 3500 feet of existing 30" VCP sanitary sewer piping with 42" FRP pipe. This work includes but is not limited to earthwork, trenching, backfilling, pipe installation, pipe testing, and removal or abandonment of existing sanitary sewer piping. This project also involves installation of new water main piping, removal of existing water piping, relocation of service lines and other utilities as needed for construction, a wastewater flow metering vault with associated electrical and process improvements, trenchless piping installation, and site restoration as required for pipeline installation.

##### 1.02 WORK UNDER OTHER CONTRACTS – NOT USED

##### 1.03 OWNER-FURNISHED CONTRACTOR INSTALLED ITEMS (O.F.C.I.) – NOT USED

- A. Certain items required for this project will be furnished by the Owner and installed by the Contractor. Such items are referred to as "Owner-Furnished Contractor Installed (O.F.C.I.)." O.F.C.I. items shall be picked up by the Contractor at the Owner's storage yard, transported to the project site and installed by the Contractor.
- B. Contractor's installation of O.F.C.I. items shall include attaching or anchoring items, connecting utilities and controls, lubricating and necessary adjustment, startup, testing, placing items in service. If items are new Contractor shall turn over operation and maintenance manuals and equipment warranties to Owner.

##### 1.04 DOCUMENTING EXISTING

- A. Prior to commencing the Work, tour the site document photographically and in writing the condition of existing structures, roadways, equipment, improvements, and landscape planting on or adjacent to the site, see Section 01390. This record shall serve as a basis for determination of subsequent damage due to the Contractor's operations.

##### 1.05 SHUTDOWN OF EXISTING UTILITIES, SERVICES OR OPERATIONS

- A. Obtain the Project Engineer's approval at least seven (7) days prior to the shutdown of any utility, service or operation of any existing facility. Give required notice and make appropriate arrangements with utility owners and other affected parties prior to shutdown of any utility service.
- B. Schedule utility service or operations shutdowns for periods of minimum use and at the Owner's convenience. Have all required material, equipment and workers on site prior to beginning any work involving a possible shutdown. Perform work as required to reduce shutdown time to the minimum. In some cases, this may require increased numbers of workers and/or premium time night or weekend work.



## 1.06 REGULATORY REQUIREMENTS

- A. The codes and regulations together with local amendments when applicable adopted by the State and other governmental authorities having jurisdiction shall establish minimum requirements for this project. This project shall comply with the following:
  - 1. International Building Code (IBC) 2021 Edition
  - 2. International Fire Code (IFC) 2021 edition
  - 3. Uniform Plumbing Code (UPC) 2024 edition
  - 4. NFPA 70, National Electric Code (NEC) 2023 edition
  - 5. NFPA 820, National Electric Code (NEC) 2023 Edition
- B. The latest edition of the requirements in effect at the date of issuance of construction documents shall apply.
- C. It is the Contractor's responsibility to comply with laws and codes applicable to Means and Methods for performing the Work.
- D. It is the Contractor's responsibility to report code deficiencies in the design to the Engineer prior to proceeding with the Work.
- E. Paragraphs addressing Pre-Engineered Systems and Performance Specifications in other Sections cover the Contractor's responsibility to comply with code requirements when (1) performance specifications are used to describe all or portions of Work or items and (2) when pre-engineered (contractor designed) systems are specified.
- F. In cases where the Contract Documents are more restrictive than applicable codes, the Contractor shall comply with the Contract Documents.

## 1.07 REFERENCE STANDARDS

- A. When these specifications state that Work or tests shall conform to specific provisions in a referenced standard, specification, code, recommendation, or manual published by an association, organization, society, or agency the referenced provisions, as they apply to the Work of the Contractor only shall be considered a part of these specifications as fully as if included in total. When these specifications or applicable codes contain higher or more restrictive requirements than those contained in reference standards these specifications or applicable codes shall govern.
- B. The latest edition of a referenced standard published at the time of submission of bids shall apply unless a specific date for the referenced standard is cited in these specifications.
- C. General provisions in referenced standards, specifications, manuals, or codes shall not change the specific duties and responsibilities between any of the parties involved in this work from those described in the General Conditions. Provisions in referenced standards with regard to measurement and payment shall not apply to this Work unless specifically cited.

## 1.08 SPECIFICATION LANGUAGE AND STYLE

- A. Many parts of the Specifications as well as notes on the Drawings are written in the active voice and are addressed to the Contractor.



1. When words or phrases requiring an action or performance of a task are used, it means that the Contractor shall provide the action or perform the task. For example: provide, perform, install, furnish, erect, connect, test, operate, adjust or similar words mean that the Contractor shall perform the action or task referred to.
  2. When words or phrases requiring selection, acceptance, approval, review, direction, designation or similar actions are referred to, it means that such actions are the Owner's or the Engineer's prerogative and that the Contractor must obtain such action before proceeding.
- B. Requirements in the Specifications and Drawings apply to all work of a similar type, kind, or class even though the word "all" or "typical" may not be stated.

## 1.09 DEFINITIONS

- A. The following terms, when used in the Contract Documents, shall have the meanings listed:

ACCEPTABLE	"acceptable to the Engineer"
PERFORM	"perform all operations required to complete the work referred to in accordance with the intent of the Contract Documents"
PROVIDE	"furnish and install the work referred to including proper anchorage, connection to required utilities or other work, testing, adjustment and startup ready to put in service and perform the intended function"
REQUIRED	"required by the Contract Documents or required to complete the Work and produce the intended results"
SATISFACTORY	"acceptable to the Engineer"
SHOWN	"as indicated on the Drawings"
SITE	"geographical location of the Project and land within the work area shown on the contract drawings and within which the Work will be installed or built"
SPECIFIED	"as written in the Contract Documents including the Specifications and the Drawings"
SUBMIT	"submit to the Engineer"

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION



## SECTION 01300

### SUBMITTALS

#### PART 1 - GENERAL

##### 1.01 SUBMITTAL PROCEDURES

- A. Accompany each submittal with a Submittal form which contains the following information:
  - 1. Contractor's name and the name of Subcontractor or supplier who prepared the submittal.
  - 2. The project name and identifying number.
  - 3. Description of the submittal and reference to the Contract requirement or technical specification section and paragraph number being addressed.
- B. Unless otherwise specified, provide submittals in electronic PDF searchable format.
- C. Submittals which include more than one (1) item or piece of equipment shall include a Table of Contents following the standard submittal form and cover sheets.
- D. Each submittal shall include a copy of the specification section and all referenced and applicable sections with addendum updates included. For each specification section, check-mark each paragraph to indicate specification compliance with the full paragraph as a whole or marked to indicate requested deviations from specification requirements. Each deviation from the specifications requested by the Contractor shall be underlined and referenced by a unique number in the margin to the right of the identified paragraph. The submittal shall include a detailed written explanation of the reasons for requesting the deviation that is clearly labeled to correspond with the unique number provided in the margin. The remaining portions of the paragraph not underlined will signify compliance on the part of the Contractor with the specifications. Failure to include a copy of the marked-up specification sections, along with justification(s) for any requested deviations to the specification requirements, with the submittal shall be sufficient cause for rejection of the entire submittal on the basis that the submittal is incomplete and will be returned to the Contractor REJECTED – RESUBMIT with no further consideration.
- E. Where applicable, a copy of the contract document control diagrams and process and instrumentation diagrams relating to the submitted equipment, with addendum updates that apply to the equipment in this Section, marked to show specific changes necessary for the equipment proposed in the submittal. If no changes are required, the drawing or drawings shall be marked "no changes required". Failure to include copies of the relevant drawings with the submittal shall be cause for rejection of the entire submittal with no further review.
- F. The Contractor shall allow 30 days for the Engineer's review of each submittal and 30 days for each resubmittal unless a different period is specified by the Engineer in writing. If the Engineer requests additional information or clarification of a submittal, the 30 days shall be measured from the date the additional information or clarification is received. If the Contractor requires more than two submittals to



obtain the Engineer's Favorable Review, the Contractor shall compensate the Owner for the cost of the Engineer's additional review time. The Contractor shall not perform work for which reviewed submittals are required without obtaining Favorable Review of submittals.

#### 1.02 SCHEDULE OF SUBMITTALS

- A. Within fifteen (15) days after the Notice to Proceed, submit a Schedule of Submittals showing the date by which each submittal required for Product Review or Product Information will be made. Identify the items that will be included in each submittal by listing the item or group of items and the Specification Section and paragraph number under which they are specified. Indicate whether the submittal is required for Product Review of Proposed Equivalents, Shop Drawings, Product Data or Samples or required for Product Information only.

#### 1.03 PLAN OF OPERATIONS

- A. Before beginning on site work, submit a plan showing Contractor's intended use of the site assigned to it. Show location of access points. Show location for Contractor's, Subcontractor's, and Engineer's field office (if applicable) and parking. Show location of Contractor's and Subcontractor's work areas and storage areas.

#### 1.04 CONSTRUCTION SCHEDULE

- A. The form of Construction Schedule may be selected by the Contractor.
- B. Revise the Construction Schedule and resubmit within seven (7) days following any monthly meeting to review Contractor's Application for Payment when Contractor's work is fifteen (15) days or more behind schedule.
- C. Accelerated Work if Required to Meet Schedule: Give Engineer and Owner three (3) days prior notice of construction that will take place outside of normal work hours or work days. Compensate Owner for extra inspection cost caused by Accelerated Work required to meet Schedule.
- D. Give Engineer and Owner three (3) days prior notice of normal work days on which construction will not take place or of scheduled construction that will not take place. Compensate Owner for extra inspection cost resulting from failure to give notice.

#### 1.05 SHOP DRAWING, PRODUCT DATA AND SAMPLES SUBMITTED FOR PRODUCT REVIEW

- A. This paragraph covers submittal of Shop Drawings, Product Data and Samples required for the Engineer's review referred to as Product Review submittals in the Technical Specifications (Divisions 2 through 17). Submittals required for information only are referred to as Product Information submittals in the Technical Specifications and are covered in paragraph 1.07. All shop drawings, product data and samples shall be considered as Product Review submittals unless specifically called out as a Product Information submittal in a technical specification.
- B. The Contractor shall make all Product Review submittals early enough to allow adequate time for the Engineer's review, for manufacture and for delivery at the construction site without causing delay to the Work. Submittals shall be made early enough to allow for unforeseen delays such as:



1. Failure to obtain Favorable Review because of inadequate or incomplete submittal or because the item submitted does not meet the requirements of the Contract Documents.
  2. Delays in manufacture.
  3. Delays in delivery.
- C. Content of Submittals:
1. Each submittal shall include all of the items and material required for a complete assembly, system or Specification Section.
  2. Submittals shall contain all of the physical, technical and performance data required by the specifications or necessary to demonstrate conclusively that the items comply with the requirements of the Contract Documents.
  3. Include information on characteristics of electrical or utility service required and verification that requirements have been coordinated with services provided by the Work and by other interconnected elements of the Work.
  4. Provide verification that the physical characteristics of items submitted, including size, configuration, clearances, mounting points, utility connection points and service access points, are suitable for the space provided and are compatible with other interrelated items that are existing or have or will be submitted.
  5. Label each Product Data Submittal, Shop Drawing, and Sample with the information required in paragraph 1.01A of this Section. Highlight or mark every page of every copy of all Product Data submittals to show the specific items being submitted and all options included or choices offered.
  6. Additional requirements for Product Review submittals are contained in the Technical Specification sections.
  7. Designation of work as "NIC" or "by others," shown on Shop Drawings, shall mean that the work will be the responsibility of the Contractor rather than the subcontractor or supplier who has prepared the Shop Drawings.
- D. Submittals that contain deviations from the requirements of the Contract Documents shall be accompanied by a separate letter explaining the deviations. The Contractor's letter shall:
1. Describe the deviation from the specifications requested and identify with a unique number and reference to the Specification Section paragraph or Drawing requirement. The letter shall include a detailed written explanation of the reasons for requesting the deviation that is clearly labeled to correspond with the unique number provided.
  2. Describe the proposed alternate material, item, or construction and explain its advantages and/or disadvantages to the Owner.
  3. State the reduction in Contract Price if any that is offered to the Owner.
- E. Engineer's Review Procedure and Meaning:
1. The Engineer will review each Product Review submittal prior to returning it to the Contractor. The submittal review form will indicate whether or not the review was favorable and what action is required of the Contractor. Review categories "No Exceptions Taken" and "Make Corrections Noted" both indicate Favorable Review.
  2. At a minimum, Favorable Review is contingent on:
    - a. The compatibility of items included in a submittal with other related or interdependent items included in previous or future submittals.



- b. Future submittal of items related to or required to be part of this submittal that were not included with this submittal.
  - 3. Favorable Review of a submittal does not constitute approval or deletion of items required as part of the submittal but not included with the submittal. Favorable Review of items included in the submittal does not constitute deletion of specified features, options or accessories that were not included in the submittal.
  - 4. The action required by the Contractor for each category of review is as follows:
    - a. **NO EXCEPTIONS TAKEN.** NO RESUBMITTAL REQUIRED.
    - b. **MAKE CORRECTIONS NOTED:**
      - 1) **NO RESUBMITTAL REQUIRED.** The Contractor shall make corrections noted prior to manufacture.
      - 2) **PARTIAL RESUBMITTALS REQUIRED.** The Contractor shall submit related accessory or optional items as noted which are required but were not included with the submittal and/or shall resubmit unsatisfactory portions or attributes of items as noted. The Contractor may proceed to manufacture those portions of the submittal that will be unaffected by required resubmittals.
    - c. **AMEND AND RESUBMIT.** The Contractor shall amend and resubmit the submittal as noted or required to comply with the Contract Documents.
    - d. **REJECTED - RESUBMIT.** The item submitted does not comply with the Contract Documents. Resubmit items that comply with the requirements of the Contract Documents.
    - e. **NOT REVIEWED.** The item submitted is incomplete or does not comply with the Contract Documents. The item has not been reviewed and is returned to the Contractor for correction.
    - f. **RECEIPT ACKNOWLEDGED.** Receipt of a submittal that is not subject to the Owner's review and approval is acknowledged; and, is being filed for information purposes only. Generally used in acknowledging receipt of Product Information. No further submittal activity is required by the Contractor.
  - 5. The Product Review submittal review form may contain numbered notes. Marking a corresponding number on a Shop Drawing or Product Data submittal shall have the same effect as applying the entire note to the submittal.
- F. Re-submittals that contain changes that were not requested by the Engineer on the previous submittal shall be accompanied by a letter explaining the change.
- G. Favorable Review Required Prior to Proceeding: Do not proceed with manufacture, fabrication, delivery, or installation of items prior to obtaining the Engineers Favorable Review of Product Review submittals.
- H. Intent and Limitation on Engineer's Review:
- 1. The Contractor has primary responsibility for submitting and providing work that complies with the requirements of the Contract Documents. That responsibility cannot be delegated in whole or in part to subcontractors or suppliers. Neither the Engineer's Favorable Review nor the Engineer's failure to notice or comment on deficiencies in the Contractor's submittals shall



relieve the Contractor from the duty to provide work, which complies with the requirements of the Contract Documents.

#### 1.06 PROPOSED EQUIVALENTS (SUBSTITUTIONS)

- A. The term "first specified item" or "first named maker" refers to the first product identified in the Specifications by a model number or trade name and/or by a maker's name for a specified item. When the first specified item is followed by a second maker's name and "or equal," the Contractor may submit Proposed Equivalent (Substitution) items for the Engineer's review. Proposed Equivalent (Substitution) items that are in the Engineer's judgment equal to the first specified item in quality, utility, and appearance, will be Favorably Reviewed. Where a product description and first maker's name is followed by "or equal" with no second maker's name, it means the specifier knows of no equivalent product and the Contractor may submit Proposed Equivalent (Substitution) products by other makers for review. Where the term "or equal" is omitted, it means that the named item is required to meet the Owner's needs; no products or makers other than those specified will be considered.
- B. Time of Submittal:
1. Submittal of Proposed Equivalents (Substitutions) shall be made within thirty-five (35) days of the Notice to Proceed. The Engineer may agree to a later submittal date if requested in writing within thirty-five (35) days of the Notice to Proceed. The request shall identify the item; give the Specification reference, and proposed manufacturer and model number of the item that will be submitted and the proposed submittal date.
  2. The Engineer's agreement to a later submittal date shall be in writing and shall not be construed as Favorable Review or acceptance of the manufacturer or item proposed.
- C. Content of submittals shall be the same as that required for Product Data, Shop Drawings, and Samples submitted for Product Review in another paragraph of this Section. In addition, the Contractor shall provide information on several recent similar installations of the item to verify its suitability. The information shall include the project name and location, the Owner's name, address, telephone number and name of a knowledgeable person to contact for information on performance of the product.
- D. If a non-equivalent substitute is submitted for review, it shall be accompanied by a proposed reduction in Contract Price which shall include the increased cost of Engineering service required to evaluate the proposed substitute (which shall be paid to the Owner whether or not the substitute is accepted) plus the greater of 1) the difference in price between the first specified item and the item submitted and 2) the difference in value to the Owner between the two items.

#### 1.07 PRODUCT INFORMATION SUBMITTALS

- A. Submittal for Informational Purpose Only is an item required for the Owner's permanent records relating, in part, to future maintenance, repair, modification, replacement of work or as otherwise required. The Contractor shall clearly separate information for Product Review from information for Product Information in submittals that include both.



- B. Make Product Information submittals prior to delivering material, products, or items for which Product Information submittals are required.
- C. The Contractor has the sole and exclusive responsibility for furnishing products and work that meets the requirements of the Contract Documents.
- D. The Engineer reserves the right to comment on any submittal and to reject any product or work delivered, installed or otherwise at any time that the Engineer become aware that it is defective or does not meet the requirements of the Contract Documents.

#### 1.08 OPERATION AND MAINTENANCE MANUALS AND PARTS LISTS

- A. Operation and maintenance (O&M) information shall be submitted in a format best suited for the type of manual to be provided to the Owner. Unless otherwise specified, provide information in electronic PDF searchable format.
- B. Provide operation and maintenance manuals and parts list for all equipment furnished under this Contract. Comply with the detailed requirements in Technical Specification sections. Include instructions for delivery, storage, assembly, installation, lubrication, adjusting, startup, operation and maintenance. Provide PDF bookmarks for all items listed in subparagraphs 1 through 5 below.
  - 1. For all equipment include:
    - a. Startup instructions
    - b. Normal operation instructions.
    - c. Trouble shooting instructions.
    - d. Lubrication instructions.
    - e. Maintenance and reinstallation instructions, and manufacturer's recommended preventative maintenance schedule.
    - f. Parts identification.
    - g. List of spare parts recommended to have on hand.
    - h. Operator safety instructions.
    - i. Cleaning instructions.
    - j. Theory of operation to discrete component level.
    - k. Schematic diagrams, flow diagrams, wiring diagrams, logic diagrams, etc. to discrete component level.
    - l. Parts list showing all discrete components with part number,
    - m. Manufacturers' service and maintenance technical manuals.
  - 2. For all Electrical Equipment, provide the following additional information:
    - a. Equipment ratings.
    - b. Calibration curves and rating tables if appropriate.
  - 3. For Complex Equipment provide in addition:
    - a. Alternate specified operating modes.
    - b. Emergency shutdown instructions.
    - c. Normal shutdown instructions.
    - d. Long-term shutdown instructions.
  - 4. Operation and maintenance manuals for systems composed of separate pieces of equipment shall include a system explanation of items 1, a, b, and c, and 3a through c, as well as the instructions for each separate piece of equipment.
- C. Submit not later than 60 days after Favorable Review of Product Review submittal.



- D. When standard manufacturer's literature is used highlight or mark all copies to shop specific items and options provided.

#### 1.09 MANUFACTURER'S CERTIFICATES

- A. When specified in the Technical Specifications section, submit manufacturers' certificate to Engineer for review. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate. Certificates may be recent or previous test results on material or product but must be acceptable to the Engineer.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION



## SECTION 01390

### PRE-CONSTRUCTION PHOTOS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Preconstruction Photos

##### 1.02 DESCRIPTION

- A. Prior to commencing work, prepare a flash drive of pre-construction photographs capturing the existing project conditions including but not limited to site work locations, site access points, drainage areas, private drives, sidewalk, pedestrian ramps, landscaping, and public infrastructure expected to be affected as part of the new work. Include photographs of all access areas for the work.

##### 1.03 QUALITY ASSURANCE

- A. Photographs shall not be made more than thirty (30) days prior to construction in any area. All records shall become property of the Owner.

##### 1.04 SUBMITTALS

- A. Submit one (1) copy of the pre-construction photographs to the Engineer.

#### PART 2 - PRODUCTS (NOT USED)

#### PART 3 - EXECUTION

##### 3.01 EQUIPMENT

- A. The Contractor shall furnish all equipment, accessories, materials and labor to perform this service.
- B. The photographs shall reproduce bright, sharp, clear pictures with accurate colors and shall be free from distortion or any other form of imperfection.

##### 3.02 RECORD INFORMATION

- A. All photographs shall, by electronic means, display on the screen the time and date the photograph was taken.



### 3.03 LIGHTING

- A. All photographs shall be captured during time of good visibility.

END OF SECTION



## SECTION 01400

### QUALITY REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 QUALITY ASSURANCE

- A. Perform all work in accordance with City of Arvada Engineering Codes and Specifications, except as otherwise noted in the Contract Documents.
- B. The Engineer may require that the manufacturer of individual products furnish a sworn statement that the inspection and all of the specified tests have been made, and the results thereof comply with the requirements of the applicable Standards specified.

##### 1.02 CONSTRUCTION OBSERVATION

- A. General
  - 1. The Owner's Inspector shall decide any and all questions that may arise as to the quality and acceptability of the materials furnished, the work performed, the manner of performance and the rate of progress of the work. The Owner's Inspector shall decide all questions which may arise as to the interpretation of the Specifications and/or the acceptable fulfillment of the Contract and all disputes and mutual rights by the Contractors, if there be more than one contractor on the project. Kennedy/Jenks Consultants acting as the consulting engineer, is not a guarantor of the construction Contractor's obligations and performance of the Contract.
  - 2. Observation of work in progress and on-site visits are not to be construed as a guarantee by Kennedy/Jenks Consultants and the Owner of the Contractor's contractual commitment.
  - 3. Kennedy/Jenks Consultants and the Owner are not responsible for safety in, on, or about the project site, nor compliance by the appropriate party of any regulations relating thereto.
  - 4. Kennedy/Jenks Consultants and the Owner, exercise no control of the safety or adequacy of any equipment, building components, scaffolding, forms, or other work aids used in or about the project and do not supervise the Contractor or his or her forces.
- B. Overtime
  - 1. Any construction observation performed at times other than between the hours of 7:30 AM and 3:30 PM, Monday through Friday or on holidays that may fall on a weekday shall be done at the Contractor's expense. The minimum charge for weekend (Saturday or Sunday) or holiday observation shall be four (4) hours per day. The Owner shall review and approve whether or not overtime construction observation is necessary.



### 1.03 REPLACEMENT OF SURVEY STAKES

- A. The Contractor shall be responsible for protecting all stakes set for his or her use, and stakes which must be reset due to the negligence of the Contractor after the initial stakeout shall be replaced at the Contractor's expense.

### 1.04 QUALITY CONTROL AND CONTROL OF INSTALLATION

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.
- D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Perform Work by persons qualified to produce required and specified quality.
- F. Verify field measurements are as indicated on Shop Drawings or as instructed by manufacturer.

### 1.05 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from the Engineer before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

### 1.06 REFERENCES

- A. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of standard, except when more rigid requirements are specified or are required by applicable codes.
- B. Conform to reference standard by date of issue current on date of Contract Documents except where specific date is established by code.
- C. Obtain copies of standards where required by product specification sections.
- D. When specified reference standards conflict with Contract Documents, request clarification from Engineer before proceeding.



- E. Neither contractual relationships, duties, nor responsibilities of parties in Contract nor those of Engineer shall be altered from Contract Documents by mention or inference otherwise in reference documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION



## SECTION 01500

### CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

#### PART 1 - GENERAL

##### 1.01 TEMPORARY UTILITIES

- A. Sanitary Facilities: Provide and maintain self-contained portable sanitary facilities for the Contractor's, subcontractor's, Project Engineer's, and Owner's use. Facilities shall comply with applicable regulations and shall be serviced, cleaned and disinfected frequently.
- B. Temporary Water, Power and Telephone Service:
  - 1. Water: The Owner's Water Operations Division personnel shall be the sole operators of existing valves through which water for testing, disinfecting and flushing is obtained. The Contractor shall be responsible for metering and paying the Owner for water used for flushing, testing, and disinfection.
  - 2. Power: Connect to the existing electrical service with a service disconnect switch. Provide overcurrent and ground fault protection. Provide a meter and reimburse Owner for the cost of energy used.
- C. Temporary Heat: Provide temporary heat for enclosed spaces for the proper installation of finishes, such as floor coverings, wall coverings, woodwork and painting, and to protect all work and moisture sensitive electrical equipment against injury, dampness and cold. Fuel, equipment, and installation shall comply with all applicable codes and regulations. Salamander heaters or other space heaters using kerosene are not permitted.
- D. Temporary Ventilation: Provide equipment to ventilate enclosed areas to facilitate curing concrete, to dissipate humidity and to prevent accumulation of dust, fumes, or gases. Utilize ventilation equipment and supplement with temporary fans to maintain clean air and safe conditions for construction operations.
- E. Temporary Lighting: Provide and maintain lighting for construction operations to achieve a minimum lighting level of 20 foot-candles for rough work and 60 foot-candles for finish work.
- F. Temporary Fire Protection:
  - 1. Provide and maintain fire protection equipment, including extinguishers, fire hoses, and other equipment required by law or insurance carriers, or as necessary for proper fire protection during the course of the work.
  - 2. Use fire protection equipment only for fighting fires.
  - 3. Locate fire extinguishers in field offices, storage sheds, tool houses, temporary buildings, and throughout the construction site.

##### 1.02 TEMPORARY CONSTRUCTION

- A. The Contractor is solely and exclusively responsible for the design, construction and maintenance of all temporary construction including forms, falsework, shoring, scaffolding, stairs, ladders and all other similar items.



- B. Construct adequate and safe forms and falsework to rigidly support partially completed structures. Provide temporary bridges to maintain vehicular and pedestrian access. Design and construct temporary forms, falsework, bridges and decking in accordance with applicable regulations and codes.

### 1.03 BARRICADES, FENCES AND ENCLOSURES

- A. Barricades: Provide temporary guardrails, ladders, stairs, guards, and barricades to protect persons in accordance with applicable regulations and OSHA requirements.
- B. Enclosures:
  - 1. Provide temporary watertight closures for openings in exterior surfaces as required to protect interiors from weather, moisture, humidity and extreme temperature.

### 1.04 PROTECTION OF INSTALLED WORK

- A. Provide temporary and removable protection for installed products. Control activity in immediate work area to minimize damage.
- B. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is unavoidable, provide adequate protection to prevent damage to waterproof membranes and comply with recommendations for protection of the waterproofing or roofing material manufacturer.
- C. Provide heavy planking to protect curbs, gutters, culverts, paving and similar surfaces from damage by heavy equipment or vehicles.

### 1.05 SECURITY

- A. Provide security facilities to protect the Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

### 1.06 ACCESS ROADS AND PARKING AREAS

- A. Parking:
  - 1. Construct temporary gravel surfaced parking areas for construction personnel in Contractor staging and storage areas.
  - 2. Contractor must receive approval to access and utilize temporary storage and staging areas from the property owner(s) prior to mobilization.

### 1.07 TEMPORARY CONTROLS

- A. Cleaning:
  - 1. During Construction: Maintain the site and all work in a clean orderly fashion free of waste debris and rubbish. Store debris in covered containers. Pick up and remove debris daily if required, but not less frequently than weekly. Burning debris on site is not permitted. Clean mud from vehicles before leaving the site.
  - 2. If work under this Contract creates dusty, dirty or unsightly conditions in adjacent areas, the Contractor shall immediately cleanup the affected areas.
  - 3. Final cleanup is specified in Section 01700.



- B. Dust Control: Employ measures to prevent the creation of dust which may produce damage or nuisance to property or persons. Be responsible for all damage resulting from dust produced by construction operations. Periodically wet down unpaved areas where vehicles are operated. See Section 02300 for additional requirements.
- C. Erosion and Sediment Control: Employ measures to prevent erosion and trap any sediment created by construction operations before it leaves the site. Prevent sediment from entering streams or other water bodies. Contractor is responsible for obtaining the required erosion control and stormwater discharge permits for the project.
- D. Noise Control: Comply with regulations limiting construction noise levels. Use whisper quiet air compressors. Use jack hammers with exhaust mufflers. Prevent noise disturbance to the public and adjacent property owners. Residential areas shall be under 50 dB of noise overnight per COA code 38-91. Decibel level to be measured at residential lot lines. Employ measures required to limit construction noise to 80 dBA at construction site boundaries during normal construction timeframes of 7:30 – 3:30 for collector streets.
- E. Water Control: Maintain excavations free of water. See Section 02140 for additional requirements.

PART 2 - PART 2 - PRODUCTS (NOT USED)

PART 3 - PART 3 - EXECUTION (NOT USED)

END OF SECTION



## SECTION 01550

### TRAFFIC CONTROL

#### PART 1 - GENERAL

##### 1.01 OBJECTIVES

- A. Provide for safe movement of vehicular, bicycle and pedestrian traffic through and around Contractor's construction operations. Traffic control requirements set forth herein are the minimum requirements imposed. The Contractor shall be solely responsible for providing all protective measures necessary.
- B. Proper traffic movement through the work area depends upon the driver controlling and directing his or her vehicle properly under unexpected situations and pedestrian attention to signs. The means of clarifying such conditions to the public include signs, flaggers, pavement markings, barricades, lights, cones, and delineators.
- C. No one standard sequence of signs or control devices will suit all conditions, which may result from construction operations. Even for the same work the conditions may vary from hour to hour, requiring adjustment and revision of the traffic control program in effect.
- D. The traffic control requirements specified herein are intended to establish general principles to be observed in the control and regulation of traffic through and around construction operations anticipated for this project. All pedestrian and vehicular detours are subject to review by the police chief, sheriff, or enforcement officer of the agencies having jurisdiction, and the Contractor shall revise the detours as ordered, at no additional cost.
- E. Cleanup site each day after completing work and remove all traffic hazards. Daily traffic control measures shall continue until cleanup activities have been satisfactorily completed and all of the Contractor's equipment has been removed from the traveled way area.

##### 1.02 DESCRIPTION OF WORK

- A. Work Included:
  - 1. At all times, provide safe and adequate passage for vehicular and pedestrian traffic through, around, and adjacent to all construction operations by use of detours, bridging, backfilling, paving, traffic barriers or other favorably reviewed means.
  - 2. Establish and maintain detours and conduct construction operations in such a manner as to minimize hazard, inconvenience, and disruption to the public.
  - 3. Traffic control shall be directed equally to the regulation and protection of pedestrian traffic including pedestrians, bicyclists, joggers, skaters, skateboarders, etc.
  - 4. Provide for protection of pedestrians and separation of pedestrians from construction operations at all times.
  - 5. Direct, divert and detour traffic through, around, and adjacent to construction operations in accordance with the traffic control plans as specified herein or in accordance with favorably reviewed Traffic Control Plans. Revise the



Traffic Control Plan, as necessary, only with the favorable review of the Project Engineer.

6. Contractor shall maintain at a minimum two lanes of traffic in the area of Work except for the portion of the Work that includes trenchless crossing of the railroad right-of-way.

### 1.03 REFERENCES

- A. Manual on Uniform Traffic Control Devices (MUTCD)
- B. Model Traffic Code for Colorado, Revised 2020.

### 1.04 SUBMITTALS

- A. Traffic Control Plan:
  1. Submit a Traffic Control Plan (TCP) to the City Traffic Engineer in accordance with the procedures specified in Section 01300 under the Product Information category to clearly describe proposed traffic control measures. The plan shall be generally in accordance with the illustrations included in the Manual of Traffic Control and in the Work Area Traffic Control Handbook.
  2. Submittal shall consist of scaled drawings for each situation anticipated to be encountered, i.e., intersections, mid-block (each during working and non-working hours), etc.
  3. Scaled drawings shall show signs, traffic control devices and flaggers as required.
  4. Designate a Traffic Lead who will have responsibility for planning, preparing, contacting agencies, and implementing the TCP. Provide not less than 30 days written notice of transfer or termination of this individual to assure a smooth transition to a new Lead.
  5. No traffic control related work shall commence until a TCP is favorably reviewed by the Owner and Project Engineer.
  6. Revise and keep the TCP up to date as the project progresses. Consult with the Owner and Project Engineer on an ongoing basis to assure having a safe and workable plan in place.
- B. Haul Routes:
  1. Submit a plan of all delivery and haul routes to be used for the Project.
  2. Haul routes shall consist of collector and arterial streets whenever possible and minimize impacts to residential areas.

## PART 2 - PRODUCTS

### 2.01 CONSTRUCTION SIGNS

- A. The term "Construction Area Signs" shall include all temporary signs required for the direction of public traffic through or around the work during construction. These signs are shown in or referred to in the current MUTCD. Construction area signs shall be installed per the TCP and at other locations as directed by the Owner or Engineer.
- B. All construction area signs shall conform to the dimensions, color and legend requirements of the MUTCD and these specifications. All sign panels shall be the product of a commercial sign manufacturer and shall be as specified in these



specifications. The base material of construction area signs shall not be plywood or cardboard unless specifically identified in these specifications.

- C. Sign panels for all construction area signs shall be visible at 500 feet and legible at 300 feet, at noon on a cloudless day and at night under illumination of legal low beam headlights, by persons with vision of or corrected to 20/20, except that the nighttime requirement shall not apply to fabric sign panels for portable signs
- D. Temporary warning signs in construction areas shall have a black legend on an orange background. Color for other signs shall follow the standard for all highway signs.
- E. All signs used during hours of darkness shall be reflectorized or illuminated.
- F. Stationary Mounted Signs
  1. Stationary mounted signs shall be installed on wood posts for installation of roadside signs, except as follows.
  2. The height to the bottom of the sign panel above the edge of traveled way shall be at least 7 feet.
  3. Construction area sign posts may be installed on above ground temporary platform sign supports as favorably reviewed by the Engineer, or the signs may be installed on existing lighting standards or other supports as favorably reviewed by the Engineer. When construction area signs are installed on existing lighting standards, holes shall not be made in the standards to support the sign.
  4. The post embedment shall be 3 feet if post holes are backfilled around the posts with 3,000 PSI batch plant mix concrete.
  5. Sign panels for stationary mounted signs shall consist of Type II, Type III or Type IV retroreflective sheeting applied to an aluminum substrate.
  6. Sign panel fastening hardware shall be commercial quality.
- G. Portable Signs
  1. Each portable sign shall consist of a base, standard or framework and a sign panel. The units shall be capable of being delivered to the site of use and placed in immediate operation.
  2. Sign panels for portable signs shall be Type VI retroreflective sheeting, or shall be cotton drill fabric, flexible industrial nylon fabric or other approved fabric. Fabric signs shall not be used during the hours of darkness. Size, color, and legend requirements for portable signs shall be as described in the MUTCD. The height to the bottom of the sign panel above the edge of traveled way shall be at least 1 foot.

## 2.02 CONES AND PORTABLE DELINEATORS

- A. Cones:
  1. Traffic cones shall be fluorescent and of good commercial quality, flexible material suitable for the purpose intended. The outer section of the portion above the base of the cone shall be translucent and be of a highly pigmented fluorescent orange polyvinyl compound.
  2. The overall height of the cone shall be at least 28 inches and the bottom inside diameter shall be not less than 10.5 inches. The base shall be of sufficient mass and size or shall be anchored in a manner that the traffic cone will remain in an upright position.



3. During the hours of darkness traffic cones shall be affixed with retroreflective cone sleeves. The retroreflective sheeting of sleeves on the traffic cones shall be visible at 1,000 feet at night under illumination of legal high beam headlights, by persons with vision of or corrected to 20/20.
- B. Portable Delineators:
1. Portable delineators shall be orange in color.
  2. The overall height of the channelizer shall not be less than 36 inches and the width shall not be less than 3 inches. The base shall be of sufficient mass and size or shall be anchored in a manner that the traffic cone will remain in an upright position.
  3. Channelizers shall have affixed white retroreflective sheeting. The retroreflective sheeting shall be 3 inches x 12 inches in size. The retroreflective sheeting shall be visible at 1,000 feet at night under illumination of legal high beam headlights, by persons with vision of or corrected to 20/20.

### 2.03 BARRICADES

- A. Barricades shall be Type I, Type II or Type III barricades as set forth in the MUTCD.
- B. Barricades used during hours of darkness shall be equipped with flashers.
- C. Markings for barricade rails shall be alternate orange and white stripes. The entire area of orange and white stripes shall be Type I, engineering grade, or Type II, super engineering grade, retroreflective sheeting. The color of the orange retroreflective sheeting shall conform to PR No. 6, Highway Orange, of the Federal Highway Administration's Color Tolerance Chart. Retroreflective sheeting shall be placed on rail surfaces in such a manner that no air bubbles or voids are present between the rail surface and retroreflective sheeting. The predominate color for barricade components other than rails shall be white, except that unpainted galvanized metal or aluminum may be used. Sign owner identification shall not be imprinted on the reflectorized face of any rail but may be imprinted elsewhere.
- D. Ballasting shall be by means of sand-filled bags placed on the lower parts of the frame or stays but shall not be placed on top of the barricade nor over any reflectorized barricade rail face facing traffic.

### 2.04 TEMPORARY RAILING (TYPE K)

- A. Temporary railing shall consist of interconnected new or undamaged used precast concrete barrier units. Exposed surfaces of new and used units shall be freshly coated with white color paint prior to their first use on the project.
- B. Reinforcing steel bars to receive bolts at ends of concrete panels shall conform to the requirements in ASTM Designation: A36/A36M. The bolts shall conform to the requirements in ASTM Designation: A307.
- C. A round bar of the same diameter may be substituted for the end-connecting bolt. The bar shall conform to the requirements in ASTM Designation: A36/A36M, shall have a minimum length of 26 inches and shall have a 3-inch diameter by 3/8-inch-thick plate welded on the upper end with a 3/16-inch fillet weld.
- D. Temporary railing (Type K) shall be set on firm, stable foundation.



- E. Abutting ends of precast concrete units shall be placed and maintained in alignment without substantial offset to each other. The precast concrete units shall be positioned straight on tangent alignment and on a true arc on curved alignment.
- F. Each rail unit placed within 10 feet of a traffic lane shall have a reflector installed on top of the rail. Reflectors shall be as specified and adhesive shall conform to the reflector manufacturer's recommendations. A Type P marker panel shall also be installed at each end of railing installed adjacent to a two lane, two-way highway and at the end facing traffic of railing installed adjacent to a one-way roadbed. If the railing is placed on a skew, the marker shall be installed at the end of the skew nearest the traveled way.

## 2.05 FLASHING ARROW SIGNS

- A. Flashing arrow signs shall be finished with commercial quality flat black enamel and shall be equipped with yellow or amber lamps that form arrows or arrowheads as required. Each lamp shall be provided with a visor and the lamps shall be controlled by an electronic circuit that will provide between 30 and 45 complete operating cycles per minute in each of the displays and modes specified. The control shall include provisions for dimming the lamps by reducing the voltage to 50 percent,  $\pm 5$  percent, for nighttime use. Type I signs shall have both manual and automatic photoelectric dimming controls. Dimming in both modes shall be continuously variable over the entire dimming range.
- B. Flashing arrow signs shall conform to the MUTCD legibility requirements. The minimum legibility distance is the distance at which flashing arrow signs shall be legible at noon on a cloudless day and at night by persons with vision of or corrected to 20/20
- C. Flashing arrow signs shall be capable of being operated in four (4) different display modes as follows:
  - 1. Pass Left Display
  - 2. Pass Right Display
  - 3. Simultaneous Display - the lamps forming both right and left arrowheads and the lamps of the arrow shaft shall flash simultaneously.
  - 4. Caution Display - a combination of lamps not resembling any other display or mode shall flash.
- D. Flashing arrow signs shall also be capable of operating in one or both of the following modes, at the option of the Contractor:
  - 1. Flashing Arrow Mode - all lamps forming the arrowhead and shaft shall flash on and off simultaneously.
  - 2. Sequential Mode - either arrowheads or arrows shall flash sequentially in the direction indicated.
- E. Each flashing arrow sign shall be mounted on a truck or on a trailer and shall be capable of operating while the vehicle is moving and shall be capable of being placed and maintained in operation at locations as specified or as directed by the Owner or Engineer.
- F. Flashing arrow signs shall be mounted to provide a minimum of 7 feet between the bottom of the sign and the roadway.
- G. Electrical energy to operate the sign shall not be obtained from the vehicle on which the sign is mounted or from a generating plant mounted on the vehicle.



Regardless of the source, the supply of electrical energy shall be capable of operating the sign in the manner specified.

## 2.06 PORTABLE TRAFFIC SIGNALS FOR ONE-LANE WORK ZONES

- A. Provide two (2) portable traffic signals for work zone traffic control during the construction that have the following features:
  - 1. Portable traffic signals with adjustable overhead lights that can clear H20 truck height clearance requirements. Provide two (2) lights per unit.
  - 2. Battery powered capable of running for 21 days without being recharged and include a solar panel to recharge the batteries.
  - 3. Motion activation to sense traffic build-up.
  - 4. Work zone light to allow workers to know which signal is red and which is green with a different flashing pattern or other means.
  - 5. Preemption system to allow emergency vehicle immediate pass through the signal work zone.
  - 6. Digital speed display to display vehicle speed through the work zone.
  - 7. Back plates to enhance visibility of the traffic lights.
  - 8. Manual operation of the signals through use of a hand controller module that lets a flagger control the signals. Provide a means to eliminate possible conflicting indications at each signal during manual controller use.
  - 9. The portable signals shall be linked and be able to communicate and assign only the proper right-of-way assignment at a time.
  - 10. Provide for wireless radio communication between the traffic signals that conforms to MUTCD guidelines.

## PART 3 - EXECUTION

### 3.01 DIVERTING PEDESTRIAN TRAFFIC

- A. Whenever construction operations obstruct the flow of pedestrian traffic or present a hazard to pedestrians, take appropriate action to protect and separate pedestrians from the work area.
- B. Such action may include placement of barricades between pedestrians and work areas, placement of warning signs, and provision of personnel as required to protect pedestrians as conditions warrant.

### 3.02 DIVERTING VEHICULAR TRAFFIC

- A. Whenever construction operations obstruct the flow of vehicular traffic or present a hazard to vehicles operating in the vicinity of construction operations, take appropriate action to warn, detour and otherwise protect approaching drivers and vehicles.

### 3.03 MAINTAINING TRAFFIC CONTROL

- A. General:
  - 1. Traffic control devices shall be provided in sufficient quantities and types as required to provide safe and adequate traffic control. To properly provide for changing traffic conditions and damage caused by public traffic or otherwise, the Contractor shall be prepared to furnish on short notice additional construction area sign panels, posts and mounting hardware or portable sign



- mounts. The Contractor shall maintain an inventory of the commonly required items at the jobsite or shall make arrangements with a supplier who is able, on a daily basis, to furnish the items on short notice.
2. During hours of darkness, approved lights and/or flares shall be included, in proper working order, to illuminate signs and hazards and alert approaching traffic.
  3. Barricades shall be furnished and maintained along all open trenches in contact with traffic.
  4. No work may begin on any day or at any time before traffic control devices have been placed and, if required, adjusted, and revised.
  5. When leaving a work area and entering a roadway carrying public traffic, the Contractor's equipment, whether empty or loaded, shall yield to public traffic.
- B. Traffic Control Placement:
1. All traffic control devices shall be placed in accordance with the MUTCD and the favorably reviewed Traffic Control Plan.
  2. Locations of devices shall be adjusted to suit the conditions and circumstances of each detour situation. In all cases, signs shall be placed to most effectively convey their messages to approaching traffic.
- C. Maintenance of Traffic Control Devices:
1. Maintain all traffic control devices, at proper locations and in proper working order, at all times during construction operations and whenever a hazard resulting from Contractor's operations exists.
  2. Adjust and revise traffic control devices, placement, etc., to suit changing conditions around construction operations.
  3. Clean all construction area sign panels at the time of installation. Used signs with the specified sheeting material will be considered satisfactory if they conform to the requirements for visibility and legibility and the colors conform to the requirements of the current MUTCD. A significant difference between day and nighttime retroreflective color will be grounds for rejecting signs.
  4. Monitor all traffic control on a daily basis and replace or restore any traffic control devices that have been displaced or damaged.
- D. Removal of Traffic Control Devices:
1. Traffic control devices shall remain in place at all times required to alert approaching traffic of upcoming hazards.
  2. After hazard has been removed, all traffic control devices shall be removed. Signs shall be removed or their messages covered until removed.
  3. Existing roadside signs conflicting with the construction area signs shall be removed and reset upon completion of work or securely covered.

### 3.04 FLAGGERS

- A. General: Flaggers shall perform their duties and shall be provided with the necessary equipment in conformance with the MUTCD.
- B. Employ flaggers:
1. As required for each specific detour in the Traffic Control Plan.
  2. For each individual railroad track crossing.
  3. At all locations on a construction site where barricades and warning signs are insufficient to properly control traffic.



- C. Placement: Where flaggers are required, they shall be logically placed in relation to the equipment or operation so as to give adequate warning and shall be placed approximately 100 feet ahead of impact point unless otherwise specified by the authority having jurisdiction.
- D. Warning Signs:
  - 1. A warning sign shall be placed ahead of the flagger reading: "Flagger Ahead." The distance between the sign and the flagger should be based on the average traffic speed, allowing approximately 50 feet for each 10 miles per hour.
  - 2. During hours of darkness, flagger stations shall be illuminated such that the flagger will be clearly visible to approaching traffic. Lights for illuminating the flagger station shall receive favorable review by the Engineer before use.
- E. Equipment:
  - 1. Each flagger shall be provided with and wear a red or orange warning garment when flagging. Flaggers shall be provided with approved hand signs and two-way radios for communication.
  - 2. When flagging during hours of darkness, a flagger shall signal with a red light or flare and shall have a belt and suspender harness outside his/her garment fitted with reflectors or made from reflectorized cloth, unless the garment is well reflectorized in one of these ways.

### 3.05 NOTIFICATIONS

- A. Notify in writing all agencies having jurisdiction and service providers, and all affected residents and businesses at least 48 hours, excluding holidays and weekends, prior to instituting any lane closure or detour. At the end of each day's work, inform the ambulance services, police and fire departments, and affected community service providers of the status of all detours and/or lane or road closures.
- B. List of agencies and service providers to be notified:
  - 1. Fire Department
  - 2. Police Department

### 3.06 EMERGENCY VEHICLE ACCESS THROUGH DETOURS

- A. During all detours and/or street closures, provide for movement of emergency vehicles through the work area.
- B. It is essential that the Contractor's work and equipment does not impede egress from any fire or police station to other areas of their service area.

### 3.07 ACCESS TO PRIVATE PROPERTY

- A. General: Schedule and organize operations to minimize disruption of access to private property.
- B. Notification: Prior to blocking access to any private driveway or parking lot entrance, notify the resident or business owner or tenant of pending closure at least 72 hours in advance and allow resident to remove vehicles.
- C. Nights: During non-working hours no driveway, house, or parking lot shall be denied access to a public roadway.



### 3.08 NIGHT DETOURS

- A. General: The Contractor shall not be permitted to maintain any lane closure or road closure during non-working hours without first obtaining written approval of the Engineer.
- B. Restoration of Pavement:
  - 1. During non-working hours, restore travel lanes to their original alignment and configuration by means of backfilling and temporary pavement or bridging the trench with beams and steel plates designed to support HS-20 vehicles.
  - 2. Place "ROUGH ROAD" signs conforming to the MUTCD at uneven temporary pavement or bridging.

### 3.09 PARKING RESTRICTIONS

- A. General: Post approved "NO PARKING" signs at all locations necessary to establish work areas and detour traffic.
- B. Signs:
  - 1. Signs shall read: "NO PARKING CONSTRUCTION TOW-AWAY ZONE."
  - 2. Signs shall be mounted such that the wording "No Parking" is at an elevation at least 3 feet and not more than 7 feet above the adjacent flow line. Signs may be tied with string to trees and power poles, taped to existing sign poles, or mounted to stakes or barricades provided by the Contractor. The signs shall be placed as needed to control the parking of cars within the construction zone.
  - 3. Signs shall be placed at least 24 hours in advance of restriction. Upon completion of the work, all signs, stakes, and barricades shall be promptly and completely removed and disposed of by the Contractor. The Contractor shall promptly reset or replace all damaged or defective signs.
- C. Towing of Vehicles:
  - 1. The Contractor shall be fully responsible for the adequate removal of all parked cars. All vehicle removal shall be coordinated by the Contractor with the Police Department. The Contractor shall notify the Police Department upon posting of the parking restrictions for a particular street. For removal of parked vehicles, the Contractor shall notify the Police not less than two (2) hours prior to the needed removal with the address nearest the parked vehicle, make, model, color and license number. The Owner shall not be responsible for any delay or additional costs associated with the removal of parked cars that obstruct the construction operation.
  - 2. If a vehicle owner successfully contests a towing citation in court, and their citation is dismissed for causes related to the Contractor's failure to perform the requirements of this section, the Contractor shall reimburse the vehicle owner for the cost of any claims associated with the towing citation.

### 3.10 BRIDGING OVER TRENCHES AND EXCAVATIONS

- A. General:
  - 1. For excavations not backfilled or permitted to remain open, bridging shall be placed across all trenches and excavations in existing streets and at driveways when work is not in progress.



- B. Design of Bridging:
  - 1. Bridging for vehicular traffic shall be of sufficient width to accommodate the required number of travel lanes.
  - 2. Bridging shall be designed to support HS-20 vehicular traffic.
  - 3. All bridging shall be set flush with travel surface or a satisfactory transition from travel surface to top of bridging shall be provided.
    - a. A satisfactory transition shall mean a change in elevation between the levels of not less than 12 inches horizontal to 1 inch vertical.
    - b. Transition may be accomplished by means of temporary pavement.

### 3.11 TEMPORARY TRAFFIC LANES

- A. Temporary traffic lanes shall be at least 10 feet wide, unless otherwise indicated on the Traffic Control Plan. Provide an additional 2 feet of clearance from curbs or other obstructions. The length of temporary lanes should be limited to the area under construction and the distance necessary to divert traffic.

### 3.12 TEMPORARY PAVEMENT MARKERS

- A. Wherever the Contractor's operations obliterate pavement delineation, including pavement markers and painted or thermoplastic lines for lane lines, stop bars, crosswalks, pavement legends, etc., such pavement delineation shall be replaced at the Contractor's expense by either permanent or temporary delineation before opening the traveled way to public traffic.
- B. Temporary delineation shall consist of reflective traffic line tape applied in pieces not less than 12 inches long and not less than 4 inches wide. The tape pieces shall be spaced no more than 12 feet apart on curves and no more than 24 feet apart on tangents.
- C. Install temporary stop bars, limit lines and crosswalks at any location where the construction operation obliterated the existing delineations. These temporary stop bars, limit lines and crosswalks shall consist of 6-inch-wide removable tape or approved equal.
- D. Reflective line tape or tabs shall be applied in accordance with the manufacturer's instructions. Temporary delineation shall be the same color as the permanent delineation.

### 3.13 STAGING AREAS

- A. The Contractor's equipment shall not be parked within any traffic lanes after working hours.
- B. The Contractor shall provide its own staging areas.

### 3.14 TRUCK TRAFFIC PLAN AND RESTRICTIONS

- A. Control the delivery and haul routes of all trucks having three or more axles used in conjunction with this work. This control shall extend to all such trucks owned by the Contractor, subcontractors, second and lower tier subcontractors, material suppliers, commercial haulers, and deliverers of equipment.
- B. To reduce tracking of dirt, tack coat, and other objectionable material onto various streets, the Contractor shall limit the number of truck haul routes.



- C. Arterial and collector streets shall be used for truck and equipment access.
- D. Trucks and equipment shall not be routed or parked on residential streets unless otherwise approved by the Owner.

3.15 MAINTAINING EXISTING AND TEMPORARY SIGNAL LIGHTING AND ELECTRICAL SYSTEMS

- A. Ensure effective operation of existing traffic signals and street lights within the construction area.
- B. When working within 100 feet of any signalized intersection, arrange with the signal owner to modify the controller timing as required to properly handle traffic during construction.
- C. Damage to Signal Lighting Electrical Systems:
  - 1. Ascertain the exact location and depth of all existing detectors, conduits, pull boxes, and other electrical facilities before using any tools or equipment that may damage those facilities or interfere with any electrical system.
  - 2. In the event that traffic signal or street light conductors are damaged, arrange for their repair within 24 hours. If a permanent repair is not possible or infeasible, make temporary repairs to ensure safe and efficient operation, until permanent repairs can be made. Both temporary and permanent repairs shall be made at the Contractor's expense and in coordination with the signal owner's requirements.
  - 3. In the event that in-pavement loop detectors are damaged, contact and coordinate with the signal owner to modify the controller timing as required to properly handle traffic during construction. Arrange for immediate replacement of loop detectors upon completion of construction work within the traffic lane where the damage occurred.

END OF SECTION



SECTION 01600  
PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.01 PRODUCTS

- A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

1.02 PRODUCT DELIVERY REQUIREMENTS

- A. Transport and handle products in accordance with manufacturer's instructions.
- B. Promptly inspect shipments to ensure products comply with product requirements, quantities are correct, and products are undamaged.
- C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.03 PRODUCT STORAGE AND HANDLING REQUIREMENTS

- A. Store and protect products in accordance with manufacturers' instructions.
- B. Store with seals and labels intact and legible.
- C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.
- D. For exterior storage of fabricated products, place on sloped supports above ground.
- E. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- F. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.
- G. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, damage, and theft.
- H. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.04 PRODUCT SUBSTITUTION PROCEDURES

- A. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.



- B. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.
- C. A request constitutes a representation that Contractor:
  - 1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
  - 2. Will provide same warranty for Substitution as for specified product.
  - 3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
  - 4. Waives claims for additional costs or time extension which may subsequently become apparent.
  - 5. Will reimburse Owner for review or redesign services associated with re-approval by authorities having jurisdiction.
- D. Substitutions will not be considered when they are indicated or implied on Shop Drawing submittals, without separate written request, or when acceptance will require revision to Contract Documents.
- E. Substitution Submittal Procedure:
  - 1. Submit cover sheet for the request for Substitution for consideration.
  - 2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence.
  - 3. Project Engineer will notify Contractor in writing of decision to accept or reject request.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION



## SECTION 01700

### CONTRACT CLOSEOUT

#### PART 1 - GENERAL

##### 1.01 FINAL CLEANUP

- A. Prior to Final Inspection, the Contractor shall clean the entire construction area and all other areas affected by the performance of work under this Contract. Perform cleaning using personnel specializing in and skilled in cleaning and maintenance work. Perform repair work using personnel skilled in executing the type of work being repaired. Perform all work to the highest trade standards applicable to that type of work.
1. Remove all temporary construction, signs, tools, equipment, excess material and debris.
  2. Remove all lumps, splatters, spots and stains caused by paint, adhesive, asphalt, concrete, mortar, sealant or other foreign material from exposed or finished surfaces. Remove all temporary labels.
  3. Repair, patch or replace new or existing work including pavement, sidewalks, curbs, gutters, catch basins, gratings, manholes, covers, landscaping, plant materials and other items that have been damaged, broken, cracked or chipped as a result of performing this Work.
  4. Sweep clean and wash down all exterior pavement surfaces. Remove all hazardous material and material that may cause sediment in drainage systems prior to washdown. Remove all grease and oil stains on pavement caused by Contractor's equipment.

##### 1.02 CONTRACTOR'S ACTION LIST OF ITEMS TO BE CORRECTED AND/OR COMPLETED

- A. During construction, the Contractor shall maintain an action list of items to be corrected and/or completed. Regularly add items and update the list as information becomes available or as requested by the Project Engineer.

##### 1.03 SUBSTANTIAL COMPLETION

- A. When the Contractor considers the Work nearly complete, the Contractor shall review the Contract Documents, inspect the Work, and use the Contractor's action list to prepare a Contractor's Punch List of all deficient or uncompleted items. Complete or correct the items on the Punch List. When the Work is Substantially Complete, notify the Owner's Inspector that the Contractor has reviewed the Contract Documents, inspected the Work, and believes that the Work is Substantially Complete and ready for Semifinal Inspection.
- B. On receipt of the Contractor's Punch List and notice that the work is ready for Semifinal Inspection, the Owner's Inspector will inspect the Work. The Owner's Inspector may add additional items to the Contractor's Punch List, may find that the Work is not ready for inspection, may find that the Work is ready for inspection but not Substantially Complete or may find that the Work is Substantially Complete. When the Owner's Inspector finds the Work is Substantially Complete, he/she will prepare a Final Punch List and a notice of Substantial Complete, which will state



the date of Substantial Completion and the time agreed to by the Owner and the Contractor (not to exceed 30 calendar days) in which the Work shall be fully complete and ready for Final Inspection.

#### 1.04 FINAL INSPECTION, FINAL COMPLETION AND FINAL PAYMENT

- A. When the Contractor has completed or corrected all the items on the Owner's Inspector's Final Punch List, the Contractor shall give the Owner's Inspector written notice that the Work is ready for Final Inspection. When the Owner's Inspector finds the Work acceptable and fully complete in accordance with the Contract Documents, and upon receipt of a final Application for Payment and all final submittals, the Owner's Inspector will recommend that the Owner issue a Notice of Final Completion, make Final Payment, and Accept the Work stating that to the best of the Owner's Inspector's knowledge, information and belief, and on the basis of the Owner's Inspector's observations and inspection, the Work has been fully completed in accordance with the terms and conditions of the Contract Documents.
- B. Final Submittals include:
  - 1. Operation and Maintenance Manuals and Parts Lists
  - 2. Record Drawings
  - 3. Insurance Certificate showing required continuation of coverage beyond Final Payment.
  - 4. Release of Liens.
  - 5. Waiver of Claims by Contractor.
  - 6. And any other submittals required by the Contract Documents and not previously received.

#### 1.05 RECORD DRAWINGS

- A. The Contractor shall maintain on the jobsite, a complete set of Contract Documents and a complete file of all addenda, contract modifications and favorably reviewed submittals. The Contractor shall prepare a set of Record Drawings concurrently with the construction of the Work and in accordance with the following:
  - 1. The contractor shall utilize the Owner's survey department to survey final rim and invert elevations. Show the invert elevation of all gravity piping and the top of pipe, top of conduit or top of protective concrete encasement for other utilities. Elevations shall be related to a permanent visible elevation benchmark set at the site by the Contractor.
  - 2. Show the horizontal location of underground utilities measured from permanent visible physical features such as edge of asphalt or centerline of roadway. Northings and eastings of new structures is also acceptable.
  - 3. Comply with detailed requirements in technical specification sections describing the type of information required on Record Drawings. The Contractor's copy of Contract Documents, Contract modifications and Record Drawings shall be available to the Project Engineer for verification that the records are being currently updated.
- B. Submit Record Drawings and obtain acceptance prior to completion.



1.06 WARRANTY

- A. Contractor shall warranty the project Work for a total of two (2) years at the date of Final Completion and Acceptance of the Work.

1.07 FINAL ACCEPTANCE INSPECTION

- A. Three (3) months prior to the expiration of the two-year guarantee period the Contractor will send a final acceptance inspection request to all applicable City Divisions/Departments to inspect the project for final acceptance. At least sixty (60) days prior to the expiration of the warranty period, the Contractor will be notified in writing of all outstanding punch list items needed to be completed and will have thirty (30) days to complete the punch list items. See Section 231.00 of the City of Arvada Engineering Code for further detail.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION



## SECTION 02050

### DEMOLITION

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide all demolition required to perform the work covered under this contract including without limitation:
1. Remove existing construction shown to be removed.
  2. Remove and replace existing construction and/or finishes as required to provide access to perform other work included in this contract.
  3. Include removal of mechanical and electrical work that is to be abandoned, removed, or is located within the work area for construction whether or not the mechanical and electrical work is shown. Disconnect and cap off utilities in accordance with applicable codes and safety regulations.
  4. Where utilities that are not shown pass through construction that must be removed, and those utilities serve other areas, notify the Engineer and utility owner before disrupting service. If rerouting is required to maintain service, the Owner may issue a Change Order to accomplish the required work.
  5. Store and protect items intended for reuse.
  6. Assume ownership of debris and unwanted materials, remove from the site and dispose of legally.
    - a. Special requirements for waste management during deconstruction and construction operations.
      - 1) Protect the environment, both onsite and offsite, during deconstruction and construction operations.
      - 2) Prevent environmental pollution and damage.
      - 3) Maximize source reduction, reuse, and recycling of solid waste.
  7. Include the cost of removing and disposing of hazardous material including without limitation asbestos or asbestos-containing material, lead-containing paint, and PCBs.
  8. Comply with all State permit requirements for demolition. The Contractor shall perform a pre-demolition survey to determine whether hazardous material is present. If material is identified as hazardous, retain qualified and State-licensed Contractor to remove and dispose of the materials legally.
  9. If illegal electrical wiring is encountered such as "BX" or nonmetallic sheathed cable, notify the Engineer.
  10. Remove all loose items including rubbish, debris, furniture, etc.

##### 1.02 NOISE AND DUST CONTROL

- A. Perform work in accordance with the requirements in Division 1. Particular attention is directed without limitation to paragraphs titled: Cleanup During Construction, Fire Protection During Construction, Dust Control, Erosion and Sediment Control, and Noise Control.
- B. Provide temporary controls to control dust and noise and exclude unauthorized persons.



- C. Perform work in a manner to cause least disturbance to the general public and least damage to work to remain.
- D. Maintain adequate means of safe, clear egress for all on-site personnel occupants.
- E. Employ all available techniques for construction noise abatement. Use remote, well-muffled air compressors and newest noise suppressed pneumatic and electric tools.

#### 1.03 WARNING

- A. The Contractor is advised that work under this Section may be hazardous. The Contractor is to take all necessary precautions to ensure the safety of workers and property. Removal of and/or working in areas containing even minor amounts of hazardous material including without limitation, asbestos, lead-based paint, PCBs or other hazardous materials requires special precautions, knowledge, and procedures. If hazardous material is suspected, notify the Engineer or Owner.

#### 1.04 QUALITY ASSURANCE

- A. Maximize use of source reduction and recycling procedures.

#### 1.05 SUBMITTALS

- A. Information to be submitted in accordance with Section 01300.
- B. Submit copies of all executed permits.

#### 1.06 PERMITS

- A. Contractor shall fill out, submit and pay for the following permits:
  - 1. Colorado Department of Public Health and Environment:
    - a. Demolition Notification Application Form (minimum 10 day lead time)
- B. Refer to CDPHE requirements and procedures for asbestos abatement and control of hazardous air pollutants.

### PART 2 - PRODUCTS - NOT USED

### PART 3 - EXECUTION

#### 3.01 SOLID WASTE MANAGEMENT

- A. Develop and implement a waste management program in accordance with ASTM E1609 and as specified herein.
- B. Handling:
  - 1. Clean materials that are contaminated prior to placing in collection containers. Deliver materials in accordance with recycling, reuse, or waste facility requirements (e.g., free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to recycling process).
  - 2. Arrange for collection by or delivery to the appropriate recycling, reuse, or waste facility.



3. Hazardous Waste and Hazardous Materials: Handle in accordance with applicable regulations.

### 3.02 REMOVAL OF CONSTRUCTION IN AREAS TO RECEIVE NEW WORK

- A. Remove all unwanted mechanical and electrical work (whether shown or not) that is not wanted and is not needed to serve other areas that is in, on, or concealed behind work being removed. Cap off or terminate all mechanical or electrical work in accordance with the requirements of Divisions 15 and 16.
- B. Protect mechanical and electrical work that serves other areas. Relocate concealed mechanical and electrical work that is required to preserve service to other areas.
- C. Remove structural work designated for removal. Take precautions not to damage structural work intended to remain. Where temporary shoring is needed, submit a design prepared by an appropriately licensed engineer for review before proceeding.
- D. If structural elements are encountered that were not shown, protect them from damage and report their presence to the Engineer.

### 3.03 REMOVAL OF EXISTING CONSTRUCTION TO PROVIDE ACCESS TO PERFORM WORK

- A. Provide careful selective cutting and removal of existing construction where required to permit installation of new structural work.
- B. Treat existing mechanical, electrical, or structural work as described in other parts of this Section.
- C. Replace and/or patch removed construction and finishes in accordance with other parts of this Section.

### 3.04 PROTECTION OF WORK TO REMAIN

- A. Protect all work to remain. Repair damage with materials, workmanship, and finishes matching existing work when new.

### 3.05 CUTTING HOLES IN CONCRETE AND/OR CONCRETE MASONRY UNIT (CMU)

- A. The Contractor is cautioned that electrical conduits and reinforcing that are not shown on Drawings may be concealed in concrete CMU construction. Use electronic detection equipment to locate concealed items before cutting holes. Take all required precautions to avoid damage to existing conduits or reinforcing.

### 3.06 IF HAZARDOUS MATERIALS ARE ENCOUNTERED

- A. If hazardous materials are discovered, comply with paragraph 1.01 of this Section and all applicable laws.

### 3.07 REMOVAL AND DISPOSAL OF MATERIAL

- A. Store debris in suitable covered containers located where directed by the Owner and remove from site when full. Burning on the site is not permitted.



- B. Removed material (other than material to be reused) shall become the property of the Contractor who shall remove it from the site and dispose of it in a legal manner.

### 3.08 UTILITY LOCATES AND DEMOLITION

- A. Contractor is responsible for locating utilities during construction and coordinating the project work with said utility owners. Utility owners may require temporary support, temporary service, encasement, and/or relocation of utilities to facilitate the work.

END OF SECTION





# DEMOLITION NOTIFICATION APPLICATION FORM

APPLICATION FEE MUST ACCOMPANY THIS FORM  
INCOMPLETE APPLICATIONS WILL BE RETURNED

(Notice will be mailed to the demolition contractor unless specified otherwise)

Fee: \$50 + \$5 per 1000 ft<sup>2</sup> of area to be demolished = \$ \_\_\_\_\_  
(See instruction #1 on reverse side)

Submit form to:  
Permit Coordinator  
Colorado Dept. of Public  
Health and Environment  
APCD-IE-B1  
4300 Cherry Creek Drive  
South  
Denver, CO 80246-1530  
Phone: 303-692-3100  
Fax: 303-782-0278  
Asbestos@state.co.us

Colorado Department  
of Public Health  
and Environment

<b>Demolition Contractor</b>	Company Name:				<b>Demolition Site</b>	Building Name:							
	Street:					Square footage of footprint of facility or portion of facility to be demolished							
	City:		State:	Zip Code:		Street:							
	Telephone # ( )		Fax # ( )			City:		County:	Zip Code:				
	Project Manager:		Cell Phone # ( )			Proposed Start Date		Proposed Completion Date					
	I certify that the Certified Asbestos Building Inspector has informed me about any remaining asbestos-containing materials in the facility to be demolished.					Method/Mean of Demolition:							
	Signature:		Print Name:			<input type="checkbox"/> Wrecking <input type="checkbox"/> Burning † <input type="checkbox"/> Implosion <input type="checkbox"/> Moving <input type="checkbox"/> Other, specify:							
Landfill Receiving Building Debris:				† Burning requires additional authorization – Please call (303) 692-3100 and ask to speak to the Open Burning Permit Coordinator									
<b>Asbestos Removal Contractor</b>	General Abatement Contractor (GAC)				<b>Building Owner</b>	Owner's Name:							
	CDPHE Asbestos Permit #		Total Quantity of Asbestos Removed			Street:							
	Date Removal Completed		Telephone # ( )			City:		State:	Zip Code:				
	Type(s) of Asbestos-Containing Material Removed:					Contact's Name:		Telephone # ( )					
<b>Certified Asbestos Inspector Certification</b>	With my signature below, I certify that I possess current AHERA accreditation and state of Colorado certification as an Asbestos Building Inspector. I also certify that I have thoroughly inspected the facility to be demolished, as listed in the Demolition Site block above, sampled all suspect materials, had all samples analyzed for the presence of asbestos by a NVLAP-accredited laboratory, and have determined that no Regulated ACM exists anywhere in the facility.* I also certify that I have informed the owner/operator of the facility or the demolition contractor that any asbestos-containing material allowed to stay in the facility must remain non-friable during demolition. Specify type(s) of ACM remaining, below: <b>(check appropriate box(es))</b> :												
	<input type="checkbox"/> Vinyl asbestos floor tile (VAT) <input type="checkbox"/> VAT mastic <input type="checkbox"/> Tar/asphalt impregnated roofing <input type="checkbox"/> Asphaltic pipe coatings <input type="checkbox"/> Spray-applied tar coatings <input type="checkbox"/> Caulking <input type="checkbox"/> Glazing <input type="checkbox"/> Other, specify:				Signature: (In Blue Ink)					Printed Name:			
	Date of Final Inspection		CO Cert #	Expiration Date		Telephone # ( )		Cell Phone # ( )					
	I verify that all refrigerants from air conditioning/refrigeration appliances have been properly recovered in accordance with AQCC Regulation No. 15 (for information on CFC requirements call 692-3100). I further verify that all luminous exit signs (containing radioactive material) have been disposed of in accordance with 6 CCR 1007-1 subpart 3.6.4.3 (for information on luminous exit sign requirements call 303-692-3320).												
<b>Building Owner or Contractor</b>	<b>CHECK THE APPROPRIATE BOX:</b> <input type="checkbox"/> Building Owner <input type="checkbox"/> Contractor <input type="checkbox"/> Other   Date:												
	Signature:				Print Name:								
	<b>THIS BOX IS FOR CDPHE USE ONLY:</b>												
Postmark or Hand Delivery Date:				Approved By:			Code: <input type="checkbox"/> initial-310 <input type="checkbox"/> transfer-380						
Form of Payment & #:			Permit #:		Record #		Date Issued:						

\* Regulated asbestos-containing materials means (a) friable asbestos-containing material, (b) Category I nonfriable ACM that has become friable, (c) Category I nonfriable ACM that will be or has been subjected to sanding, grinding, cutting, or abrading or (d) Category II nonfriable ACM that has a high probability of becoming or has become crumbled, pulverized, or reduced to powder by the forces expected to act on the material in the course of



## Demolition Notice Application Form Information and Instructions:

1. To determine the proper amount for the application fee, multiply the length of the building (lineal feet) by the width of the building (lineal feet). Divide the total by 1000, round the result up to the next whole number and multiply this number by 5\$. This is the square footage fee. Add the square footage fee to the base fee of \$50 and submit the total amount to the Division along with the demolition notice application form.  
  
Ex: 40ft. x 52ft. = 2080 square feet;  $2080 / 1000 = 2.08$  (round up to 3);  $3 \times \$5 = \$15$  (square footage fee)  $\$15 + \$50$  (base fee) = \$65 total application fee.
2. In the event that only a load-bearing member is demolished, the square footage fee is calculated the same way as in “number 1”. However, you only need to calculate the actual footprint of the load-bearing member.
3. All spaces must be filled in on the application. If the information is not applicable, please write N/A. Incomplete information may result in a delay in processing the application, which may delay your project.
4. We must have proposed start and end dates for the demolition.
5. There is a 10 working-day advance notification requirement for permit applications. Day 1 is the 1<sup>st</sup> business day following the postmark or hand-delivery date. (Working Day means Monday through Friday and including holidays that falls on any of the days Monday through Friday.) If a demolition follows a **permitted** or **noticed** asbestos abatement project within 10 business days of the completion of the abatement project, the 10 working-day advance notification requirement will be waived.
6. The Colorado-certified asbestos inspector must sign the form in blue ink. (Original signature must be submitted.) The building owner or the contractor must also sign the application certifying that all refrigerants and luminous signs have been properly removed from the site.
7. If the notice must be modified after the application has been submitted, notify the Asbestos Unit by fax at 303-782-0278 or e-mail at [asbestos@state.co.us](mailto:asbestos@state.co.us) by the end of the next regular State business day following the modification. Project modifications include discovery of unidentified asbestos-containing materials, changes in scope of work or the scheduled work dates. Please use the Permit/Notice Modification Form.
8. Recycling of materials, such as concrete or wood, that are bonded or contaminated with asbestos-containing material (ACM), such as floor tile or mastic, is NOT permitted.
9. Demolition of a building that has non-friable asbestos-containing materials remaining must be completed without causing the asbestos-containing materials to become friable. Burning a building with any asbestos-containing materials is PROHIBITED. Concrete floors covered with floor tile shall be removed in as large sections as possible. Operations such as crushing, pneumatic jacking, etc. of materials containing asbestos are not permitted.
10. All provisions of laws and ordinances governing this type of work shall be complied with whether specified herein or not. Demolition permits or approval notices appearing to give authority to violate or override the provisions of any other laws or ordinances shall be invalid.



Furthermore, demolition permits or approval notices issued in error or based upon incorrect information supplied to the Division shall also be invalid.



## SECTION 02070

### WASTEWATER FLOW MANAGEMENT PLAN

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Planning and implementation of wastewater flow diversions.

##### 1.02 SUBMITTALS

- A. Wastewater Flow Management Plan as specified herein.
- B. Public Notification Letter as specified herein.

##### 1.03 GENERAL REQUIREMENTS

- A. Contractor shall provide labor, materials, and supervision to temporarily provide bypass pumping and flow control around the Contractor's work in accordance with the specific needs of the inspection, cleaning, or construction work.
- B. The means and methods of accomplishing and maintaining the bypass system shall be the sole responsibility of the Contractor.
- C. No interruption of sewage flow shall be permitted throughout the duration of the project.
- D. The Contractor is advised that the bypass plans must provide for accessibility to pedestrians and vehicular traffic in accordance with City, County, and property owner requirements.
- E. Bypass Operation will be required 24 hours per day during the period of Work. The bypass pumps and piping flow shall be continuously monitored by a competent operator.
- F. Contractor shall inspect upstream and downstream diversion structures and/or manholes prior to installation. Any modifications, excavations, or improvements required for the upstream and downstream structures/manholes to facilitate bypass pumping equipment should be included in the Wastewater Flow Management Plan submitted by the Contractor and shall be performed by the Contractor. The Contractor is responsible for providing pumps and temporary storage, if required, to handle the incoming flows.
- G. Bypass pumping shall be performed in a manner so as not to create a public nuisance or health hazard and shall conform to current Colorado Department of Public Health and Environment practices. The Contractor shall supply and operate equipment for pumping the listed flow rates with provisions for 100% backup pumping capacity onsite during pumping operation. Discharge line locations and street crossings shall be coordinated with the appropriate governing agency.
- H. Contractor shall coordinate with Metro Water Recovery (Metro) on the use of a bypass flow estimate for the project. Contractor shall be responsible for providing Metro with estimated bypassing flow rates based on agreed upon methods. Metering is not required on bypass piping.



- I. During construction of the tie in point with the Metro's interceptor it is expected that Metro's interceptor flows will need to be bypassed. Contractor shall coordinate with Metro on the appropriate bypass discharge location, flow rates, and pump/pipe staging to ensure that bypassed flow is accounted for during construction. Bypass flow for the Clear Creek interceptor shall be bypassed into the same interceptor system downstream of the tie in point, unless otherwise directed by Metro.
- J. Contractor shall submit the WFMP and Emergency Response Plan at a minimum 14 days in advance of proposed bypassing operations. Contractor shall receive approval of the WFMP and Emergency Response Plan from Metro prior to commencement of bypassing operations.

#### 1.04 PUBLIC RELATIONS

- A. The Contractor is responsible for contacting property owners and businesses that are affected by the construction activities to inform them of the Work to be done and the estimated schedule and timing for the Work. Written notice shall be delivered to each home or business 2 weeks prior to construction. Notice shall include a local telephone number of the Contractor, and contact information for the Owner. Written notices must be reviewed by the Owner prior to distribution to the public.

#### 1.05 WASTEWATER FLOW MANAGEMENT PLAN

- A. The Contractor shall submit to the Engineer a Wastewater Flow Management Plan (WFMP) at least fifteen (15) working days prior to implementation of flow diversion/bypass. The WFMP shall indicate the sequence of diversion operations, and all other operations the Contractor will establish to maintain wastewater service during the diversion/bypass period. The WFMP shall be reviewed and accepted by the Engineer before flow can be diverted/bypassed. No deviation from the approved WFMP will be allowed without prior approval from the Owner or Engineer.
- B. The WFMP shall include, but not be limited to, the following:
  - 1. Drawings indicating the scheme and location of pumps, suction piping, discharge piping, and temporary sewer plugs for each of the project sites.
  - 2. Capacities and sizes of pumps, standby equipment, and power requirements if applicable.
  - 3. Design calculations proving adequacy of the system and selected equipment, including static lift, friction losses, fitting losses, flow velocity, pump curves showing operating range, and pipe thickness calculations.
  - 4. The submittal shall include a start date, time, and duration of diversion.
  - 5. Sewer plugging method and type of plug.
  - 6. Method of noise control for each pump and generator.
  - 7. Thrust and restraint block sizes and locations where space is limited.
  - 8. Temporary pipe supports and anchoring where required.
  - 9. Staffing Plan.
- C. The WFMP shall include a Wastewater Discharge Emergency Response Plan indicating the procedures, personnel, equipment, and activities that will be implemented in the event of a wastewater discharge, spill or overflow to the environment, or diversion system failure. The Contractor shall be responsible for



implementation of the Wastewater Discharge Emergency Response Plan in accordance with Section 02072.

- D. The Contractor shall submit as part of the WFMP the monitoring procedure and frequency and shall continuously monitor the flow levels downstream and upstream of the flow diversion to detect any possible failure that may cause a wastewater discharge. The Contractor shall maintain a daily log of the monitoring and provide weekly copies to the Engineer in a manner acceptable to the Owner.
- E. The Contractor shall observe and comply with all Federal, State, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to wastewater discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing wastewater discharges, spills or overflows, containing the wastewater, recovery and legal disposal of wastewater, any fines, penalties, claims and liability arising from negligent or willful discharge of wastewater, and violation of any law, ordinance, code, order, or regulation as a result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Owner for such wastewater discharges, spills, or overflows, including any attorney fees and costs associated with defending any action against the Owner resulting from such discharges, spills, or overflows.

#### 1.06 FLOW DATA

- A. The current average daily flow in the sewer pipe is 1,940 gallons per minute (gpm) and the current peak flow is 3,300 gpm. Contractor shall verify flows before bypass pumping commences. Contractor is responsible for designing the bypass system to accommodate peak flows at the time of construction.

### PART 2 - PRODUCTS

#### 2.01 TEMPORARY DIVERSION STRUCTURES

- A. Contractor, at his/her discretion, may construct additional diversion structure(s) at the bypass pump set-up location to accommodate the incoming wastewater flows for pumping. The Contractor is responsible for providing pumps and temporary storage, if required, to handle the incoming flows.

#### 2.02 BYPASS PUMPING EQUIPMENT

- A. All bypass piping must be rigid pipe; flat piping (hose) is not acceptable.
- B. The Contractor shall only use equipment inspected and found to be fully functional. The Contractor shall use pressure-rated piping materials in good working condition. Where two or more pipes will be used, provide one redundant, additional pipe of greater or equal size.
- C. The Contractor shall provide a pumping system consisting of pumps, pipe, and generators capable of handling an estimated peak flow of 3,300 gpm. Extra pumps and generators with a total capacity equal to 100% of the design flows must also be provided. A minimum of two pumps and generators shall be on site with no single pump and generator having less than 100% capacity of the design flows. The Contractor shall utilize the flow bypass system to perform the necessary maintenance and repairs on the flow bypass system, and exercise and ensure the



operation of the backup pumps. The Contractor shall operate the backup pump(s) for a minimum of 25% of the total bypass time on a weekly basis. All pumps shall be fully installed, operational, and ready for immediate use.

- D. The influent flow rate into the bypass pumping diversion structure could be variable, and the flow rate could change from low flow to high flow over a short period of time. The bypass pumping system shall be capable of quickly adjusting to accommodate the variability in the influent flow rate.
- E. Pumps and generators shall be equipped with devices such as (but not limited to) mufflers and/or plywood/Styrofoam noise panels enclosing the engines to keep the noise level down to a minimum. A maximum noise level of 50 decibel (dBA) is permitted overnight as measured at residential lot lines. See requirements in Section 01500 for additional requirements.
- F. The Contractor is responsible for providing adequate freeze protection for the bypassing pumping equipment to allow the equipment to maintain pumping operations during the fall, winter and spring timeframe in Arvada, Colorado.

## PART 3 - EXECUTION

### 3.01 BYPASS PUMPING EQUIPMENT

- A. The Contractor shall continuously monitor the flow levels downstream and upstream of the flow diversion to detect any possible failure that may cause a wastewater discharge. The Contractor shall maintain a daily log of the monitoring and provide weekly copies to the Owner in a manner acceptable to the Engineer.
- B. The Contractor shall provide one dedicated fuel tank for every single pump/generator, if fuel/generator driven pumps are used. The Contractor shall provide a fuel level indicator outside each fuel tank. The Contractor shall continuously (while in use) monitor the fuel level in the tanks and ensure the fuel level does not drop below a level equivalent of 2 hours of continuous flow diversion system operation. The Contractor shall take the necessary measures to ensure the fuel supply is protected against contamination. This could include, but is not limited to, fuel line water traps, fuel line filters, and protecting fuel stores from precipitation. The Contractor shall also monitor all piping and repair leaks immediately.
- C. The Contractor shall provide fuel leak containment around all generators.
- D. Drain residual wastewater from piping system to pipelines prior to disassembly, taking care to avoid wastewater spills.
- E. All pumps, generators and other equipment shall be placed on a plastic tarp to protect against spills of petroleum products used by the equipment.
- F. The Contractor can also utilize electric pumping options with provisions for backup power if preferred.

### 3.02 QUALITY CONTROL

- A. The Contractor must provide 24-hour supervision of the bypass pumping system during operation.
- B. The Contractor shall inspect the entire bypass pumping and piping system for leaks or spills on an hourly basis. The bypass system shall have trained and



qualified attendants around the clock whose only duty is to maintain the bypass pumping system until the bypassing of that specific pipeline is no longer required. The attendants shall be qualified to both operate and repair any and all problems that may occur. The attendants shall have a cellular phone for communication between the Owner and the site in the event of emergencies. No bypassing to the ground surface, receiving waters, storm drains, or bypassing which results in soil or groundwater contamination or any potential health hazards shall be permitted. In the event of any sewage spill, the Contractor shall be responsible for the prompt cleanup and disinfecting of the spill as outlined in Section 02072, Wastewater Discharge Emergency Response Plan. The Contractor shall compensate the Owner for the cost of any fines levied as the result of a spill or unauthorized discharge.

- C. The Contractor shall inspect and maintain the bypass system daily, including the backup system. The Contractor shall maintain a log of all inspection, maintenance, and repair records, and provide copies to the Engineer upon request.
- D. The Contractor shall not damage existing public and private improvements, interrupt existing services and/or facility operations which may cause a wastewater discharge, spill, or overflow. Any utility and/or improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.
- E. The Contractor is prohibited from discharging any groundwater, stormwater, or hazardous waste to surrounding water bodies or wastewater/stormwater infrastructure unless previously approved by the authority having jurisdiction.

### 3.03 HYDROSTATIC PRESSURE TESTING

- A. The diversion system shall be hydrostatically pressure tested in the presence of the Owner or its representative using potable water prior to wastewater flow diversion. The Contractor shall demonstrate to the satisfaction of the Owner or its representative that both the primary and backup flow diversion systems are fully functional and adequate, and shall certify the same, in writing, to the Owner in a manner acceptable to the Engineer.
- B. Hydrostatic Pressure Test:
  - 1. Prior to operation, test each section of discharge piping.
  - 2. Test pressure shall be 50% greater than maximum operating pressures, or 10 psi above maximum operating pressures, whichever is greater.
  - 3. The test shall run for a period of 2 hours in the presence of the Owner or its representative.
  - 4. The Contractor shall fill the line with water.
  - 5. The line shall be sealed on the discharge end.
  - 6. The line may be put in service if after the 2-hour period the pressure has been maintained and there are no observable leaks.
  - 7. Notify Engineer 24 hours prior to testing.

### 3.04 CLEAN-UP

- A. The bypass pumping system shall be cleaned and drained prior to being dismantled and moved. The Contractor shall alternate pigging and purging of the system to remove all loose material. After the Contractor has cleaned the pipe, and prior to dismantling of the piping for removal from the Project site, the Contractor shall disinfect the pipe with 10% chlorine and water solution. Notify the appropriate



governing agency of the downstream Wastewater Treatment Plant for chlorine added to sanitary sewer pipe larger than 24-inches in diameter.

- B. Disturbed Areas: Upon completion of bypass pumping operation, clean disturbed areas, restoring to original condition, including, but not limited to, pavement restoration and landscaping, at least equal to that which existed prior to start of Work.

### 3.05 SCHEDULING

- A. The bypassing system shall not be shut down between shifts, on holidays or weekends, or during work stoppages without written permission from the Owner.

### 3.06 WASTEWATER DISCHARGE/DIVERSION SYSTEM FAILURE

- A. In the event of a wastewater discharge, spill or overflow, or diversion/bypass system failure, immediately implement the Wastewater Discharge Emergency Response Plan (Section 02072).
- B. The Contractor will be charged for all costs associated with the Owner's efforts if they are dispatched to the discharge, spill, or overflow.

END OF SECTION



## SECTION 02072

### WASTEWATER DISCHARGE EMERGENCY RESPONSE PLAN

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Development of a Wastewater Discharge Emergency Response Plan, to be implemented in the event of a wastewater discharge, spill, or overflow to the environment.

##### 1.02 SUBMITTALS

- A. Emergency Response: Detailed implementation plan.

##### 1.03 WASTEWATER DISCHARGE EMERGENCY RESPONSE PLAN DEVELOPMENT

- A. The Contractor shall develop and submit to the Owner at least fifteen (15) working days prior to the start of construction, a written Wastewater Discharge Emergency Response Plan (WDERP) in a form similar to the attached sample at the end of this section. The WDERP shall be developed to respond to any construction related wastewater discharge, spill, or overflow to the environment. The Contractor is prohibited from discharging any wastewater or hazardous waste encountered during the construction project into the environment.
- B. The WDERP shall include at minimum, the following:
  - 1. Identification of environmentally-sensitive areas that could be affected by a wastewater discharge, spill, or overflow, including but not limited to, waterways, channels, catch basins, and entrances to existing underground storm drains.
  - 2. Development of an emergency notification procedure that complies with State and Federal requirements including but not limited to, Section 25-8-601(2), C.R.S. The Contractor shall designate primary and secondary representatives, their respective office telephone numbers, mobile phone numbers, and e-mail addresses shall be provided. Owner contacts shall also be listed.
  - 3. Identification of personnel and equipment/tools that will be utilized in the event of a wastewater discharge, spill, or overflow to the environment. Include an emergency response team with arrangements for backup personnel and equipment. The emergency response team shall be able to dispatch to the site 24 hours a day 7 days a week including weekends and holidays to respond immediately to any wastewater discharge, spill, or overflow to the environment related to the Work.
  - 4. Identification of downstream public water systems.
  - 5. Identify owners of stormwater inlets in immediate vicinity.
  - 6. Step-by-step procedures to contain, control, and minimize wastewater discharges, spills, or overflows to the environment.
- C. At the pre-construction meeting, the Contractor will be provided with a list of Owner representatives to contact in case of a wastewater discharge, spill, or overflow to the environment. These contacts shall be added to the WDERP.



- D. Contractor cannot begin work until the Owner has accepted the WDERP in writing. The complete and final copy of the WDERP shall be available on the job site at all times.
- E. It shall be the Contractor's responsibility to assure that all employees, including subcontractors, know and obey all emergency procedures included in the WDERP.
- F. The emergency response plan shall comply with local regulations, including the City of Arvada, CDPHE, Adams County, and all other applicable regulations.

#### 1.04 WASTEWATER DISCHARGE EVENT

- A. In the event of a wastewater discharge, spill, or overflow to the environment, the Contractor shall:
  - 1. Immediately implement the WDERP without direction from the Owner or the Engineer, to control and contain the discharge, spill, or overflow to the environment.
  - 2. Contact the Owner's personnel immediately. Information to provide shall include at minimum, the following:
    - a. Location of discharge, spill, or overflow to the environment
    - b. Estimated volume
    - c. Time discharge, spill, or overflow began
    - d. Duration if already terminated, or expected duration if in progress
    - e. Cause (if known)
    - f. Control measures implemented
    - g. Type of remedial and/or clean up measures taken
    - h. Description of affected or potentially affected sensitive areas such as waterways, channels, catch basins, and entrances to existing underground storm drains.

Based on this information, personnel will determine whether the discharge, spill, or overflow is contained, and whether or not the Owner's maintenance contractor should be dispatched to the site. If dispatched, the Contractor shall be responsible for all costs incurred by the Owner's maintenance contractor as associated with the discharge, spill, or overflow.
  - 3. Contact owner of stormwater inlets if discharge, spill, or overflow enters stormwater system.
- B. The Contractor shall, within 2 working days of the wastewater discharge, spill, or overflow, submit to the Owner a written Wastewater Discharge Incident Report (Figure 1).
- C. The Owner's representative will evaluate the suggested procedural changes to avoid further discharges, spills, or overflows and will instruct the Contractor through the Owner on changes. The Owner may institute further corrective actions, as deemed necessary.
- D. The Contractor shall observe and comply with all federal, state, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to wastewater discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing wastewater discharges, spills, or overflows to the environment, containing the sewage, recovery and legal disposal of sewage, any fines, penalties, claims and liability arising from negligent or willful discharge of wastewater, and violation of any law, ordinance, code, order, or regulation as a



result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Owner for any such sewage discharge, spill, or overflow, including any attorney fees and costs associated with defending any action against the Owner resulting from such discharge, spill or overflow.

- E. The Contractor shall not damage existing public and private improvements or interrupt existing services and/or facility operations which may cause a wastewater discharge, spill, or overflow to the environment. Any utility and/or improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.
- F. Once the discharge, spill, or overflow has been contained and the situation causing the event has been stabilized, the Contractor shall restore the affected areas to original condition.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION







## SECTION 02080

### PRECAST CONCRETE SECTIONAL MANHOLES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

###### A. Section Includes:

1. Precast reinforced concrete cylindrical sectional manholes, complete with openings, inserts, hardware, drains, covers, and frames.
2. Precast reinforced concrete manhole bases and tops.

##### 1.02 REFERENCES

###### A. ASTM International (ASTM), Standard Specifications:

1. A36 Structural Steel
2. A48 Gray Iron Castings
3. A615 Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
4. A955 Deformed and Plain Stainless Steel Bars for Concrete Reinforcement
5. A1064 Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
6. C150 Portland Cement
7. C478 Precast Reinforced Concrete Manhole Sections
8. C1821 Installation of Underground Circular Precast Concrete Manhole Structures
9. C990 Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
10. C443 Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
11. C913 Precast Concrete Water and Wastewater Structures

###### B. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Highway Bridges:

1. M198 Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
2. M199 Standard Specification for Precast Reinforced Concrete Manhole Sections

###### C. American Iron and Steel Institute (AISI).

##### 1.03 SUBMITTALS

###### A. Submit in accordance with Section 01300.

###### B. Product Data:

1. Descriptive details of the manufacturer's proposed standard products, including:
  - a. Precast manhole sections.
  - b. Precast roof slab or cone section.



- c. Precast base slab.
  - d. Minimum concrete 28-day compressive strength.
  - e. Cement certification.
  - f. Manhole cover and frame.
  - g. Technical data sheets for protective coatings inclusive of MSDS, grade of materials, and design thickness
  - h. Coatings Work Plan inclusive of surface preparation, mixing instruction, application procedures, curing procedures and schedules, and all other pertinent items for the successful application of coatings per the manufacturer's recommendations.
2. Shop drawings, including:
- a. Layout:
    - 1) Plan:
      - a) Orientation of eccentric manhole with laterals shown
      - b) Indicate location of latter rungs
      - c) Inserts, attachments, and openings
    - 2) Section:
      - a) Finished grade of manhole lid/cover/grate
      - b) Elevations of bottom of manhole and pipe invert(s)
      - c) Inserts, attachments, and openings
      - d) Joint types and number of risers.
  - b. Reinforcing steel location and concrete cover.
  - c. Buoyancy calculations

#### 1.04 QUALITY ASSURANCE

- A. Provide products of a manufacturer who has been regularly engaged in the design and manufacture of the product.

### PART 2 - PRODUCTS

#### 2.01 DESIGN CRITERIA

- A. General: ASTM C478, and AASHTO M199 and also:
  - 1. Structure live load: HS-20
  - 2. Dead and operating loads from any attached equipment.
  - 3. Handling and installation loads.
  - 4. Backfill material: Structural backfill.
  - 5. Base material: Crushed rock meeting No. 67 coarse aggregate standard in section 703 of CDOT specifications
  - 6. Buoyancy: Design manhole for groundwater up to grade, showing resistance to buoyancy with factor of safety of at least 1.2.
- B. Permanent bypass manholes and manholes downstream of the meter vault shall be designed, constructed, and installed in accordance with Metro Water Recovery standard details and specifications.

#### 2.02 PRECAST SECTIONS

- A. General:
  - 1. Manhole cone section: Eccentric; concentric not permitted



2. Cement: ASTM C150, Type II Portland cement, low alkali. See Section 800 of the City of Arvada Engineering Code of Standards and Specifications.
  3. Roof slab opening: Size to support the manhole cover frame.
  4. Lifting eyes: Provide for each section.
  5. Manhole Bases and Base Beams
- B. Precast concrete risers (barrel sections) and tops shall comply with ASTM C478.
- C. Manufacturer: Jensen Precast, Reno, NV.; Oldcastle Infrastructure, Atlanta, GA; or equal.

#### 2.03 JOINTS AND SEALANT

- A. Tongue and Groove Joint General: Joint shall conform to ASTM C990 and federal specification SS-S-210A.
- B. Sealant: Preformed, continuous rope gasket, protected by removable two-piece wrapper constructed from bitumen or butyl resins, blended with hydrocarbons and plasticizing compounds, and reinforced with inert mineral filler. Provide recommendation to Engineer, or Owner's Inspector, of cross-sectional dimensions that will produce an ASTM C990 compliant joint. Suggested products include Rub'r Nek LTM by Henry Co. or equal. No solvents, irritating fumes, or obnoxious odors.
- C. External Sealing Bands: Apply external sealant bands at joints for all concrete structures conforming to ASTM C877.
- D. Manufacturer: Henry® Co. or equal.

#### 2.04 EXTERIOR COATING

- A. Provide a coating of coal tar epoxy applied at 16 mils to 20 DFT in one coat to the entire exterior surface of all concrete structures.
- B. Acceptable coatings are Tnemec 46H413, Koppers Bituplastic #33, or equal.
- C. If applied at the manufacturer's site, repair any damage to coating created during the maintenance hole installation in accordance with manufacturer's instructions. Abrasive blast exterior to SP 13, fill all bung and surface holes with Tnemec Series 218 Mortarclad, or equal prior to applying coal tar coating.

#### 2.05 JOINT WRAP

- A. Joints shall be wrapped to prevent infiltration and exfiltration through the joints. Joint wraps shall conform to ASTM C877.
- B. Where joining two sections, or where two ends meet together, provide an overlap of approximately 2" and firmly press the overlapping strip onto the end of the underlying strip to seal the joint.
- C. Acceptable Manufacturers
1. Conwrap by ConSeal
  2. Rubr-Nek External Joint Wrap
  3. Or Approved Equal.

#### 2.06 FRAMES AND COVERS

- A. Material: Cast iron; ASTM A48, Class 30B.



- B. Marking: In raised letters, as specified and as shown on the Drawings.
- C. Coating: Bituminous paint, black.
- D. Size: 24-inch diameter or 30-inch diameter as shown on the Drawings.
- E. Pick Hole: open, side, 1-inch diameter as shown on the Drawings.
- F. Manufacturers
  - 1. 24-inch: Neenah R-1706/1741, Deeter 1258, East Jordan Iron Works 2420/2405-C with 2420 Z1 ring
  - 2. 30-inch: Deeter #1197, Neenah R-1798, or East Jordan Iron Works 2500.
- G. See Section 522.08 of the City of Arvada Engineering Code of Standards and Specifications for additional requirements.

## 2.07 WATERTIGHT FRAMES AND COVERS

- A. Material: Cast iron; ASTM A48, Class 35B.
- B. Marking: In raised letters, as specified and as shown on the Drawings.
- C. Coating: Bituminous paint, black.
- D. Size: 24-inch diameter or 30-inch diameter as shown on the Drawings.
- E. Manufacturers
  - 1. See Section 2.06.
- F. Watertight: Shall include bolt and gasket design to prevent water infiltration. Cover shall be bolted with a minimum quantity of six (6) 1/2"-13 SS bolts and washers.

## 2.08 LADDER RUNGS

- A. Cast-in Steps: Copolymer polypropylene plastic molded on ASTM A615 Grade 60 steel or ASTM A955 stainless steel reinforcing bar. Steps shall be one-half (1/2) inch diameter steel-reinforcing rods completely encapsulated in Copolymer Polypropylene. Rungs shall provide at least 12-inch-wide tread with non-slip surface. The minimum distance from the finished ground (street) surface to the first step shall be twenty-four (24) inches, and the maximum shall be thirty (30) inches. Refer to Section 522.04 City of Arvada Standard Details.
- B. Steps shall conform to OSHA requirements.
- C. Steps shall have a minimum tensile strength of 38,000 psi, minimum yield strength of 35,000 psi, and an elongation of not less than ten (10) percent in two (2) inches. Steps shall carry a load of 1,000 pounds when projected six (6) inches from the wall and 1,500 pounds when projected four (4) inches from the wall without permanent deformation.
- D. Manufacturer: M.A. Industries, or approved equal

## 2.09 MANHOLE BASES AND BASE BEAMS

- A. The minimum slab thickness shall be eight (8) inches. The minimum reinforcement shall be #4 reinforcing steel at twelve (12) inches on center, each direction or welded wire fabric, 4x4/W4xW4. The placing, fastening, splicing and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the Drawings, and the latest edition of "CRSI Recommended Practice for



Placing Reinforcing Bars.” Splicing of the welded wire fabric shall be by lapping one space and securing the wire mesh together. All wire fabric shall conform to the requirements of the “Wire Reinforcement Institute, Inc.”

- B. Manhole base beams shall be precast, reinforced concrete. The beams shall be twelve (12) inches wide by nine (9) inches deep by eight (8) feet long. Beams shall be set at a minimum of twelve (12) inches from the outside edge of the pipe.
- C. Cast-in-place concrete bases are acceptable and shall meet the standard details in the Contract Documents. See Section 03300 for additional requirements.
- D. Manhole benches shall be cast-in-place concrete or grouted in place. Precast benches are not allowed.

## 2.10 ACCESSORIES

- A. Boot connector:
  - 1. May be mechanically installed, cast-in or push-in.
  - 2. Shall provide a watertight connection meeting ASTM C923.
  - 3. Shall accommodate angular and lateral deflection with stress on the connector

## 2.11 SOURCE QUALITY CONTROL

- A. Precast Sections:
  - 1. Verify concrete compressive strength test results are satisfactory for the sections supplied.
  - 2. State the curing method. Identify the start and end dates for the sections supplied.
- B. Frames and Covers:
  - 1. Verify cast test bar tensile strengths are satisfactory.

## 2.12 INTERIOR PROTECTIVE COATINGS

- A. All precast manholes shall be field coated with an H<sub>2</sub>S resistant coating. Coating shall be suitable for application onto concrete surfaces. Coating shall be applied to the interior of all manholes to provide a protective surface against corrosive gases expected from normal wastewater collection operations
- B. Contractor or manufacturer shall follow the coating manufacturer’s preparation and application instructions for a proper application.
- C. City of Arvada Maintenance Holes:
  - 1. Type: Polymer
  - 2. Minimum Application Thickness: 500 mils or manufacturer’s recommendation for a complete system installation
  - 3. Acceptable Manufacturers:
    - a. CCI Spectrum: Spectrashield
    - b. No approved equal
- D. Metro Water Recovery Maintenance Holes and Vaults:
  - 1. Protective coatings shall meet the requirements of Metro Water Recovery’s standard specification 09 96 01 – Concrete Coating/Lining 100% Solids High-Build Epoxy.
  - 2. Type: 100% solids high build epoxy



3. Minimum Application Thickness: 125 mils
4. Acceptable Manufacturers:
  - a. Environmental Coatings, Inc. – Sewer Sheild -100 (trowel), -101S (spray), 101A, or 150
  - b. Warren Environmental, Inc. – 301-14 (01-04) Epoxy
  - c. Sauereisen, Inc. – SewerGard 210XHB Epoxy
  - d. Vortex Companies – Quadex Structure Guard
  - e. No approved equal

## PART 3 - EXECUTION

### 3.01 OPENINGS AND EMBEDMENTS

- A. The Contractor and manufacturer shall be responsible for the integration of embedded items in the quantity, materials, elevations, and locations required.
- B. Embedded pipes, conduits, sleeves, and other items intended to pass through walls and slabs shall be installed perpendicular to the surface unless noted otherwise.
- C. Openings in the structure shall be placed integrally at the time of casting. Unreinforced knockouts may be provided for post installed opening if approved by the Engineer. Openings shall not be placed by coring or cutting through reinforced concrete after the item has been cast.

### 3.02 INSTALLATION

- A. General: ASTM C1821 and also:
  1. Excavate and support excavations for manholes in accordance with Section 02300.
  2. Compact subgrade to a 12-inch minimum depth in accordance with Section 02300 or as otherwise shown on the Drawings.
  3. Provide a 12-inch crushed rock layer under the base slab and compact in accordance with Section 02300.
  4. Apply primer compatible with gasket to joint surfaces in accordance with manufacturer's instructions. Make all joints watertight with sealant gaskets.
  5. Concrete bases shall extend at least eight (8) inches below the bottom of the pipe and 2 inches above the top of pipe. The concrete manhole bench shall slope upward at least two (2) inches per foot from the top of the pipe. Refer to Section 523.06 City of Arvada Standard Details.
  6. Backfill around manholes with Structural Backfill material. Compact the backfill material in accordance with Section 02300 from the base up to final finish grade, over an area defined as being within a distance of 4 feet from the exterior walls.
  7. The top of the manhole structure shall be a minimum of twelve (12) inches and a maximum of eighteen (18) inches below the finished street or ground surface elevation. Concrete extension risers or collars shall be used to bring the manhole ring and cover up to the finished street or ground surface elevation. Accurately locate and place the manhole or hatch frames to within 1/8 inch vertical elevation in paved areas and to 1/2 inch in other areas. Coordinate the activities of all trades so that this tolerance is achieved.



Manholes five (5) feet deep or less shall be constructed as flat-top manholes. Refer to Section 522.04 of City of Arvada Standard Details.

8. Install the manhole cover in the frame. Machine the cover, if necessary, to obtain a solid fit, without rattling under load.
9. Locate eccentric manhole lids outside of the path of travel. Identify areas where this may not be achievable and coordinate with the Engineer prior to excavating for the manhole.

### 3.03 FIELD QUALITY CONTROL

- A. Verify all precast sections are continuously sealed with gaskets.
  1. Contractor shall receive favorable review of initial section and seals from the Engineer prior to placing subsequent sections.
- B. Verify all manhole covers fit quietly in the frames.

### 3.04 TEST FOR MANHOLES

- A. The Owner reserves the right to require a vacuum test on all new manholes installed, particularly in areas where the groundwater level is high or where there are questions regarding the integrity of the new barrel sections. All manholes shall be vacuum tested in accordance with ASTM C1244.
- B. All lift holes and any pipes entering the manhole shall be plugged prior to a vacuum being drawn and the drop over a specified time determined. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations. A vacuum of ten (10) inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off. The time shall be measured for the vacuum to drop to nine (9) inches of mercury. The manhole shall pass if the time for the vacuum reading to drop from ten (10) inches of mercury to nine (9) inches of mercury meets or exceeds the values indicated in the table provided in Section 524.02 of the City of Arvada Engineering Code of Standards and Specifications.

END OF SECTION



## SECTION 02140

### DEWATERING

#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. The Contractor shall perform site dewatering necessary to lower and control groundwater levels and hydrostatic pressures to allow excavation and construction to be performed properly under dry conditions. This Section includes materials, installation, maintenance, operation, and removal of temporary dewatering systems.
- B. The Contractor shall perform all treatment necessary for the legal disposal of all groundwater encountered. The cost of treatment shall be borne by the Contractor and no additional compensation will be made for inadequate treatment facilities. Based on available groundwater quality analyses, it is anticipated that a short-term remediation permit will likely be required from CDPHE to discharge water into local receiving bodies. Other options for dewatering activity discharge may be pursued at the Contractor's discretion.
- C. Dewatering operations shall be adequate to ensure the integrity of the finished project. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with the Contractor. The cost of repairing any damage to adjacent structures and restoration of facilities shall be the responsibility of the Contractor.

##### 1.02 REFERENCE SPECIFICATIONS, CODES AND STANDARDS

- A. The Contractor shall obtain and comply with the applicable discharge requirements of the agency that will receive project dewatering. This may include but is not limited to:
  - 1. Colorado Department of Public Health and Environment (CDPHE) – General Permit COG80000 – Discharges for Short-term (< 2 year) Construction Dewatering Activities

##### 1.03 CONTRACTOR SUBMITTALS

- A. The following shall be submitted in compliance with Section 01300:
  - 1. Before starting excavation, the Contractor shall submit Shop Drawings including a detailed plan, schedule, and description of the dewatering of excavations. The Shop Drawings shall include:
    - a) The proposed type of dewatering system
    - b) The arrangement, location, and depths of system components
    - c) A complete description of the equipment and instrumentation to be used, with installation, operation, and maintenance procedures
    - d) A description of the Contractor's means and methods for measuring groundwater levels and piezometric water levels
    - e) Documentation of proposed treatment methods including treatment equipment cutsheets and verification from equipment vendors that the proposed equipment can perform treatment of groundwater to meet the requirements of legal disposal
    - f) Methods for disposal of dewatering effluent



2. Before starting excavation, the Contractor shall submit copies of well installation permits, if required.
  3. Before starting excavation, the Contractor shall obtain and submit copies of the dewatering discharge permit obtained for the project Work.
  4. The Contractor shall submit copies of well destruction permits, if applicable.
  5. The Contractor shall be solely responsible for obtaining groundwater discharge permits. The Contractor must submit copies of these permits to the Owner.
- B. Contractor shall submit a daily report that includes the following information:
1. Groundwater levels and piezometric water levels in observation wells (if any).
  2. Changes in elevation of reference points to detect settlement in adjacent structures.
  3. The average dewatering flow rate.
  4. Water quality testing results as required by the approved groundwater discharge permit.

#### 1.04 QUALITY ASSURANCE

- A. The Contractor shall conduct a demonstration of its proposed system and shall provide verification that adequate personnel, materials, and equipment are available.
- B. The Contractor shall maintain adequate control to ensure that the stability of excavated and constructed slopes is not adversely affected by water, that erosion is controlled, and that flooding of excavations or damage to structures does not occur.
- C. Where critical structures or facilities exist immediately adjacent to areas of proposed dewatering, the Contractor shall establish reference points and shall observe the reference points at frequent intervals to detect any settlement which may occur. Frequency of intervals of detection testing shall be determined based on recommendations of the geotechnical engineer and the nature of the critical structure or facility and distance from the excavation, except that the minimum frequency shall be twice per working day (once at the beginning of the workday and once at the conclusion of the workday).

#### 1.05 DEWATERING EXPECTATIONS

- A. The Contractor shall assume that groundwater may be present in all excavations throughout the length of the project. The Contractor shall be prepared for dewatering activities and legally dispose of groundwater in compliance with all Federal, State, and Local regulations and the requirements of the permits relating to groundwater discharge.

#### 1.06 WATER QUALITY

- A. Water quality analytical results are provided as an appendix to these specifications. These are for reference only and not intended to reflect actual water quality at the time of dewatering. Contractor shall obtain additional samples and perform water quality testing as required by the groundwater discharge permit.

## PART 2 - MATERIALS

### 2.01 MATERIALS AND EQUIPMENT



- A. Dewatering includes well points, sump pumps, treatment facilities, temporary pipelines for water disposal, rock or gravel placement, observation wells, and other means including standby pumping equipment maintained on the jobsite continuously.
- B. The Contractor shall provide piezometers for monitoring groundwater levels or other instruments and measuring devices, as required.
- C. The Contractor shall be prepared to collect water samples and coordinate water quality testing with a certified laboratory as required by the groundwater discharge permit.

## PART 3 - EXECUTION

### 3.01 GENERAL REQUIREMENTS

- A. The Contractor is responsible for compliance with the approved dewatering discharge permit, City of Arvada, and CDPHE requirements for any discharge of groundwater to the environment. Before starting dewatering operations, the Contractor shall obtain the required permits and authorization, as required, for the disposal of groundwater. The Contractor shall comply with all applicable sampling, testing, monitoring, and reporting requirements.
- B. The Contractor shall maintain an adequate system to lower and control the groundwater to permit excavation, construction of structures, and placement of fill materials to be performed under dry conditions.
- C. Sufficient dewatering equipment shall be installed to pre-drain the water-bearing strata below the bottom of foundations, drains, water lines, sewer lines, and all other excavations.
- D. The hydrostatic head in water-bearing strata below pipelines, appurtenances, foundations, and all other excavations shall be reduced to ensure that the water level is a minimum of two (2) feet below the excavation surface at all times.
- E. The system shall be placed into operation before excavation below groundwater level is started. The system shall be operated continuously 24 hours per day, 7 days a week until pipelines, appurtenances, and structures have been constructed, fill materials have been placed, and dewatering is no longer required.
- F. The site shall be graded to facilitate drainage, and runoff shall be diverted from the excavation. Surface runoff shall be directed to local stormwater collection or collected in shallow ditches around the perimeter of the excavation, drained to sumps, and pumped or drained by gravity away from the excavation.
- G. Dewatering shall at all times be conducted to preserve the undisturbed bearing capacity of the subgrade soils at proposed bottom of excavation.
- H. If foundation soils are disturbed or loosened by the upward seepage of water or an uncontrolled flow of water, the affected areas shall be excavated and replaced with drain rock at no additional cost to the Owner.
- I. Flotation of structures and facilities shall be prevented by maintaining a positive and continuous removal of water.



- J. If well points or wells are used, they shall be adequately spaced to provide the necessary dewatering and shall be sandpacked and/or other means shall be used to prevent pumping of fine sands or silts from the subsurface. A continuous check shall be maintained to ensure that the subsurface soil is not being removed by the dewatering operation.
- K. Water and debris shall be disposed of in a legal and suitable manner in compliance with dewatering discharge permit requirements and Section 02050, without damage to adjacent property. No water shall be drained into work built or under construction. Before disposal, water shall be treated in accordance with permit requirements. Before disposal, water shall be filtered to remove sand and fine- sized soil particles.
- L. The release of groundwater to its original level shall be performed in a manner that avoids disturbance of natural foundation soils, prevents disturbance of compacted backfill, and prevents flotation or movement of structures.

END OF SECTION



## SECTION 02200

### SITE PREPARATION

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Site preparation shall consist of all clearing, grubbing, and related work necessary to prepare the project site for construction operations.
  - 2. No open burning of debris, lumber, or other scrap will be permitted.

#### PART 2 - PRODUCTS (NOT USED)

#### PART 3 - EXECUTION

##### 3.01 DEMOLITION

- A. Demolish and remove any fences, posts, poles, or other structures from within the project site, areas to be cut or areas to receive fill, and pipeline alignments.

##### 3.02 CLEARING

- A. Clearing shall consist of the removal of shrubs, grasses, debris, and rubble from the project site which will obstruct or otherwise impede construction operations.
- B. Clear the following areas:
  - 1. Trenching and excavating extents within the area of Work.
  - 2. Construction staging areas
  - 3. Material and equipment storage areas if not included in the construction staging areas

##### 3.03 GRUBBING

- A. Grubbing shall consist of the removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the construction area. This material, together with logs and other organic debris, shall be excavated and removed to a depth of not less than 18 inches below the original surface level of the ground in areas indicated as construction areas under this Contract, such as areas for structures, pavement, fills. Depressions made by grubbing shall be filled with structural backfill material and compacted to make the surface conforms with the original adjacent surface of the ground unless further excavation is required. Grub borrow areas to the extent necessary to obtain material free of stumps and roots.

##### 3.04 DISPOSAL

- A. Dispose of remaining vegetation and debris in accordance with Section 02050.

END OF SECTION



## SECTION 02300

### EARTHWORK

#### PART 1 - GENERAL

##### 1.01 SUMMARY

###### A. Section Includes:

1. Perform all excavation, trenching, shoring, dewatering, backfilling, compaction, grading, and disposal of excess material necessary or required for the construction of the work as covered by these Specifications and indicated on the Drawings. The excavation shall include, without classification, the removal and disposal of all materials of whatever nature encountered, including water and all other obstructions that would interfere with the proper construction and completion of the required work.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 300.
- B. American Association of State Highway and Transportation Officials (AASHTO)
1. AASHTO T99 Standard Method of Test for Moisture-Density Relations of Soils
  2. AASTO T193 Standard Method of Test for The California Bearing Ratio
- C. ASTM International (ASTM)
1. ASTM C33 - Standard Specification for Concrete Aggregates
  2. ASTM C131 - Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
  3. ASTM C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  4. ASTM D448 - Standard Classification for Sizes of Aggregate for Road and Bridge Construction
  5. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft<sup>3</sup>).
  6. ASTM D1556 - Standard Test Method for Density of Soil in Place by the Sand-Cone Method.
  7. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft<sup>3</sup>).
  8. ASTM D1883 - Standard Test Method for California Bearing Ratio (CBR) of Laboratory-Compacted Soils
  9. ASTM D2167 - Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
  10. ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
  11. ASTM D2487 - Standard Classification of Soils for Engineering Purposes (Unified Soil Classification System).



- 12. ASTM D2844 - Standard Test Method for Resistance R-Value and Expansion Pressure of Compacted Soils
  - 13. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 14. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).
  - 15. ASTM 3744 - Standard Test Method for Aggregate Durability Index
  - 16. ASTM D4253 - Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
  - 17. ASTM D4254 - Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
  - 18. ASTM D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  - 19. ASTM D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis
  - 20. ASTM D7928 - Standard Test Method of Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis
- D. Colorado Department of Health and Environment (CDPHE) Design Criteria for Domestic Wastewater Treatment Works
  - E. Municipal Government Pavement Engineers Council (MGPEC)
  - F. Colorado Department of Transportation (CDOT) Standard Specifications (CDOT Standard Specifications)
  - G. Standards listed below apply when no other more stringent standard is referenced. The order of precedence is as follows:
    - 1. City of Arvada Engineering Code of Standards and Specifications
    - 2. Adams County Development Standards and Regulations
    - 3. CDPHE Design Criteria for Domestic Wastewater Treatment Works
    - 4. CDOT Standard Specifications

### 1.03 DEFINITIONS

- A. Site: Area of Work as depicted in the Drawings.
- B. Fill: Earth used to fill holes, pits, or depressions necessary to bring the final grade up to the specified elevation or contours.
- C. Pipe Bedding: Zone of material that extends from six (6) inches below the pipe to 12 inches above the crown of the pipe.
- D. Trench Zone: Zone of material that extends from the top of the pipe bedding to the bottom of the pavement subgrade in pavement areas or to the top of the trench in earth areas.
- E. Subgrade: Zone of material that is improved to create a stable, suitable platform for subsequent layers.
  - 1. Finished Subgrade: Finished subgrade indicates the top of the subgrade section in a cut scenario.
- F. Over excavation: Excavation beyond the limits shown in the Drawings.



- G. Relative Compaction: In-place dry density divided by the maximum dry density laboratory compaction expressed as percentage.
- H. Rock Excavation:
  - 1. Rock excavation shall consist of igneous, metamorphic, and sedimentary rock which cannot be excavated without blasting or with the use of rippers and all boulders or other detached stones each having a volume of one cubic yard or more, as determined by physical or visual measurements. Unless specified in the Contract, rock excavation is material that meets one of the field test criteria outlined in Section 360 of the Arvada Engineering Code of Standards and Specifications to be conducted by the Contractor.

#### 1.04 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Contractor shall not excavate, construct embankments, or fill until all the required submittals have been reviewed and approved.
- C. Submittals for Informational Purposes:
  - 1. Excavation Protection Plan: Identify location, extent, and type of excavation protection. Describe sheeting, shoring, and bracing materials and installation required to protect excavations and adjacent structures and property; include structural calculations for cuts 20 feet, or greater, to support plan. Structural calculations for cuts 20 feet, or greater, shall be done under the supervision of a Professional Engineer experienced in the design of this Work and licensed in the State of Colorado.
  - 2. Dewatering Plan: submit dewatering plan in accordance with Section 02140.
- D. Product Data:
  - 1. Potholing Report.
  - 2. Gradation report(s) for bedding material and import backfill materials.
  - 3. Test results on bedding and import material indicating Sand Equivalent, R-value, Durability Index, Liquid Limit, Plastic Limit and Plasticity Index.
  - 4. Compaction Reports indicating results from quality control testing.
  - 5. Flow-fill and flashfill: Mix design and laboratory testing data verifying compliance with air content, slump, strength and removability (RE) requirements.
  - 6. Geotextile fabric indicating fabric and installation procedure
  - 7. Pipe manufacturer's data regarding bedding methods of installation and general recommendations.
- E. Samples and Test Results:
  - 1. Furnish, without additional cost to the Owner, such quantities of bedding material and Import materials, listed herein, as may be necessary for testing. All testing and retesting to meet requirements and specifications shall be at the Contractor's expense.
  - 2. Test bedding and import materials proposed for use demonstrating that the materials conform to the specified requirements. Materials testing shall be performed by a qualified Geotechnical Engineer working under the direction of a Colorado Registered Professional Engineer. Perform tests no more than 60 Calendar Days prior to submission. Submit results to the Project Engineer at least ten (10) days prior to delivery.

3. Submit certifications for each source of all imported/borrow materials indicating the location where the imported/borrow material will be obtained, including the street address, town, lot and block, county and state, and a brief history of the site which is the source of the material.
    - a. Owner may request a copy of the material delivery ticket at delivery of each load each day.
  4. Notify the Project Engineer a minimum of 48 hours before obtaining samples. The Project Engineer may choose to be present while samples are obtained.
- F. Testing Agency Qualifications
1. The Testing Agencies' submittal shall include, at a minimum, the inspection certificate of the Testing Agency, within the last two (2) years, by a third party such as the American Association for Laboratory Accreditation, the National Voluntary Laboratory Accreditation Program or the Cement and Concrete Reference Laboratory, as appropriate; and a copy of the Testing Agencies Quality Assurance Program as outlined in Section 1.05.F.

#### 1.05 QUALITY ASSURANCE / QUALITY CONTROL

- A. All material furnished and all work performed shall be subject to rigid inspection. No material shall be delivered to the site until it has been favorably reviewed by the Project Engineer and sample test results provided. All material furnished and all work performed shall be subject to inspection, and no material shall be delivered to the site until it has been favorably reviewed by the Project Engineer.
- B. Source Quality Control: Furnish all bedding material from a single source throughout the work unless otherwise approved.
- C. Field Quality Control:
1. All testing shall meet minimum testing requirements as outlined in Section 322.00 of the Arvada Engineering Code of Standards and Specifications.
  2. The Contractor shall hire an independent soil testing laboratory approved by the Owner to perform the following tasks for flatwork, pipeline installation, non-structural fill or items not requiring special inspection as outlined under Special Inspections:
    - a. Perform a Particle-Size Distribution (Gradation) Analysis every 5,000 cubic yards of materials delivered.
    - b. Test Pipe Bedding and Trench Zone material for quality and in-place density requirements specified herein. Contractor shall test every 200 feet of trench.
    - c. Where Special Inspections are not required, test fill materials to verify conformance with material quality every 5,000 cubic yard of materials delivered.
  3. The Person responsible for and is in direct supervision of all the Quality Control testing shall be a Registered Professional Engineer in the State of Colorado and practicing in the field. If any materials furnished or the work performed by the Contractor fails to meet the Specifications, such deficiencies shall be reported to the Owner's Inspector immediately. Preliminary written field reports and/or test results shall be given to the Owner's Inspector immediately after they are performed. Final reports shall be forwarded to the Owner's Inspector no later than one week following the testing.



4. Results of all tests, including failing tests, shall be reported. When the work fails to pass tests or meet specifications, additional tests shall be taken as directed by the Project Engineer. All testing and retesting services shall be at the expense of the Contractor except for City projects where the cost of testing will be covered by the Owner unless otherwise noted in the Special Conditions for the project. Testing agency personnel are not authorized to stop work or to alter, relax or release any requirements of these Specifications, or to approve, accept or reject any portion of the Work.
  5. Material that does not meet the gradation, quality or compaction requirements shall be removed and replaced with material that does comply at no additional cost to the Owner.
- D. Field Quality Assurance
1. The Project Engineer will:
    - a. Review materials, not covered under Special Inspections.
    - b. Review results of the Contractor's independent testing laboratory tests and request additional testing at the Project Engineer's discretion.
  2. The Contractor shall provide access as required throughout the earthwork process for observation and testing purposes. The Contractor shall not proceed with work until the certified materials Testing Agency is on site for observation and testing, unless approved by the Owner or Project Engineer. Refer to Section 320.00 of the Arvada Engineering Code of Standards and Specifications for further requirements.
  3. Preliminary written field reports and/or test results shall be given to the Owner's Inspector immediately after they are performed. Final reports shall be forwarded to the Owner's Inspector no later than one week following the testing.
- E. Special Inspections:
1. The Contractor shall be responsible for special inspections in accordance with the building code IBC Chapter 17 Section 1705.6. Special inspection is required for work related to constructing buildings, structures, structural work, and roadways, and includes but is not limited to:
    - a. Verifying materials below foundations are adequate to achieve the design bearing capacity requirements.
    - b. Verifying excavations are to the depth identified in the Drawings and the bottom of excavations are suitable materials.
    - c. Perform classification and testing of compacted fill materials.
    - d. Verifying materials meet quality, lift thickness, and in-place density requirements specified herein.
    - e. Prior to placement of compacted fill, inspect subgrade and verify the site has been prepared properly.
  2. Testing shall be performed at the frequency listed below or as otherwise established by Section 322.00 of the Arvada Engineering Code of Standards and Specifications, whichever is more stringent.
    - a. Project Engineered Fill: Test every 500 square feet for each 2 feet of fill.
    - b. Subgrade: Test every 200 square feet where in-place materials have been disturbed and recompacted or as recommended by the Project Engineer.
    - c. Structural Backfill:

- a) Test every 200 square feet of building footprint, with no less than two tests per structure.
- b) Test every 200 cubic yards of material placed within 10 feet around the building.

F. Testing Methods:

1. Testing shall conform to the requirements of the Arvada Engineering Code of Standards and Specifications Section 321.00.
2. Agencies testing soil and rock shall meet the requirements of ASTM D 3740. All testing agencies shall meet the requirements of ASTM E 329.
3. Conduct sampling and testing in general accordance with the FHWA Report No. FHWA NHI-01-031 (Mayne and others, 2002) and the AASHTO (1988) Manual on Subsurface Investigations.
4. In-situ testing per Tables 3-2 and 3-3 of the CDOT Geotechnical Design Manual.
5. Classify rock core samples in accordance with the International Society of Rock Mechanics (ISRM) publication, Suggested Methods for the Quantitative Description of Discontinuities in Rock Masses (ISRM, 1981).
6. Follow applicable testing procedures outlined in the current AASHTO and ASTM Standards specified in the CDOT Laboratory Manual of Test Procedures.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Earthwork materials shall be stored in a location approved by the jurisdiction where the storage area is located and by the Owner.
- B. Stockpile material so that it's not contaminated, does not cause damage, does not become saturated, and is identifiable.
- C. Storage of Excavated Materials:
  1. Neatly place excavated materials far enough from the excavation to prevent stability problems. Keep the materials shaped to cause the least possible interference with drainage.
  2. Excavated materials unsuitable for backfill shall be disposed of immediately.

1.07 SUBSURFACE INVESTIGATIONS

- A. Geotechnical investigations for design purposes for this project were completed by Lithos Engineering in a report dated MM DD, YYYY. A copy of this report is included in the Appendix of these specifications.

1.08 ADDITIONAL SAFETY RESPONSIBILITIES

- A. The Contractor shall select, install, and maintain shoring, sheeting, bracing, and sloping as necessary to maintain safe excavations. The Contractor shall be responsible for ensuring such measures: (1) comply fully with 29 CFR Part 1926 OSHA Subpart P Excavations and Trenches requirements, (2) provide necessary support to the sides of excavations, (3) provide safe access to the Geotechnical Engineer's sampling and testing within the excavation, (4) provide safe access for backfill, compaction, and compaction testing, and (5) otherwise maintain excavations in a safe manner that shall not endanger property, life, health, or the project schedule. All earthwork shall be performed in strict accordance with applicable law, including local ordinances, and applicable OSHA requirements.



- B. The Contractor shall be responsible for the safety of his/her workers and shall comply with safety and health standards of authorities having jurisdiction and any other appropriate safety and health codes.

PART 2 - PRODUCTS

2.01 MATERIAL DEFINITIONS

- A. Engineered Fill: Engineered fill may be Imported Soil or Native Soil that has been processed to meet the below requirements.
  - 1. Native Soil: Native soil shall have organic material less than 3 percent by weight. It shall not contain rocks or lumps larger than 3 inches in greatest dimension or more than 15 percent of the material larger than 1 ½ inches and be free of organics, debris, and other deleterious materials. Wet, soft, or frozen material, organic matter, asphalt chunks, or other deleterious substances shall not be used as backfill. Refer to section 360.01 of the Arvada Engineering Code of Standards and Specifications.
  - 2. Imported Soil: Imported soil shall meet the general gradation of “Class 1 Structure Backfill Material” as specified in Section 703.09 of the CDOT Standard Specifications for Road and Bridge Construction.
    - a. This material shall have a liquid limit not exceeding 35 and a plasticity index of not over six when determined in conformity with AASHTO T 89 and T 90 respectively.

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inch	100
No. 4	30 to 100
No. 50	10 to 60
No. 200	5 to 20

- B. Sand:
  - 1. Sand gradation shall have 90 percent passing No. 4 sieve and less than 3 percent passing a No. 200 sieve with a minimum sand equivalent (SE) of twenty (20). Well-graded sand or squeegee sand must comply with Section 367.00 of the Arvada Engineering Code of Standards and Specifications.
  - 2. Well-graded sand:

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	70 to 100
No. 8	36 to 93
No. 16	20 to 80
No. 30	8 to 65
No. 50	2 to 30
No. 100	1 to 10
No. 200	0 to 3

3. Squeegee Sand:

Sieve Size	Percent Passing
3/8 inch	100
No. 200	0 to 5

C. Flow-Fill:

1. Flow-fill shall consist of a controlled low-strength, self-leveling concrete material composed of various combinations of cement, fly ash, aggregates, water, chemical admixtures and/or cellular foam for air-entrainment.
  - a. Air Content, ASTM C231: 6% minimum
  - b. Compressive Strength, ASTM D4832: 50psi-150psi at 28 days
  - c. Slump, ASTM C143: 7" - 10"
  - d. Removability Modulus, RE (as defined in MGPEC Section 19.2C): 1.5 maximum
2. When flow-fill is used for backfilling abandoned structures, the compressive strength shall not exceed 200 psi at 28 days.

D. Flashfill:

1. Flashfill shall consist of a controlled low-strength, self-leveling cementitious material composed of various combinations of fly ash, water, chemical admixtures and/or cellular foam for air-entrainment. No aggregate or sand is usually needed. It shall have a minimum specified air content to provide suitable resistance to frost heaves. Flashfill may generally be placed without lift thickness limits.
  - a. Air Content, ASTM C231: 15% Minimum
  - b. Compressive Strength, ASTM D4832: 100psi - 300psi at 28 days
  - c. Slump, ASTM C143 (one lift, no rodding): 8"-11"
  - d. Spread, ASTM D6103: 8"-12" or greater
  - e. Removability Modulus, RE (as defined in MGPEC Section 19.2C): 1.5 maximum
2. When flashfill is used for backfilling abandoned structures, the compressive strength shall not exceed 200 psi at 28 days.

E. Crushed Rock:

1. Crushed rock can be used as an alternative bedding material in the presence of groundwater if approved by the project Geotechnical Engineer. Crushed Rock shall be ¾" maximum conforming to the following gradation and rock quality requirements:

Sieve Size	Percent Passing
1 inch	100
3/4 inch	90 to 100
1/2 inch	30 to 60
3/8 inch	0 to 20
No. 4	0 to 5
No. 8	0
100 Revolutions	15 maximum
500 Revolutions	52 maximum



- F. Fine Aggregate:  
Material that complies with the gradation of "Fine Aggregate" as specified in Section 703.01 of CDOT Standard Specifications for Road and Bridge Construction.

<u>Sieve Size</u>	<u>Percent Passing</u>
3/8 inch	100
No. 4	95 to 100
No. 8	80 to 100
No. 16	50 to 85
No. 30	25 to 60
No. 50	10 to 30
No. 100	2 to 10

- G. Stabilization Rock:
1. Material which shall be placed in over-excavation areas, areas with unsuitable in situ material, or areas with a high water table in order to stabilize the existing material. Gradation of stabilization material shall be determined on a case by case basis and shall be approved by the project Geotechnical Engineer and shall be used in areas of unstable subgrade and as coordinated with the Project Engineer.
  2. Uniformly graded rock ranging from ¾ inch to 1-½ inch.

<u>Sieve Size</u>	<u>Percent Passing</u>
2 inches	100
¾ inch	0 to 10

- H. Geotextile Fabric:
1. Non-woven, non-biodegradable, needle punched geotextile comprised of polypropylene fibers. Install with a minimum 12-inch overlap, unless otherwise shown in the Drawings.

Apparent Opening Size	70	U.S. Sieve
Permittivity	1.7	sec <sup>-1</sup>
Flow Rate	135	gal/min/ft <sup>2</sup>
Grab Tensile Strength	120	lbs
Tensile Elongation	50	%
UV Resistance @ 500 hrs	70	%

2. Acceptable Manufacturers:
  - a. TC Mirafi; Model 140N; or Equal.

## 2.02 TRENCH BACKFILL

- A. Trench Backfill may be native soil or imported soil meeting the above requirements and conforming to Section 368 of Arvada Engineering Code of Standards and Specifications. For trenches beneath pavements and flatwork, backfill from a minimum of 1 foot below grade to grade shall consist of material meeting the requirements for AASHTO class A-1 or A-2 material.

- B. The following special trench backfill requirements shall apply for utilities located in existing or planned road right-of-ways.
  - 1. Constrained Areas - Areas in which proper backfill compaction cannot be achieved such as utility crossing, under curb and gutter, or any area identified by the Certified Materials Tester or Construction Inspector, shall be backfilled with Controlled Low Strength Material (CLSM) "flow-fill" as defined above.
- C. Materials used above the subgrade level shall comply with the requirements for sub-base and base course materials as defined Section 02721.
- D. Bracing installed to prevent cave-ins shall be withdrawn in a manner that shall maintain the desired support during the backfill operations. Driven sheet pilings shall be cut off at or above the top of pipe, and the portion below the cut-off line shall be left in the ground.
- E. Adams County Trench Backfill Requirements
  - 1. The following requirements shall be met when backfilling trenches within Adams County right-of-way.
  - 2. Adams County generally follows the "PIPE In TRENCH" detail in CDOT M-206-1, Excavation and Backfill for Structures, with the following clarifications and additional requirements under pavement.
    - a. Lower trench backfill material from bottom of trench (top of bedding) up to 1 foot above top of pipe shall be CDOT Structural Backfill (Class 1).
    - b. Upper trench backfill material from 1 foot above top of pipe up to top of subgrade shall be predominantly granular soils by classification (A-1, A-2-4, A-2-5, A-2-6, A-2-7, and A-3) and meet the following additional requirements:
      - 1) A maximum of 35 percent of material by dry weight passing the No. 200 sieve.
      - 2) Maximum Liquid Limit of 60
      - 3) Maximum Plastic Index of 25
      - 4) The upper 2 feet of backfill material below the subgrade elevation shall have a resistance value of at least 40 when tested by the Hveem Stabilometer or the equivalent resilient modulus.
      - 5) The material shall be tested and compacted in accordance with the requirements for CDOT Structural Backfill (Class 2).
    - c. The native soil excavated from the trench may be used for backfilling if it meets all requirements and is of acceptable quality.
    - d. CDOT Structural Backfill (Class 1) may be used to backfill the full height of the trench.
    - e. Flow-Fill may be used to backfill any part of the trench height.
    - f. Trenching for sanitary sewer removal may be backfilled with material that meets the requirements of Part 3 above, CDOT Structure Backfill (Class 1), Flow-Fill, or some combination thereof.
- F. For sections of pipe owned by Metro Water Recovery (Metro), Contractor shall use acceptable trench backfill (embedment) materials as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Section 2.1.B of this specification for additional requirements.



## 2.03 PIPE BEDDING

- A. Bedding material for all FRP, PVC, HDPE, CUP, and DIP (“flexible pipe”) shall be fine aggregate, well-graded sand, or squeegee sand as defined above.
- B. Bedding material for all RCP shall consist of materials that meet the gradation of “No. 67 Coarse Aggregate” as specified in Section 703.00 of the CDOT Standard Specifications for Road and Bridge Construction unless otherwise recommended by the Geotechnical Project Engineer and approved by the Owner. RCP shall be bedded to springline at a minimum.
- C. Crushed rock can be used as an alternative bedding in the presence of groundwater. Crushed Rock shall be  $\frac{3}{4}$ ” maximum conforming to the gradation and rock quality requirements described above.
- D. Excavated native soil, meeting the above requirements, is not suitable to be used as pipe bedding material.
- E. All pipe shall be installed with sufficient bedding material to provide a minimum of six (6) inches of separation between the subsoil and the barrel of the pipe. Bedding material shall be placed to a minimum depth of twelve (12) inches above the barrel section of all flexible pipes. Bedding material shall be worked under pipe to provide uniform haunch support.
- F. For sections of pipe owned by Metro, Contractor shall use acceptable trench bedding materials as defined in Metro’s standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Sections 2.1.A and 2.1.C of this specification for additional requirements.

## 2.04 STRUCTURAL BACKFILL

- A. Structural backfill is earthen material that is installed around and over any structure shown on the approved plans. Structural backfill may be imported soil, flow-fill, or flashfill as specified in the material definitions above.

## 2.05 WATER

- A. The water used shall be reasonably free of objectionable quantities of silt, oil, organic matter, alkali, salts, and other impurities.

## 2.06 TRACER WIRE

- A. Per Colorado Senate Bill 18-167, all new underground facilities, including laterals and services up to the structure or building being served, require tracer wire.
- B. Tracer wire shall be #12 AWG Copper Clad Steel insulated by high molecular weight high density polyethylene (HMWPE) and shall be installed on all pipe, including at least one carrier pipe inside a casing pipe. 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 ends of the casing pipe. Attach wire with 2-inch-wide tape, taped at 12-inch intervals. Property ground tracer wire at all dead ends and stubs. Tracer wire shall follow the uniform color

code per American Public Works Association (APWA). Refer to Section 400.20 Arvada Engineering Code of Standards and Specifications.

1. Provide: Copper Clad Steel Tracer Wire by KrisTech, or Solid Tracer Wire by T. Christy's; or equal.
  2. Manufacturers: KrisTech West Coast; T. Christy Enterprises, Inc.; or equal.
  3. Splice Kit: '3M' Type DBY-6 Low Voltage Direct Bury Splice
  4. Copper Split connector: Burndy KS17 copper or equal
  5. Test Stations: CP Test Services, Glenn Series Glenn-4 with locking lid, 2 7/8" X 4 1/2" OR approved equal.
- C. For sanitary sewer mains, tracer wire shall meet the requirements above and be taped to the carrier pipe before installation of carrier pipe supports and installed in the steel casing along with the carrier pipe. A test station shall be installed for the tracer wire in the Arvada ROW near each end of the steel casing pipe. A separate, electrically isolated, tracer wire shall be welded to each end of the casing.
- D. A qualified tester shall verify continuity of tracer wire and a report shall be submitted to the Owner and Project Engineer with other record drawings. Uninterrupted continuity shall be tested in accordance with the requirements of Section 420.20 - Tracer Wire and Warning Tape and Marker Posts of Arvada Engineering Code of Standards and Specifications and is a requirement for construction acceptance into warranty.
- E. For sanitary infrastructure owned by Metro, Contractor shall provide tracer wire meeting the following requirements:
1. Materials:
    - a. Wire:
      - 1) HDPE Insulation suitable for direct bury
      - 2) 12 GA AWG
      - 3) Solid Core
    - b. Test Station:
      - 1) Copperhead Industries Snakepit Test Station or approved equal
      - 2) Green Lid
    - c. Wire nuts: Waterproof type
    - d. Split Bolts: Brass
    - e. Splice Kit: '3M' Tyle DBY-6 Low Voltage Direct Bury Splice or Equal

## 2.07 WARNING TAPE

- A. All domestic water lines shall have a 2-inch-wide, inert, fade-resistant plastic film resistant to acids, alkalis, and other components likely to be encountered in soil. Warning Tape colors shall follow the uniform color code per American Public Works Association (APWA) and shall not be placed more than 24 inches above top of pipe.
1. Provide: Terra Tape® Standard; T. Christy Enterprises, Inc. T A.ND.3-COLOR-CODE; or equal.
  2. Acceptable Manufacturers: Reef Industries, Inc.; T. Christy Enterprises, Inc.; or equal.
  3. Color code per American Public Works Association (APWA).
- B. All sanitary pipelines shall have a six (6) inch wide, detectable, magnetic warning tape installed twelve (12) to eighteen (18) inches above all pipe, on top of the



bedding, for the purpose of warning of location of buried pipeline. For sanitary sewers, the marker tape shall be green in color with black lettering in a continuously repeating pattern with the words "Caution Sanitary Line Below".

- C. For sanitary infrastructure owned by Metro, Contractor shall provide tracer wire meeting the following requirements:
  - 1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
  - 2. Replace or install tape for existing utilities within the excavation area.
  - 3. Fabrication:
    - a. Legend: Preprinted and permanently imbedded
    - b. Message continuous printed
    - c. Tensile strength: 1750 psi
    - d. Minimum thickness: 4 mils
    - e. Width: 6 inches
  - 4. Manufacturers:
    - a. Reef Industries, Terra Tape
    - b. Allen, Markline
  - 5. Sanitary Pipelines Marking Schedule:
    - a. Minimum letter height: 1 ¼ inch
    - b. Color: Green with black letters
    - c. Legend:
      - 1) First line: "CAUTION CAUTION CAUTION"
      - 2) Second line: "BURIED SEWER LINE BELOW"

## 2.08 MARKER POST

- A. All sanitary structures that are not located in a hard paved surface, asphalt or concrete, shall have a triview marker post. Marker posts for wastewater shall be green. Refer to Section 522.12 of the Arvada Engineering Code of Standards and Specifications.
- B. Marker posts shall include on all three sides, a decal with City of Arvada's logo, Utilities phone number 303-898-7780 and the universal "Call Before You Dig" symbol.
  - 1. Acceptable Manufacturers: Rhino Industries Decal - Rhino SD-6308K-R or equal.
- C. For domestic water lines, marker posts shall be blue. Refer to Section 420.20 of the Arvada Engineering Code of Standards and Specifications.
- D. For sanitary structures owned by Metro, Contractor shall use Brady-Stake, Carsonite, or equal for marker posts. Marker posts shall be set in an 8 inch diameter by 18 inch deep concrete foundation.

## PART 3 - EXECUTION

### 3.01 GENERAL CONSTRUCTION REQUIREMENTS

- A. Barriers: Barriers shall be placed at each end of all excavations and at such places along excavations as may be necessary to warn all pedestrian and vehicular traffic of such excavations.

- B. Access: Free access must be maintained to all fire hydrants, water valves and meters, and private driveways.
- C. Temporary Pavement: Place temporary pavement or first lift of permanent pavement on trenches in existing streets within 24 hours after the trench has been backfilled. Refer to Section 02740 for paving requirements. Maintain temporary pavement until permanent pavement is to be placed.
- D. Preparation: Identify required lines, levels, contours, and datum locations. Protect plant life, lawns, rock outcropping and other features remaining as portion of final landscaping. Protect benchmarks, existing structures, fences, sidewalks, paving, and curbs from excavating equipment and vehicular traffic. Maintain and protect above and below grade utilities indicated to remain. Provide traffic control and detours as necessary per Sections 01500 and 01550.

### 3.02 CONTROL OF WATER

- A. Prepare and submit a Dewatering Plan in accordance with Section 02140.

### 3.03 EXISTING UTILITIES

- A. General: The known existing utilities and pipelines are shown on the Drawings in their approximate location. The Contractor shall exercise care in avoiding damage to all utilities as he or she will be held responsible for their repair if damaged. There is no guarantee that all utilities or obstructions are shown, or that locations indicated are accurate. Utilities are piping, conduits, wire, cable, ducts, manholes, pull boxes, and the like, located at the project site.
- B. Potholing:
  - 1. Contact all affected utility owners and request them to locate their respective utilities prior to the start of "potholing" procedures. The utility owner shall be given 7 days written notice prior to commencing potholing. If a utility owner is not equipped to locate its utility, the Contractor shall locate it.
  - 2. Clearly paint the location of all affected utility underground pipes, conduits, and other utilities on the pavement or identify the location with suitable markers if not on pavement. In addition to the location of metallic pipes and conduits, non-metallic pipe, ducts, and conduits shall also be similarly located using surface indicators and detection tape if present and shall then be similarly marked.
  - 3. After the utility survey is completed, commence "potholing" to determine the actual location and elevation of all utilities where crossings, interferences, or connections to new pipelines or other facilities are shown on the Drawings, marked by the utility companies, or indicated by surface signs. Prior to the preparation of piping shop drawings, or the excavating for any new pipelines or structures, the Contractor shall locate and uncover these existing utilities including services and laterals to a point 1 foot below the utility. Submit a report identifying each underground utility and its depth and location. Any variation in the actual elevations and the indicated elevations shall be brought to the Project Engineer's attention.
  - 4. Excavations around underground electrical ducts and conduits shall be performed using extreme caution to prevent injury to workmen or damage to electrical ducts or conduits. Similar precautions shall be exercised around gas lines, telephone, and television cables.



5. Excavations shall have a surface dimension of no more than 18-inch by 18-inch. Air spades and vacuum excavators shall be used to limit the size of the excavation and damage to adjacent facilities. Backfill after completing potholing.
  6. Repair potholes in accordance with Section 900 – Asphalt Mix Design and Construction of the Arvada Engineering Code of Standards and Specifications.
- C. Interferences:
1. If interferences occur at locations other than shown on the Drawings, the Contractor shall notify the Project Engineer, and a method for correcting said interferences shall be coordinated with the Project Engineer. If the Contractor does not expose all required utilities prior to shop drawing preparation, he or she shall not be entitled to additional compensation for work necessary to avoid interferences, nor for repair to damaged utilities.
  2. Any necessary relocations of utilities, whether shown on the Drawings or not, shall be coordinated with the affected utility. The Contractor shall perform the relocation only if instructed to do so in writing from the utility and the Project Engineer.
- D. Shutdowns: If the Contractor requires a utility to be shutdown for a period of time to commence construction, the Contractor shall notify the utility owner and receive approval of the shutdown, including the shutdown schedule, prior to proceeding with the work.
- E. Overhead Facilities: There are existing overhead electric and telephone transmission lines at the site. Extreme caution shall be used when working in the vicinity of overhead utilities to prevent injury to workmen or damage to the utilities. The Contractor shall be required to comply with the applicable provisions of OSHA when working anywhere on this project.
- F. Existing gas, water, sewer, and telephone house laterals exist along the pipeline alignments. Protect all service laterals from damage due to construction operations. If any laterals are damaged, notify the Project Engineer and the affected utility immediately. The cost of repair shall be borne by the Contractor.

### 3.04 TRENCH EXCAVATION

- A. This section is exclusive of the railroad corridor from the manhole just south of the corridor (SSMH 4-8) to the manhole just north of the corridor (SSMH 4-9). Refer to the 02400 series of the project specifications for specialized requirements related to this work.
- B. All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line and removed from the jobsite prior to starting the trench excavation. If the vertical edges of a trench in a roadway ravel during construction, they shall be trued to a vertical plane to a point twelve (12) inches outside the limits of excavation prior to milling and placing the resurfacing material. This material shall not be used in any fill or backfill.
- C. Excavation for pipe and other utilities shall be in open cut. The trench shall be as wide as necessary for sheeting and bracing and the proper performance of the work up to the maximum width permitted as shown on the Drawings. The sides of the trenches shall be vertical in paved areas. The bottom of the trench shall be

constructed to the grades and shapes indicated on the Drawings. Favorable review by the Project Engineer is required prior to use of alternative methods of construction.

- D. Remove lumped subsoil and rock up to one cubic yard, measured by volume. Remove larger material as specified in Paragraph 3.15 Rock Excavation.
- E. Do not advance open trench more than 200 feet ahead of installed pipe.
- F. Accurately grade the bottom of the trenches to provide uniform bearing and support for each section of the pipe or conduit at every point along its entire length, except for the portions of the pipe sections where it is necessary to excavate for bell holes and for the proper sealing of pipe joints, and as hereinafter specified. Dig bell holes and depressions for joints after the trench bottom has been graded. For the pipe to rest on the bedding for as nearly its full length as practicable, bell holes and depressions shall be only of such length, depth, and width as required for properly making the joint. Remove stones as necessary to avoid point bearing.
- G. The trench shall not be backfilled until the Owner's Inspector favorably reviews the pipe and bedding installation.
- H. If unsatisfactory material is encountered at the bottom of excavation, coordinate with the Project Engineer steps to remove and replace with material approved by the Project Engineer.
- I. Backfill and compact excavations with material approved by the Project Engineer.
- J. For all piping or conduits to be placed in any excavated and backfilled area, such as at manholes or for building connections, the structural backfill shall be first compacted to a level at least 3 feet from the top of the piping or conduit elevation and then retrenched to pipe grade.
- K. Provide secured ladders for access to the trench by construction and inspection personnel. Additional secured ladders shall be provided to any structure or pipe that must be inspected and tested. Failure to provide safe inspection access shall void initial inspection and follow up inspection shall not be performed until proper safe access is provided to the items to be inspected.
- L. If the bottom of the excavation is soft or unstable, and in the opinion of the Project Engineer, cannot satisfactorily support the pipe, the soft or unstable material shall be removed and replaced a minimum of 12-inches below grade with Stabilization Rock or as otherwise specified by the Project Engineer.
- M. All trenching shall be performed in accordance with all Occupational Safety and Health Administration (OSHA) requirements. Refer to Section 364 Arvada Engineering Code of Standards and Specifications.
- N. For sections of pipe owned by Metro, Contractor perform trench excavation as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Section 3.2 of this specification for additional requirements.
  - 1. Trench size:
    - a. Maximum trench width at top of pipe may not exceed outside diameter of utility service by more than the following dimensions:
      - 1) Overall diameter of utility service is 33 inches or less: 18 inches



- 2) Overall diameter of utility service is more than 33 inches: 24 inches
  - b. Cut trench walls vertically from bottom of trench to 1 foot above top of pipe.
  - c. Keep trenches free of surface water runoff.
2. Follow Section 3.2.E for electrical conduit trenching requirements.

### 3.05 EXCAVATION FOR STRUCTURES

- A. Excavate to such width outside the lines of the structure to be constructed as may be required for proper working methods, the erection of forms, and the protection of the work.
- B. Inspection of Excavation: Notify the Owner's Inspector when excavation for the structure is complete. No forms, reinforcing steel, concrete, or precast structure shall be placed until the excavation has been inspected and approved by the Owner's Inspector.

### 3.06 SURPLUS EXCAVATION MATERIAL

- A. All surplus excavation shall be removed from the jobsite and disposed of properly. If the surplus excavation is disposed of on private property, written permission shall be obtained from the property owner and a copy given to the Project Engineer.
- B. The Contractor shall investigate and determine if excavated soils are hazardous in nature and require specialized disposal. It is the Contractor's responsibility to legally dispose of surplus excavated material.

### 3.07 SHEETING AND SHORING

- A. Sheet, shore, and brace excavations in accordance with OSHA regulations to prevent danger to persons, structures and adjacent properties and to prevent caving, erosion, and loss of surrounding subsoil.
- B. Support trenches excavated through unstable, loose, or soft material. Provide sheeting, shoring, bracing, or other protection to maintain stability of excavation.
- C. Repair damage to new and existing Work from settlement, water or earth pressure or other causes resulting from inadequate sheeting, shoring, or bracing.
- D. Remove sheeting, shoring and/or bracing without damage to the pipe, the alignment of the pipe, or the pipe bedding.

### 3.08 SUBGRADE PREPARATION

- A. Finished Subgrade: Finished subgrade material may be native soil or import material and prepared to be non-yielding when proof-rolled by passing over all areas to receive fill or as required by the Project Engineer with a minimum 10-ton roller, front-end loader with loaded bucket, or other heavy rubber-tired vehicle with high tire pressure (e.g., loaded tandem dump truck), in the presence of the Owner's Inspector. If subgrade is unstable, wet, or soft and air-drying is not an option, Contractor shall coordinate with the Project Engineer for corrective methods prior to placing subsequent lifts.
- B. Unstable Soils

1. If the bottom of the excavation is soft or unstable, and in the opinion of the Project Engineer, cannot satisfactorily support the pipe, the soft or unstable material shall be removed and replaced a minimum of 12-inches below grade with Stabilization Rock or as otherwise specified by the Project Engineer.
- C. For sections of pipe owned by Metro, Contractor notify Metro when unstable materials are encountered. If Metro determines that the subgrade cannot be made stable, Contractor will be directed to over excavate and stabilize with crushed rock and geotextile fabric.
  1. Over excavate to a depth of 12 inches or as directed by the Geotechnical Engineer.
  2. Place crushed rock directly on the geotextile.
  3. Crushed rock shall be fully encapsulated in geotextile and edges shall lap at least 12 inches.
  4. Crushed rock shall be placed up to the design subgrade elevation.

### 3.09 SUPPORT OF EXCAVATIONS

- A. Adequately support excavation for trenches and structures to meet all applicable requirements in the current rules, orders, and regulations. Excavation shall be adequately shored, braced, and sheeted so that the earth will not slide or settle and so that all existing structures and all new pipe and structures will be fully protected from damage. Keep vehicles, equipment, and materials far enough from the excavation to prevent instability.
- B. The support for excavation shall remain in place until the pipeline or structure has been completed. During the backfilling of the pipeline or structure, the shoring, sheeting, and bracing shall be carefully removed so that there shall be no voids created and no caving, lateral movement, or flowing of the subsoils.

### 3.10 TRENCH BACKFILL

- A. Backfill shall comply with Section 368.00 of the Arvada Engineering Code of Standards and Specifications.
- B. Backfill materials shall be compacted by vibrating, tamping, or a combination thereof.
- C. Trench Backfill:
  1. Place trench materials true to the lines, grades, and details indicated on the Drawings.
  2. Place trench materials in uniform, level layers, not exceeding 8 inches thick measured before compaction. The difference in level on either side of a pipe shall not to exceed 4 inches.
  3. Backfill material shall not be placed over the pipe or conduit until after the joints have been completed and inspected by the Owner's Inspector.
  4. Protect the pipe or conduit from damage during the construction period. It shall be the Contractor's responsibility to repair broken or damaged pipe at no extra cost to the Owner. Once repair is inspected and approved by the Owner's Inspector, contractor shall retest the line. Carefully place backfill around and over the pipe. Tamping of backfill over the pipe shall be done with tampers, vibratory rollers, and other machines that will not injure or disturb the pipe.



5. Do not allow construction traffic over the pipe trench until the trench has been backfilled to be even with the existing adjacent grade, temporary AC pavement has been placed over the backfilled trench and/or a traffic rated metal plate has been placed over the trench.
- D. Import Backfill: The removal and replacement limits and quantity of import backfill material shall be coordinated and accepted by the Project Engineer and Owner prior to proceeding with the installation.
  - E. Flow-Fill: Generally, the Contractor may place Flow-Fill in approximate 3 feet thick layers, allow bleed water to rise and divert away from placement before another layer may be added. Refer to MGPEC Section 19.4E for more information.
  - F. Flashfill: flashfill may generally be placed without thickness limits.
  - G. Excavated material: Excavated material can be reused as backfill provided all organic material is removed unless more stringent requirements are provided in the geotechnical report. For trenches beneath pavements and flatwork, backfill from a minimum of 1 foot below grade to grade shall consist of material meeting the requirements for AASHTO class A-1 or A-2 material. All excavated material which meets the requirements for backfill materials shall be stockpiled in a manner which shall not contaminate the excavated material and shall be located a sufficient distance from the trench to avoid overloading, to avoid obstructing sidewalks, driveways, or streets, and to provide the least possible interference with traffic.
  - H. Backfill of service lines in streets: Service lines trenches cut through surfaced streets or adjacent to existing curbs, gutters, and sidewalks in public ROW shall be bedded using squeegee and backfilled using an approved backfill material.
  - I. For sections of pipe owned by Metro, Contractor perform trench excavation as defined in Metro's standard specification 31 23 33 Trenching, Backfilling, and Compacting for Utilities. See Section 3.4 of this specification for additional requirements.
    1. Furnish backfill to a minimum of 24 inches above top of pipe.
      - a. Place backfill in lifts not exceeding 8 inches loose thickness
      - b. Hand place, shovel slice, and pneumatically tamp all carefully compacted backfill.
      - c. Observe specific manufacturer's recommendations regarding backfill and compaction.
      - d. Compact each lift to specified requirements.
    2. Water flushing for consolidation is not permitted.
    3. Follow Section 3.4.E for electrical conduit backfilling requirements.

### 3.11 BACKFILL UNDER STRUCTURES

- A. Crushed Rock shall be placed in uniform, level layers, not exceeding 6 inches thick measured before compaction under manhole structures and vaults.
- B. Backfill Adjacent to Structures
  1. Do not place backfill against structures until the concrete has been patched and cured.
  2. Do not place backfill against structures until at least 28 days after the concrete was placed, or until the concrete has achieved a strength of at least 80% of the required design strength, whichever is earlier. Concrete strength

- shall be demonstrated by field cured cylinders tested at the Contractor's cost, prepared and tested in accordance with ASTM C31 and ASTM C39.
3. Place Structural Backfill within 2 feet of a structure.
  4. Place structural backfill in uniform, level layers, not exceeding 6 inches thick measured before compaction. Bring backfill up uniformly on all sides of the structure, and on both sides of buried walls.
  5. The Contractor shall uniformly process, maintain proper moisture in, and properly compact each lift throughout the backfilling process.
- C. Backfill for Walls Below Grade
1. Backfill should be placed in horizontal lifts not exceeding 6 inches in loose thickness. Only light, hand-operated compaction equipment (e.g., jumping jack, walk-behind vibratory plate compactor) shall be used within 10 feet of walls below grade.
  2. All sheeting and bracing used for structure excavation shall be removed by the Contractor prior to backfilling.
- D. Rock Subgrade Under Structures
1. Unless shown specifically otherwise in the Drawings, do not use rock as backfill above the elevation of the highest base slab of the structure.
  2. 3/4-inch Crushed Rock shall be used in areas subject to expansive soils as recommended by the Geotechnical Engineer.
- E. In constrained areas where proper compaction of backfill cannot be achieved around structures, CLSM "flowable fill" shall be used as defined in Section 360.01 of the Arvada Engineering Code of Standards and Specifications.

### 3.12 BEDDING

- A. All pipe shall be installed with sufficient bedding material. The bedding material shall be tamped under the haunches for the full length of the pipe barrel to ensure support for the entire length of pipe. The pipe barrel shall be uniformly supported along the entire lengths of the pipe.
- B. Standard Bedding: Limits of bedding material shall be from 6-inches below the bottom of the pipe to 12-inches above the top of the pipe.
- C. Bedding shall be compacted by vibrating, tamping, or a combination thereof, to 70% relative density for well-graded sand or squeegee material as determined by ASTM D4253 and D4254.
- D. Geotextile Fabric shall be installed with Class B Bedding per the bedding detail on the Drawings.

### 3.13 COMPACTION

- A. Trench backfill shall be placed in lifts of eight (8) inches or less in loose thickness when heavy, self-propelled compaction equipment is used or six (6) inches or less in loose thickness when hand-guided equipment (i.e. jumping jack, plate compactor) is used, processed and moisture-conditioned, and each lift thoroughly consolidated by tamping, vibrating, or a combination thereof, until the moisture content and the relative compaction complies with the values shown in the table below.



- B. For new landscape areas, compaction shall be between ninety (90) percent or greater of the maximum Standard Proctor dry density in the top two (2) feet of soils below finished grade. Where sidewalk or concrete trail will be constructed, soils shall be scarified for a minimum depth of twelve (12) inches, moisture treated, and recompacted two (2) feet wider than the footprint of the sidewalk or trail until the moisture content and the relative compaction complies with the values shown in the table below.

<b>Soil Classification AASHTO M145</b>	<b>Relative Compaction By Standard Proctor ASSHTO T99 with CP23 (ASTM D698) (percent compaction)</b>	<b>Relative Compaction By Modified Proctor ASSHTO T180 with CP23 (ASTM D1557) (percent compaction)</b>	<b>Moisture Content Range (with respect to Optimum Moisture Content)</b>
A-1 through A-5	-	95	-2 to +2 (based on AASHTO T180)
A-6 and A-7	95	-	0 to +2 (based on AASHTO T99)

- C. Add water to the backfill material or dry the material as necessary to obtain moisture content within 2 percent of optimum. Employ such means as may be necessary to secure a uniform moisture content throughout the material of each layer being compacted.
1. Contractor shall use air-drying to reduce moisture content and/or achieve compaction before other methods may be considered. Or, where applicable, Contractor shall demonstrate air-drying is not possible before other methods may be considered.
- D. When densities of compacted materials do not meet the requirements, remove and/or recompact the material until the requirements are met. The Contractor is responsible for the cost of retesting all failing tests, including the initial retest.
- E. After the material has been moisture conditioned, compact it with compaction equipment appropriate for the use to achieve specified compaction.
- F. If the backfill material becomes saturated through negligence or otherwise, remove the faulty material and replace it with suitable material compacted to the specified density at no additional cost to the Owner.
- G. Compaction within Adam's County ROW shall be in accordance with ASTM D1557 (Modified Proctor) or ASTM D698 (Standard Proctor) as depicted in the table above unless otherwise specified.
- H. Compaction for Metro pipelines shall meet 95 percent maximum dry density as measured by ASTM D698.
- I. Compaction of embankment and backfill materials by flooding, ponding, or jetting is not permitted.

### 3.14

#### 3.14 SITE GRADING

- A. Swales: Reconstruct stormwater swales as required to match existing conditions. Take care not to excavate into swales and cause destabilization of the swale structure so that stormwater cannot be adequately conveyed in quantities previously experienced. Provide temporary stabilization as needed to maintain the shape and cross sectional area of storm swales along the project alignment.
- B. Gravel Areas: Place gravel material onsite to finished grade elevations as shown on the Drawings, unless otherwise noted.
- C. Where filter fabric is installed within an earthen or rock-lined drainage swale or channel, overlap filter fabric a minimum 12" with upstream fabric placed over downstream fabric. Join seams per manufacturer recommendations.

#### 3.15 ROCK EXCAVATION

- A. Rock excavation shall begin when a CAT 325 to 336 (or equal) excavator is no longer able to dig on a single pass with tiger teeth and is scraping at the trench due to refusal.
- B. Sedimentary bedrock is defined as Rock Excavation if it does not satisfy the Ripping Test criteria as described in Section 203 of CDOT's Standard Specifications for Road and Bridge Construction, 2017.
- C. Excavate and remove rock by mechanical method using single tooth ripper, hydraulic chiseling or drilling.
- D. Cut away rock at bottom of excavation to form level bearing.
- E. Remove shaled layers to provide sound and unshattered base for manhole bases and pipe bedding.
- F. In utility trenches, excavate to 9-inches below invert elevation of pipe and a maximum of 24-inches wider than pipe diameter or as indicated on the typical trench detail.
- G. Remove excavated materials from site.

#### 3.16 EMBANKMENT CONSTRUCTION

- A. Embankment construction shall comply with Section 361 of Arvada Engineering Code of Standards and Specifications.
- B. Embankment construction shall include placement, processing, and compaction of all embankment material, and all related work required to ensure proper bond of materials with previously placed embankment material. All embankment construction should be conducted in accordance with specifications and procedures provided and under the direct supervision of the project Geotechnical Engineer.
- C. No excavation shall be performed in any area until the proposed work has been staked by the Contractor, cross-sections of existing ground are determined and plotted, and all survey elevations and cross-sections shown on the approved plans are reviewed and approved by the Project Engineer. Excavation shall be performed to the lines and grades shown on the approved plans. Prior to placement of subgrade, utilities shall be installed, utility service lines shall be



stubbed to the edge of the ROW, and all trenches shall be backfilled and properly compacted.

- D. Earthmoving equipment, watering equipment, processing equipment, and compaction equipment are the responsibility of the Contractor. Equipment shall be suitable for performing excavation and embankment work in accordance with Specifications set forth in Section 300 Arvada Engineering Code of Standards and Specifications.
- E. Embankment material shall be a homogenous mixture of Suitable Material as defined below. The full depth of each layer shall be processed to ensure a satisfactory bonding surface for the next layer of embankment material. If more than 24 hours have lapsed between the time of compaction testing and placement of the next layer of roadway embankment, the area shall be retested.
  - 1. Suitable Material is defined as earthen material that consists of non-organic sands, gravels, clays, silts, and mixtures thereof. Rock with a maximum size of six (6) inches is allowable for embankment. Claystone fragments exceeding three (3) inches in particle size are not to be incorporated in embankment material unless specifically approved by the project Geotechnical Engineer and the Project Engineer. Bedrock that breaks down to specific soil types and sizes during excavation, hauling and placement may be considered as suitable material if they are excavated and moisture conditioned and aged for a period of time to achieve a uniform, homogeneous material.
- F. Following clearing and grubbing, scarify remaining native material below embankments to a minimum depth of 6 inches. Moisture condition the scarified surface to within 2 percent of optimum water content and compact native material in accordance with the requirements of these specifications unless otherwise specified or shown on the Drawings.

END OF SECTION

## SECTION 02411

### TUNNEL EXCAVATION AND INITIAL SUPPORT

#### PART 1 GENERAL

##### 1.01 WORK INCLUDED

- A. This section presents requirements for guided tunnel excavation and the installation of the Initial Support associated with the work, including furnishing all labor, equipment, and materials for tunnels in the Contract.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.
- C. Section 1.06 herein specifies allowable tunnel construction methods for the tunnel.

##### 1.02 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
  - 1. 02470 – Geotechnical Instrumentation and Monitoring
  - 2. 02430 – Contact Grout
  - 3. 02450 – Carrier Pipe Installation and Backfill
  - 4. 02444 – Construction Shafts
  - 5. Geotechnical Baseline Report (GBR), Lithos Engineering
  - 6. Geotechnical Data Report (GDR), Lithos Engineering

##### 1.03 DEFINITIONS

- A. CASING PIPE: Pipe installed along the designed tunnel alignment that also serves as the Initial Support.
- B. CARRIER PIPE: Pipe that carries the product fluid.
- C. CUTTERHEAD: The leading face of a rotary tunnel excavation system that is responsible for excavation of the ground.
- D. GOVERNING AGENCY: Agency which owns and/or operates the property in which the tunnel work will be conducted.
- E. GUIDANCE SYSTEM: A system that is utilized to guide the tunnel excavation along the design line and grade within specified tolerances.
- F. INITIAL SUPPORT: Temporary ground support installed concurrent with tunnel excavation to maintain tunnel stability prior to installation of the Carrier Pipe. Includes Erected Support and Casing Pipe.



- G. JACKING: The process of propelling a TBM or Tunnel Shield forward utilizing thrust jacks located within the tail shield of the TBM or Tunnel Shield to move the machine forward.
- H. LAUNCH SEAL: A seal that is fitted on the shaft wall and through which the boring machine and casing pipe passes to reduce inflow of groundwater and ground into the tunnel shaft.
- I. OBSTRUCTION: Objects or portions of objects located within the cross-sectional area of the tunnel excavation face. An Obstruction shall be defined as:
  - 1. Makes further advancement of the tunnel impossible using techniques typically used for the current tunnel excavation method; and
  - 2. Has an unconfined compressive strength greater than 15,000 psi, or consists of steel, concrete, brick, timber, rock, rubble, or other artificial material.
- J. ONE-PASS TUNNELING SYSTEM: A method of tunneling in which Initial Support is the Final Support and no secondary Carrier Pipe is required.
- K. OVERCUT: The difference between the radius of the excavation created by the boring machine or cutting shoe as appropriate, and the outside radius of the Initial Support.
- L. OVERCUT BAND: A thin band attached to the front of the first Casing Pipe segment or cutting head used to create an Overcut and lessen skin friction and decrease required installation forces.
- M. TUNNEL BORING MACHINE (TBM): A non-pressurized, rotary method of tunnel excavation operated from inside the tunnel, capable of accurate steering in both line and grade directions.
- N. TUNNEL SHIELD: A steel cylinder that provides ground support at the tunnel face and the leading edge of the Initial Support and is advanced through the ground either with the Casing Pipe or using jacks thrusting off the Erected Support. Capable of accurate steering in both line and grade directions.
- O. TWO-PASS TUNNELING SYSTEM: A method of tunneling in which Initial Support is installed prior to installation of the Carrier Pipe.

#### 1.04 REFERENCE STANDARDS

- A. ANSI/AWS D1.1 Structural Welding Code
- B. ASTM A36 / A36M-19 - Standard Specification for Carbon Structural Steel
- C. ASTM A123 – Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- D. ASTM A252 – Standard Specification for Welded and Seamless Steel Pipe Piles
- E. ASTM A1011 - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.

- F. ASTM A1097 - Standard Specification for Steel Casing Pipe, Electric-Fusion (Arc)-Welded (Outside Diameter of 10 in. and Larger)
- G. AREMA – 2020 Manual for Railway Engineering, Chapter 1
- H. BNSF 2023 Utility Accommodation Policy, Part 3 – Utilities Perpendicular to Railroad Property
- I. UPRR 2023 Pipeline Installation Engineering Specifications

#### 1.05 GENERAL REQUIREMENTS

- A. Be responsible for design and construction of Initial Support, and performance of the tunnel excavation.
- B. Minimum design requirements are presented herein. Be responsible for developing and implementing the design to fulfill the specified design requirements provided by the Engineer which are necessary for completion of the work.
- C. Perform tunnel excavation in accordance with all Governing Agencies, applicable permits and requirements, and all applicable laws and regulations.
- D. Construct and install tunnel Initial Support concurrently with the tunnel excavation. Exposed, unsupported ground will not be allowed.
- E. Provide means to control the face of the tunnel in the case of loss of ground integrity. Face control can include but is not limited to: slurry, the cutterhead, competent soil plugs, ground improvement, sand bags, breasting boards/plates, shotcrete, or other means subject to approval of the Engineer.
- F. The Contractor will select Initial Support while adhering to requirements specified herein.
  - 1. Safely withstand all installation and long-term loads, and specifically: rail, ground, roadway, construction and machine loads including non-uniform loading, and stress concentrations.
  - 2. Include all loads and stresses caused by fabrication, transportation, and construction operations including handling, erecting, and grouting pressures.
  - 3. Minimum Casing Pipe thickness is specified herein. Increase Casing Pipe thickness as necessary to correspond with Contractor equipment, safely resist applied loads, and to control ground movement.

#### 1.06 ALLOWABLE TUNNELING METHODS

- A. Use of a TBM is the only allowable method. Allowable methods have been selected based on anticipated ground conditions and ground behavior as described in the GBR and in conjunction with the dimensions of the tunnel. The Contractor may propose to use an alternative system for tunnel excavation and support. Any alternative methods are subject to approval by the Owner, Engineer, and Governing Agencies. Note that approval of specified methods has been obtained by the Governing Agencies prior to bid and approval of alternative methods may result in substantial time delays and will be the sole responsibility of the Contractor.



## 1.07 GROUND CONDITIONS:

- A. Information regarding the ground conditions to be anticipated can be found in the GBR and GDR.

## 1.08 QUALIFICATIONS

- A. Prequalified tunnel contractors will substantially perform all tunnel construction work. Subcontracting of the Work detailed in this specification will not be allowed. Ancillary work may be subcontracted with approval from the Owner and Engineer; for example, trucking and grout supply/mixing.
- B. The Contractor directly engaged in tunnel excavation and support work will have completed at least four (4) tunnel projects during the past two (2) years using similar methods as allowed and selected for use under Section 1.06 and similar scope as proposed for this project. This experience will cover the full range of the Work detailed in this specification, including but not limited to the excavation of the tunnel, disposal of muck, and control of the encountered conditions.
- C. The onsite foreman for tunnel construction shall have:
  - 1. At least five (5) years of construction experience with excavation and support of tunnels
  - 2. Successfully completed at least two (2) similar jobs within the last three (3) years using excavation and support methods similar to those proposed by the Contractor.
- D. All personnel employed by the Contractor in the work will be experienced and competent in their respective tasks and will work only under the direct control of a suitably experienced foreman or superintendent.
- E. Design of engineered structures as defined herein will be signed and sealed by a Registered Professional Engineer in the State of Colorado who has completed a minimum of two (2) tunnel projects of similar scope in the past five (5) years.  
(NOTE TO REVIEWER – THIS ITEM CAN BE COMPLETED BY THE CMGC TEAM DURING FUTURE DESIGN EFFORTS)

## 1.09 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity. Each number submittal below is to be submitted as a single package, i.e. submit all portions of the 2. Tunnel Work Plan as a single submittal package.
  - 1. Submit qualifications as stated in 1.08.
  - 2. Tunnel Work Plan. Submit a detailed work plan of all proposed tunnel construction operations and Initial Support provisions. Include a description and drawings of proposed methods and procedures for:
    - a. Working drawings including the launch and retrieval shaft layouts, ancillary equipment, thrust block and/or rail system configuration, and limits of construction during tunneling;
    - b. Tunnel excavation equipment to be used including manufacturer literature, drawings, as-built and modified dimensions, anticipated overcut, and capacities;

- c. Guidance System selection and line and grade control methods;
  - d. Line and grade surveying methods during installation;
  - e. Excavating the tunnel including description of activities involved in a single cycle of excavation and Initial Support Installation;
  - f. Addressing and handling excavating the tunnel in mixed face conditions where shown in the GBR
  - g. Procedures for measuring excavated muck quantities versus the installed length or progress during tunneling operations;
  - h. Lubrication system and lubricants;
  - i. As necessary, Casing Pipe coupling methods to maintain pipe segment alignment during installation;
  - j. Hauling and disposal of excavated muck, including disposal site details;
  - k. Adhering to noise ordinances stipulated for the project. This may include but not be limited to noise barriers and restrictions on working hours;
  - l. Detailed contingency plans for the following:
    - 1) Obstructions (as defined herein) encountered during tunnel construction;
    - 2) Settlement and/or heave;
    - 3) Loss of line and grade during tunnel construction.
3. Submit a plan to maintain stability of the face and prevent ground loss at the beginning of the drive. This may include but is not limited to: ground modification outside the shaft and machine design.
  4. If Initial Support selected by the Contractor differs from as provided in Part 2, Initial Support design calculations including loads, methods, assumptions, results, and safety factors.
    - a. Include as a minimum, evaluation of axial, flexural and shear of the Initial Support in uniform and non-uniform loading and support conditions as dictated by the proposed installation techniques and long-term loading. A safety factor appropriate for the level of uncertainty and the nature of the construction shall be applied.
    - b. Calculations shall be signed and stamped by a Professional Engineer Registered in the State of Colorado with minimum qualifications as stated in Section 8.
  5. The Contractor will submit dewatering plans in accordance with Section 31 23 22 – Dewatering for approval in locations where Shaft or Tunnel excavations extend beneath baselined groundwater elevations as indicated in the GBR. The Contractor shall develop and submit groundwater related contingency plans including:
    - a. Contingency plan to handle excess water encountered in the tunnel.
    - b. Contingency plan to address unstable ground encountered in the tunnel due to incomplete dewatering.
  6. Schedule. A critical path schedule of tunneling-related activities and activities for project components interfacing with the tunnel. The schedule will include at a minimum:
    - a. Duration for launch and receiving shaft or pit excavation;
    - b. Launch pit set up; and
    - c. Anticipated daily production rate for tunnel excavation and initial support installation;
    - d. Contact Grouting;
    - e. Carrier Pipe Installation; and
    - f. Backfill Grouting, as applicable.



7. Submit Manufacturer's written certifications that Initial Support materials meet or exceed the specified requirements as stated herein.
  8. Contractor's safety plan for personnel conducting tunneling operations including, but not necessarily limited to, provisions for ventilation, temperature control, lighting, electrical safeguards, safety of the public, monitoring, and warning systems, submittal will be for information only and not approved or disapproved by Engineer;
  9. Certifications of qualified welders where welding is required.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
1. Provide Written Daily Logs including: a summary of encountered ground conditions and ground behavior; the length of excavated and supported tunnel; an estimate of estimated muck quantity; and a general summary of daily tunneling activities. Written Daily Logs are to be recorded by the Contractor's onsite personnel and signed by the Contractor's Tunneling Superintendent for each shift and will be submitted to the Engineer within two working days of the date of the log.
  2. Instrumentation monitoring results as required herein and in Section 02470 – Geotechnical Instrumentation and Monitoring.
- C. Provide copies of reports as detailed in this specification and as required by public authorities to the Engineer within two working days hours following preparation and submittal to third party authority. These reports are for record purposes only.
- D. Postconstruction Submittals:
1. Record Drawings as detailed in Section 3.12.

## PART 2 EQUIPMENT, PRODUCTS AND MATERIALS

### 2.01 EQUIPMENT

- A. The Contractor will determine and provide the equipment necessary for excavation and Initial Support of the tunnel and to complete all work associated with this Section within the ground conditions stated in the GBR, without impacts to overlying infrastructure, and without showing evidence of undue stress or failure. Backup equipment shall be required in the event of an equipment breakdown and where the condition of the equipment to be used indicates that routine component replacement or repair will likely be necessary during the work.
- B. Tunnel excavation equipment will have the following minimum attributes:
1. Be capable of controlling the ground during excavation and shutdown.
  2. If applicable, have a system to minimize roll of the boring machine and Initial Support during installation and/or allow for rotation to correct roll.
  3. Be capable of being operated in a manner that will prevent loss of ground during excavation and be steerable and capable of controlling the advance of the heading to maintain line and grade within the tolerances specified.
  4. Utilize a Guidance System capable of accurately measuring and controlling the excavation equipment and Initial Support position during installation such that the Carrier Pipe can be installed to the line and grade tolerances specified in this Section.

5. The excavation and installation equipment will be capable of handling and removing all anticipated material documented in the GBR.
6. Have the minimum thrust capacity required to install the Casing Pipe.

## 2.02 PRODUCTS AND MATERIALS

- A. Minimum Initial Support diameters are listed on the Drawings. The Contractor may, at its discretion use a larger Initial Support diameter subject to approval by the Engineer.
- B. Casing Pipe:
  1. A Casing Pipe will be used for the RR crossings.
  2. The minimum casing pipe thickness 1.0 inch(es) as required by the Governing Agency granting the utility permit; whichever results in a greater thickness. Casing Pipe thickness may be increased by the Contractor at its discretion.
  3. At a minimum the Casing Pipe will conform to ASTM A 252 Grade 2 steel and be manufactured specifically for jacking.
  4. The pipe will be utilized in accordance with the pipe manufacturer's specifications, guidelines for tunnel installation, and recommendations of the equipment manufacturer.
  5. The contractor will adhere to pipe manufacturer's installation guidelines for:
    - a. Handling;
    - b. Launch shaft preparations;
    - c. End preparations, mating procedures; and
    - d. Installation.
  6. The Casing Pipe will be round. Casing Pipe are required to have a roundness tolerance so that the difference between the major and minor outside diameters are not exceed to lesser of 1% of the specified nominal outside diameter or 0.25-inches.
  7. Steel pipe shall be in conformance with ASTM A1097 and of leakproof construction, such as butt welded or interlocking joints which are capable of withstanding railroad loading. Pipe shall have a specified minimum yield strength of at least 35,000 psi.
  8. All metallic casing pipes are to be designed for effective corrosion control, long service life, and relatively free from routine servicing and maintenance. Corrosion control measures for metallic casing pipe must include cathodic protection which can be an active induced current, or a passive system that could be sacrificial anodes and/or protective coating rated for cathodic protection such as fusion bonded epoxy with an abrasion resistance overcoating.
- C. Pipe Joints:
  1. Jacked Casing – Either of:
    - a. Welded with a full penetration butt weld in accordance with ANSI/AWS D1.1.
    - b. T5 as manufactured by Permalok, Tri-Loc as manufactured by Trinity Products, or equivalent.
  2. The joints are to be in accordance with the pipe manufacturer's specifications and guidelines for jacked or rammed pipe.



- D. Grout Ports: Install grout ports as shown on the Contract Drawings and as specified in specification Section 02430 – Contact Grout. Grout Ports are to be installed prior to Initial Support installation if Casing Pipe is used. Grout Ports may be installed prior, during, or after Initial Support installation if Erected Support is used.
- E. Lubricant:
  - 1. Lubricant used to reduce friction shall consist of a mixture of bentonite, water, and additives, and is the responsibility of the Contractor.
  - 2. Lubricant will be non-toxic, and not release environmental contaminants into the groundwater either directly or from degradation and shall comply with NSF/ANSI Standard 060

## PART 3 EXECUTION

### 3.01 TUNNEL REQUIREMENTS – GENERAL

- A. Do not begin tunneling until:
  - 1. Required preconstruction submittals have been made and the Engineer has reviewed and accepted submittals in writing.
  - 2. All required permits are in place and the Governing Agency has been satisfactorily notified of the schedule and work.
  - 3. Shaft excavations, stabilization and shoring have been satisfactorily completed in accordance with Section 0444 – Construction Shafts.
  - 4. The locations of all monitoring and instrumentation points have been established and initial baseline measurements have been obtained in accordance with Section 02470 – Geotechnical Instrumentation and Monitoring.
  - 5. A pre-job activity and safety meeting has been conducted with the Contractor and Engineer. Arrange this conference and inform the Engineer of the time and place of the conference at least seven (7) days in advance of tunneling.
  - 6. Existing utilities near the proposed alignment have been identified both horizontally and vertically.
- B. Perform tunneling operations in a manner that will minimize loss of ground and minimize settlement or heave of the ground surface, structures, utilities and other facilities above and adjacent to the tunnel.
- C. Maintain clean working conditions at all times inside and around the tunnel and shafts. All excavated muck, and any other material not required for tunneling are to be removed from the excavation in a timely manner.
- D. Design, install and operate tunneling support utilities as necessary for support of construction and the safety of workers in accordance with project requirements and all Federal, State, and local laws, regulations, and codes. Utilities including but not be limited to electrical, lighting, water, and ventilation.

### 3.02 TUNNEL EXCAVATION - GENERAL

- A. Maximum radial Overcut is to be compatible with the subsurface conditions, stiffness characteristics of selected pipe, and joint system, tunnel diameter, and excavation method at the designed maximum installation loads. Overcut may not exceed 0.75-inches unless approved otherwise by the Engineer.
- B. Monitor and control the volume of muck removed. Compare theoretical and actual volumes of spoil removed as excavation progresses. Investigate potential voids created by over excavation and fill them with grout to avoid surface settlement or structure damage.
- C. During shutdowns and other interruptions in tunnel excavation work, provide means to maintain the integrity of the ground at the face of the tunnel.
- D. Avoid damage to pipe sections, joints, and overall Initial Support during tunnel construction. In the event of damage to a pipe section or pipe joint during Tunneling, the Contractor must notify the Engineer within the day of observation of the damage.
  - 1. If a damaged Casing Pipe cannot be repaired, jack all damaged pipe sections completely through the tunnel following completion of tunnel excavation.
- E. Limit the jacking force to stay at or below safe working limit of the Initial Support.
- F. Continuously monitor and record the jacking loads at the jacking frame or boring machine as applicable.

### 3.03 TUNNEL BORING MACHINE

- A. Requirements presented in Sections 3.01 and Section 3.02 of this Specification apply to this Section unless modified herein.
- B. The TBM Guidance System shall consist of an optical theodolite or laser-based system capable of continuously monitoring the location of the TBM head's position.
- C. Employ use of a cradle upon initial setup to properly align the TBM with the design line and grade.
- D. Operate the TBM in a manner to minimize movement of the ground in front of and surrounding the tunnel and to minimize loss of ground, surface settlement, and heave of the ground surface. Control the advance rate, volume of material excavated, and pressure applied to the tunnel face to avoid over-excavation, loss of ground, and heave of the ground surface.
- E. Maintain cutterhead pressure against the excavation face at all times, including during work shutdown periods.
- F. Equip the TBM with stabilizers or extendable fins, or a bidirectional cutterhead that allow the equipment to maintain a level orientation and correct a condition in which the shield begins to roll.



- G. Steering corrections made to the alignment are to be carried out in such a manner that the joint angle of any two adjacent pipes or Initial Support segments does not exceed allowable limits.
- H. Record, at a minimum, the following data which will be made available to the Engineer:
  - 1. Maximum jacking load encountered during each segment advance;
  - 2. Cutter head torque;
  - 3. Steering pressures utilized to maintain or return to design line and grade;
  - 4. Cutter head RPM; and
  - 5. Line and grade.

#### 3.04 LUBRICATION OF CASING PIPE

- A. For Initial Support methods using Casing Pipe, provide the means to inject lubrication into the overcut annulus.
- B. Provide adequate protection for the lubrication system to withstand all anticipated ground conditions as described in the GBR.
  - 1. Breakage or failure of the lubrication system shall not relieve the Contractor of its responsibility to install the Casing Pipe as required or for excessive settlement of the ground surface or other underground structures.
- C. Maintain the overcut annulus full of lubrication at all times from the start of jacking or ramming until the installation of Casing Pipe is complete.

#### 3.05 OBSTRUCTION DURING TUNNELING

- A. Remove, clear, or otherwise make it possible for the tunneling equipment and Initial Support to progress past, or through an Obstruction in accordance with the Contractor's submitted contingency plan.
- B. Additional payment for Obstruction removal will be made if the object is found to meet the definition of an Obstruction and subject to the following requirements:
  - 1. Notify the Owner in writing on the same calendar day as encountering the Obstruction.
  - 2. Notify and obtain approval from affected Governing Agencies of the intent to excavate to remove the Obstruction if excavation is necessary within the right-of-way limits of affected Governing Agencies.
  - 3. Submit a complete plan for removal of the Obstruction including estimated time and costs to the Owner prior to starting Work to remove the Obstruction.
  - 4. Upon written authorization by the Owner, proceed with removal of the Obstruction by means of the approved removal procedure.
  - 5. No excavation to remove the Obstruction will be allowed without the Owner being present.
- C. If the Obstruction is such that the tunnel is at risk of endangering life and/or property, the Contractor is directed to work 24-hours/7-days per week as necessary to create a stable and safe condition. Requirements in Section 3.05.B apply thereafter.

### 3.06 QUALITY CONTROL

- A. Perform all Tunnel Excavation and Initial Support work in the presence of the Engineer, unless the Engineer has granted prior approval in writing to perform such work in their absence.
- B. Perform all work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the most restrictive applicable requirements.

### 3.07 TUNNEL LINE AND GRADE TOLERANCES

- A. At a minimum, the tunnel is to be within 6 inches of the design line and 3 inches of the design grade, or sufficiently true and accurate to the design alignment and profile to allow for accurate placement of the Carrier Pipe, whichever is more stringent. Installed Initial Support not meeting the tolerances indicated will be reconstructed or replaced at the Contractor's cost.
- B. The Initial Support will allow for a clearance of at least 3 in. between the outside of the Carrier Pipe and the closest point of the Initial Support in all directions.
- C. Changes in Initial Support alignment and grade during installation are to be made gradually such that joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- D. If the Initial Support is off line and/or grade by more than the specified tolerances, make adjustments, repairs and changes as necessary to achieve the specified tolerances.
- E. If the tunnel is sufficiently far off line and/or grade to require redesign of structures, acquisition of easements, or backfilling and re-excavation, the Contractor shall be responsible for doing all necessary additional work as determined by the Engineer and all associated costs. If the Initial Support is off line and/or grade by an amount that requires, in the opinion of the Engineer, re-design of any structure, the Contractor is responsible for all redesign costs.
- F. The Contractor is responsible for setting control points and controlling the line and grade of the tunnel as necessary to achieve the specified line, grade and tolerances for the Initial Support.

### 3.08 SAFETY REQUIREMENTS

- A. Designate a site or project Safety Officer. The Safety Officer will administer an accident prevention program and prepare a code of safe practices and an emergency plan. Provide the Engineer with a copy of each prior to starting tunnel excavation. Hold safety meetings and provide safety instruction for new employees and site visitors.
- B. Lighting Work Areas: Provide all work areas with sufficient lighting to facilitate proper performance and inspection of work, provide safe passage between the installation Shaft and Tunnel heading, and be in accordance with applicable federal, state and local laws, safety codes, regulations, and ordinances.



### 3.09 TUNNEL ACCESS

- A. Provide safe access for the Owner and Engineer during active tunnel work. Access will be for, but not be limited to, the following: to inspect and observe the work; to perform independent line and grade surveys; for geologic mapping, for monitoring of instrumentation; and for installation of additional instrumentation.

### 3.10 EXCAVATED MATERIAL

- A. Transport and dispose of all excess excavated materials and muck properly away from the construction site in such a fashion that trucks and other vehicles do not create a dirt nuisance on roads and pathways.
- B. Secure the required permits and promptly remove and dispose of any spillage and excess muck as required.

### 3.11 CLEANUP AND RESTORATION

- A. Remove all equipment, unused materials, and debris from the site once the required work has been completed. Restoration will follow construction as the work progresses and be completed as soon as possible. Restore and repair any damage resulting from surface settlement or heave caused by the work immediately. Any property or improvements damaged or destroyed, will be restored to a condition equal to or better than existing prior to construction at no additional cost to the Owner. Restoration will be completed immediately, if a third party or the Owner are inconvenienced by the damage, and in no case later than thirty (30) days after the damage is discovered. This provision for restoration includes all property which was affected by the construction operations.

### 3.12 CONSTRUCTION RECORDS

- A. Maintain Written Daily Logs for all components and phases of tunnel construction. Submit Daily Logs to the Owner or Engineer within two working days. The Daily Logs are to be signed by the site Superintendent or shift foreman and contain the following:
  - 1. Subcontractors onsite with their personnel and equipment, and the work performed. The reports are to be broken down into work time and down/standby time for each Subcontractor;
  - 2. Work crews and equipment onsite, and the work performed. The reports are to be broken down into work time and down/standby time for each crew and piece of equipment;
  - 3. Progress made for each construction stage;
  - 4. Survey results – line and grade;
  - 5. Problems or unusual conditions encountered and actions taken to address these situations;
  - 6. Record of safety meetings conducted; and,
  - 7. List of visitors to construction site.
- B. Maintain records of all surveys.
- C. Maintain records of the tunnel excavation including but not limited to the following:
  - 1. The station of the face of the excavation and advance distance;

2. The position of the tunneling face or machine in relation to the design line and grade;
  3. The maximum jacking load encountered during each Initial Support segment advancement.
  4. The date, starting time, and finish time;
  5. Any unusual conditions, breakdowns, and delays; and
  6. Excavated muck quantity.
- D. Maintain records of all monitoring of the during construction including but not limited to the following:
1. Description and position of complete and partially complete Initial Support installed;
  2. Description of ground type and conditions, and ground behavior; and
  3. Inconsistencies such as unusual spacings, deformations, and unusual performance.
- E. Construction Record Drawings. Keep and maintain at the construction site a complete set of final design drawings for recording as-built conditions. It will have been marked or noted thereon all field information, properly dated, recording as-built conditions. This set of field drawings will be kept up-to-date during construction. The record drawings will be updated at least once every week to current conditions. The record drawings will contain the following as a minimum:
1. Locations (line and grade) of the installed Initial Support as required herein.
- F. As-built drawings shall be submitted and accepted by the Engineer prior to recommending final payment.

### 3.13 PROGRESS MEETINGS.

- A. Contractor's onsite foreman to attend the periodic hour-long (weekly or bi-weekly) construction meetings in person during a time frame of two weeks before the active tunneling operations to two weeks after the active tunneling operations for each tunnel.

END OF SECTION



SECTION 02430  
CONTACT GROUT

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Section includes requirements for conducting Contact Grouting of overcut and voids outside the Initial Support.
- B. Requirements in this Section apply to all tunnels on the project. Submittals must be provided for each tunnel separately.

1.02 RELATED WORK:

- A. Related documents and Specification Sections include but are not necessarily limited to:
  - 1. 02065 – Concrete
  - 2. 02470 – Geotechnical Instrumentation and Monitoring
  - 3. 02411 – Tunnel Excavation and Initial Support
  - 4. 02450 – Carrier Pipe Installation and Backfill
  - 5. 02444 – Construction Shafts
  - 6. Geotechnical Baseline Report (GBR), Lithos Engineering
  - 7. Geotechnical Data Report (GDR), Lithos Engineering

1.03 DEFINITIONS

- A. CONTACT GROUT: An approved mixture of Portland cement and water used to fill the annular overcut space created during tunneling.
- B. CONTACT GROUTING: The filling of the overcut and voids in the ground or between the ground and Initial Support.
- C. GROUT PORTS: Location along the tunnel Initial Support where grout is injected in the overcut and void space.
- D. See Section 02411 – Tunnel Excavation and Initial Support for additional definitions.

1.04 REFERENCE STANDARDS:

- A. ASTM C150 – Standard Specification for Portland Cement.
- B. ASTM C827 - Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
- C. ASTM C942 – Test Method for Compressive Strength of Grout for Pre-placed Aggregate Concrete in the Laboratory.

## 1.05 GENERAL REQUIREMENTS

- A. The Contractor is responsible for construction and performance of the Contact Grouting on this project.
- B. The Contractor is responsible for developing and implementing Contact Grouting to fulfill the specified requirements necessary for completion of the work.
- C. The Contractor will provide testing of materials and verification of material properties.
- D. The Contractor will provide the Engineer with a schedule of Contact Grouting activities at least two (2) weeks before beginning grouting, and update weekly. Notify the Engineer at least one working day in advance of schedule changes.

## 1.06 QUALIFICATIONS:

- A. The Contractor will be experienced in grouting tunnels and underground projects using methods, materials, and equipment comparable to this project. Demonstrate successful completion of at least three (3) grouting jobs in the last five (5) years with similar scope to the proposed Contact Grouting plan.

## 1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity. The preconstruction submittals below shall be submitted as a single package.
  - 1. Contractor Contact Grouting qualifications.
  - 2. Descriptions and shop drawings describing and illustrating methods and equipment proposed for grouting. Include at a minimum the method(s) of transporting/delivery, sequence and stages of Contact Grouting, injection locations, and verification of grouting.
  - 3. Provide the maximum anticipated Contact Grout pressure, calculated by an engineer registered in the State of Colorado. This pressure is to be verified in the field and will not be exceeded without prior approval from the Engineer. The maximum anticipated Contract Grout Pressure is not to cause heave or distress the ground surrounding the Casing Pipe and will not damage the Casing Pipe.
  - 4. Mix design for the grout including proportions of all constituents, properties of the test results of the wet mix, and test results of the cured backfill.
    - a. Submittal will fulfill all the QA/QC requirements specified herein.
    - b. Submit test results from samples made using the same materials, including water and cement that will be used on the Project. Use of potable water will exclude submitting test results with the same water.
  - 5. Description of equipment and methods proposed to mix Contact Grout including mixing equipment, quantity controls and instrumentation.
    - a. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of grout.
  - 6. Injection methods for grout including pumping equipment, mixer, agitator, hoses, boosters, pumping distances, return flow lines, flow rates, and pressures.



- a. Include methods and description of instrumentation to monitor and control placement of the grout, and procedures to be used to verify complete placement and check for voids.
  7. Drawings and description of grout ports, plugs and valves for the ports, and materials used to plug and permanently seal the grout ports following Contact Grouting.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
1. Test results. Include results of all Contact Grout tests specified herein for the grout including but not limited to field tests and laboratory tests.
  2. Instrumentation and monitoring collected data during contact grouting as specified in Section 02470 – Geotechnical Instrumentation and Monitoring.
  3. Daily Logs as specified herein. Submit logs daily for the previous day's work within 1 day.

## PART 2 EQUIPMENT, PRODUCTS, AND MATERIALS

### 2.01 GROUTING EQUIPMENT

- A. If Contact Grout is batched onsite, the Contractor's grouting equipment is to consist, at a minimum, of:
1. Water meter in gallons;
  2. High speed shear mixer;
  3. Paddle type agitator;
  4. Grout pump; and
  5. Grouting header assembly.
- B. Provide grouting equipment with the ability to grout to the maximum grout pressure, controllable to within 0.5 pounds per square inch (psi), and controllable to within 0.5 gallons per minute (gpm).
- C. Provide controls on the proportioning and mixing of the grout sufficient to assure the designed mix is achieved.
- D. Provide a pressure gauge at the injection point with a range suitable for the expected pressures and reading to an accuracy of 0.1 psi or better.
- E. Provide a flow meter with a range suitable for the expected grout flows and measuring the rate of flow to an accuracy of 0.2 gpm or better.
- F. Provide a total flow indicator capable of measuring the grout injected at each port to an accuracy of 1 gallon or better.
- G. Provide piping with a spigot and valve at the injection point for collecting grout samples.

### 2.02 COMMUNICATIONS EQUIPMENT

- A. Provide equipment to communicate between workers in the tunnel at the grout injection points with workers outside the tunnel.

## 2.03 MATERIALS

- A. Cement: per Division 02065, Concrete.
- B. Contact Grout.
  - 1. A mixture of Portland cement and water.
    - a. Maximum water/cement ratio of 1:1 by volume.
    - b. 28-day strength of at least 500 psi.
    - c. No shrinkage when tested per ASTM C827.
  - 2. Sand may be added only with approval of the Engineer.
  - 3. Tested for compressive strength per ASTM C942.
  - 4. Use only potable water. Alternative water sources may be utilized with the approval of the Engineer.
- C. Ports and Port Patches in Initial Support.
  - 1. Ports and Port Patches in the Initial Support as shown on the Contract Drawings. The holes or ports are to be compatible with a minimum 1-inch diameter pipe nipple.
  - 2. Ports are to be pre-fabricated in Casing Pipe.

## PART 3 EXECUTION

### 3.01 CONTACT GROUTING

- A. Contact Grout using methods and procedures that track the movement of grout and verify presence of grout throughout the tunnel by injecting grout at one port and using nearby ports to detect the presence of grout. Sequentially close off and move injection points to ensure full grout coverage of voids outside of the casing pipe.
- B. The grout pressure is to be sufficient for the grout to fill voids and displace fluids surrounding the pipe. Maximum allowable grouting pressure is to be maintained from the start of grout injection of each hole to refusal of the hole.
- C. The maximum grout pressure at all locations is to be less than the pressure that would cause ground surface heave and/or cause hydraulic fracturing and/or cause damage to the Initial Support.
- D. Maximum Contact Grout injection port spacing as shown on the Contract Drawings. Contact Grout through any injection port will be considered complete when the grout take is  $\frac{1}{4}$  of a cubic foot of grout or less for a minimum of 5 minutes at maximum grout injection pressure, or when grout delivery causes rapid increases in the grout injection pressure beyond the maximum grout injection pressure.
- E. After completion of Contact Grout, replace plug, and fill or patch in accordance with Initial Support manufacturers' specifications and recommendations.



### 3.02 RIBS AND LAGGING INITIAL SUPPORT

- A. If ribs and lagging are used and stable ground exists as determined by the Engineer, Contact Grouting may be performed concurrently with Backfill Grouting through grout transmission holes cut in the Initial Support. The maximum size of a single grout transmission hole is to be one rib board spanning between two members of steel ribs.
- B. If unstable ground exists as determined by the Engineer, perform Contact Grouting through ports drilled or cut in the lagging. Follow all other requirements specified herein.
- C. Regardless of ground type, space ports as shown on the Contract Drawings similar to other Initial Support types.

### 3.03 QUALITY CONTROL

- A. Monitor and record as a minimum all data necessary to complete the required Submittals.
- B. Pressure gauges of appropriate diameters and ranges for monitoring the Contact Grout injection pressures are to be located as close as possible to the point of injection in the line transporting the Contact Grout. Contact Grouting is not permitted without pressure gauges in good working condition.
- C. The volume of grout injected is to be measured, recorded, and compared with the anticipated volume per foot of grout expected. The advance of the grout will be monitored using grout injection ports.
- D. Perform all monitoring and testing as specified and as necessary to complete all submittals.
- E. Ground Movement
  - 1. The Contractor is solely responsible for damage caused by grouting operations. The Contractor is to determine the amount of movement allowed and control movements within those limits. The Contractor at his expense, will be required to repair any damage caused by grouting.
  - 2. Surface survey points as designated in Section 31 09 13 – Tunnel Instrumentation and Monitoring are to be monitored and measured during Contact Grout pumping. If surface heave is measured during Contact Grouting, grouting at that specific Port will be immediately ceased and the Contactor will move on to the next port in series.

### 3.04 TESTING

- A. Test the Contact Grout. Obtain samples of Contact Grout at the point of discharge or alternatively at a simulated point of discharge through the same or greater pumping distance.

- B. Compression and Shrinkage Testing of Grout: A minimum of one set of five 3-inch diameter by 6-inch high cylinders shall be made for each 200 LF of contiguous tunnel. At least one set of test samples shall be made from each 75 cubic feet, or major fraction thereof, of Contact Grout placed in any one day. Test grout compressive strength at 7 days and 28 days.
- C. Testing results are to be provided to the Engineer as they become available from the Contractor-employed testing agency.

### 3.05 DAILY LOGS

- A. Maintain Daily Logs of the work. As a minimum, the Daily Logs will contain the following:
  - 1. Work hours, equipment and crews in use with persons and craft designations;
  - 2. Stations of grouting;
  - 3. Volume and pressures injected at each location and grout sequence with take at each port and observations of return from nearby holes;
  - 4. Record of holes grouted with locations, quantities, pressures, injection times, and verifications used; and
  - 5. Problems or unusual conditions encountered, and actions taken to address these situations.

END OF SECTION



## SECTION 02444

### CONSTRUCTION SHAFTS

#### PART 1 GENERAL

##### 1.01 WORK INCLUDED

- A. Section includes Requirements for construction of shafts, pits, portals and all excavations to access tunnel work including requirements for excavation, ground support, and abandonment.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Norther Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.

##### 1.02 RELATED WORK

- A. Related documents and Specification Sections include but are not necessarily limited to:
  - 1. 02470 – Geotechnical Instrumentation and Monitoring
  - 2. 02411 – Tunnel Excavation and Initial Support
  - 3. 02430 – Contact Grout
  - 4. 02450 – Carrier Pipe Installation and Backfill
  - 5. 02300 – Earthwork
  - 6. Geotechnical Baseline Report (GBR), Lithos Engineering
  - 7. Geotechnical Data Report (GDR), Lithos Engineering

##### 1.03 DEFINITIONS

- A. **SHAFTS:** The launch or retrieval locations of the tunnel installation, typically situated adjacent to the excavation, the Initial Support is installed under or at tie-in locations to the larger pipe system(s). In shallow tunneling scenarios, can also be pits or portals, excavated in a sloped manner up and away from tunneling equipment.
- B. **SHAFT SUPPORT SYSTEM:** Temporary erected support within the excavated Shafts to create a safe location for launch and retrieval of the tunnel installation. Shaft Support Systems commonly include but are not limited to trench boxes, slide rails, sheet piles, ring beams and liner plate, or soldier pile and lagging.
- C. See Section 02411 – Tunnel Excavation and Initial Support for additional definitions.

##### 1.04 REFERENCE STANDARDS

- A. Occupational Safety and Health Administration (OSHA) Regulation 1926 Subpart P, Excavations.

## 1.05 GENERAL

- A. Be fully responsible for the construction pits, shafts, or shaft support systems.

## 1.06 REQUIREMENTS

- A. The Contractor will determine the shaft footprint size, methods of excavation, ground control, ground support type, and allowable excavation slopes needed to perform the work and provide access for tunnel construction subject to the limitations specified herein and elsewhere in the Contract Documents.
- B. Ground support for shafts and excavations shall stay within established easements unless the Contractor obtains additional easements, permits and approvals from affected property owners.
- C. Where excavations are undertaken near any structure or facility including but not limited to buildings, highways, streets, or utilities; do not alter, damage, impair, or interfere with the operation of the structure or facility.

## 1.07 GROUND CONDITIONS:

- A. Information regarding the ground conditions can be found in the GDR and GBR.

## 1.08 QUALIFICATIONS

- A. The onsite Foreman or Superintendent for shaft construction shall have successfully completed at least two (2) similar jobs within the last five (5) years using excavation and support methods similar to those proposed by the Contractor. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- B. The Shaft Support Designer shall have successfully designed at least two (2) similar jobs within the last five (5) years using excavation and support methods similar to those proposed by the Contractor. These jobs must be completed at the time of bidding to count as relevant experience for this project.
- C. All personnel employed by the Contractor in the work shall be experienced and competent in their respective tasks and shall work only under the direct control of a suitably experienced supervisor.
- D. Shaft Support Designer shall be a Registered Colorado Professional Engineer with qualifications as listed under Section 1.08.

## 1.09 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity.
  - 1. Shaft Work Plan including:
    - a. Description and shop drawings of the shafts, components of the shaft, and shaft excavation.
    - b. Details of proposed methods and procedures for excavating shafts.
    - c. Proposed shaft size and shape.
    - d. Layout and proposed location(s) of shaft and tunnel support equipment.



2. Shaft Support including:
    - a. Descriptions and shop drawings describing and illustrating the type of Shaft Support System proposed, methods of installation, and equipment proposed to install the support.
  3. For Shafts greater than 20 feet in depth, provide Shaft support design calculations including loads, methods, assumptions, results, and safety factors. Shaft support shall consider support around the openings where the tunnel will exit the launch shaft and enter the receiving shaft. Calculations shall be signed and stamped by the Shaft Support Designer.
  4. As necessary, Thrust Block design as part of the shaft to withstand applied Casing Pipe installation loads. The design shall include loads, methods, assumptions, results, and safety factors.
    - a. Thrust Block designer shall be a Registered Colorado Professional Engineer with at least five years of experience with the design of tunnels and shafts.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
1. Written Daily Logs. The Daily Logs shall have field logs submitted to the Engineer. As a minimum, the logs shall include:
    - a. The depth of excavation at each shaft.
    - b. The number of people on the crew.
    - c. Method of excavation.
    - d. Shaft support installed.
    - e. Description of the soils encountered, position of different soils layers, estimated groundwater inflow rates and depths, and description of ground behavior.
    - f. Any unusual conditions, breakdowns, and delays.
- C. Postconstruction Submittals:
1. Record of what shaft support elements remain in the ground with location and top elevation.
  2. Written Daily Logs shall be provided for Shafts prior to initiating tunnel construction.

## PART 2 EQUIPMENT, PRODUCTS, AND MATERIALS

### 2.01 EQUIPMENT

- A. Excavation Equipment. The Contractor will determine the equipment used to excavate the shafts.
- B. Ancillary Equipment. The Contractor will determine the equipment used for all ancillary work including but not limited to spoil removal, materials transfer, and tunneling utilities.

### 2.02 MATERIALS

- A. Contractor will determine the type and design the shaft temporary support.

## PART 3 EXECUTION

### 3.01 GENERAL EXECUTION

- A. The Contractor will determine the shaft and excavation sizes and shapes subject to easement, utility, and property limitations.
- B. Perform excavations in a manner that will limit loss of ground and limit settlement of the ground surface, structures, and utilities above and adjacent to the shafts.
- C. Designate an OSHA Competent Person and identify and adhere to all relevant OSHA regulations.

### 3.02 EXCAVATION SUPPORT SYSTEMS

- A. Design and construct shafts to withstand all imposed loads, including at a minimum, ground conditions identified in the GBR, dynamic loads from equipment, applicable live loading conditions, and surcharge loads from materials.
- B. Grade ground surface in the vicinity of shafts to prevent surface water from entering the excavation.

### 3.03 RESTORATION

- A. All structures and utilities modified or moved shall be restored to the original condition or as determined by the Engineer.

### 3.04 ABANDONMENT

- A. Backfill around pipes and manholes inside shafts to the spring line of the pipe with flowable fill and pipe bedding in accordance with the Construction Drawings. Backfill shafts above spring line in lifts with approved materials in accordance with 02300 Earthwork.
- B. Backfill shafts and excavations with specified and approved materials and methods in accordance with Project Specifications.
- C. Remove all structural elements within five feet of the ground surface that are used for support of shafts and excavations. Any materials left in the ground shall be approved by the Engineer and surveyed and documented on the Record Drawings.

END OF SECTION



## SECTION 02450

### CARRIER PIPE INSTALLATION AND BACKFILL

#### PART 1 GENERAL

##### 1.01 WORK INCLUDED

- A. This section covers requirements for installation of the Carrier Pipe in the tunnel and backfilling the annulus between the Carrier Pipe and Initial Support with Backfill Grout.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.

##### 1.02 RELATED WORK

- A. Related Documents and Specification Sections include but are not necessarily limited to:
  - 1. 02411 – Tunnel Excavation and Initial Support
  - 2. 02430 – Contact Grout
  - 3. 02444 – Construction Shafts
  - 4. 02470 – Geotechnical Instrumentation and Monitoring
  - 5. Geotechnical Baseline Report (GBR), Lithos Engineering
  - 6. Geotechnical Data Report (GDR), Lithos Engineering

##### 1.03 DEFINITIONS

- A. **BULKHEAD:** Material placed between the Carrier Pipe and the Initial Support used to contain the Backfill Grout during placement. Bulkheads are typically required at both ends of a tunnel and may also be located at intermediate locations within a tunnel to contain the Backfill Grout in the annular space between the Carrier Pipe and Initial Support.
- B. **BACKFILL:** Filling of the annular space between the Carrier Pipe and Initial Support.
- C. **BACKFILL GROUT:** Flowable material to be used in the Backfill operations; can be Cellular Grout or Flyash Grout.
- D. **CELLULAR GROUT:** A low density, lightweight, cementitious material that contains stable air or gas cells as preformed foam uniformly distributed throughout the mixture.
- E. **CONTACT GROUTING:** As defined in Section 02430 – Contact Grout.

- F. FLYASH GROUT: A self-leveling and self-compacting, cementitious material using pozzolanic flyash as the primary cementitious material.
- G. See Section 02411– Tunnel Excavation and Initial Support for additional definitions.

#### 1.04 REFERENCE STANDARDS

- A. ASTM C495 – Standard Test Method for compressive strength of lightweight insulating concrete.
- B. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
- C. ASTM C796 – Standard Test Method for foaming agents for use in producing Cellular Grout using preformed foam.
- D. ASTM C869 – Standard Specification for foaming agents used in making preformed foam for Cellular Grout.
- E. ASTM C939 – Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method)
- F. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material Test Cylinders
- G. ASTM D5971 – Standard Practice for Sampling Freshly Mixed Controlled Low-Strength Material
- H. ASTM D6023 - Standard Test Method for Density (Unit Weight), Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low-Strength Material
- I. ASTM D6103 - Standard Test Method for Flow Consistency of Controlled Low Strength Material

#### 1.05 GENERAL REQUIREMENTS

- A. Contractor shall be responsible for design, construction, and execution of the carrier pipe installation and pipe backfill.
- B. Minimum design requirements are presented herein. It is the Contractor's responsibility to develop and implement the design to fulfill the specified design requirements determined by the Contractor which are necessary for completion of the work.
- C. Requirements
  1. Install Carrier Pipe without damage and to the grades shown and specified.
  2. Restrain Carrier Pipe from movement due to buoyant and other forces during Backfill Grouting.
  3. Backfill annulus outside Carrier Pipe fully with Backfill Grout.



4. Introduce Backfill Grout into the annulus outside the Carrier Pipe using grout lines (slick lines) secured to the Carrier Pipe or Initial Support or directly from the shafts. Grout ports through the Carrier Pipe are not allowed.
5. Introduce Backfill Grout in tunnels at a spacing of not greater than 1/3 the total tunnel length through the use of slicklines, or other approved method(s).
6. Provide testing of materials and verification of material properties as required herein.
7. Notification.
  - a. Provide the Owner's Representative with a schedule of Carrier Pipe installation and Backfill Grouting activities at least three (3) weeks before beginning pipe installation, and update weekly.
  - b. Notify the Owner's Representative at least one working day in advance of schedule changes.

D. Pipe Installation Methods

1. Install Carrier Pipe in the tunnel either incrementally or by jacking or pulling a pre-assembled pipe string as determined by the Contractor.
2. Utilize casing spacers or other approved blocking method on the Carrier Pipe to prevent pipe movement.
3. Utilize the manufactures (Hobas) recommended joint restraint methods or devices to prevent pull-out or over-assembling of Carrier Pipe joints.

## 1.06 QUALIFICATIONS

- A. The Contractor will be experienced in the installation of pipe in tunnels and backfilling annular spaces using methods, materials, and equipment comparable to this project.
- B. Designate Installation and Backfill Grouting Experts. The Installation and Backfill Grouting Experts may be the same person. The Experts will have the a minimum of the following experienced:
  1. Be thoroughly knowledgeable about the transportation, placement, and securement of prefabricated pipe in tunnels.
  2. Successfully have completed at least two (2) similar projects in which the pipe was placed in the Initial Support using the same methods as proposed for this project.
  3. Successfully have completed at least two (2) similar projects in which the pipe annulus in a tunnel was backfilled with Flyash Grout or Cellular Grout as applicable.
  4. Be thoroughly knowledgeable about mixing, pumping and placement of Backfill Grout, including Flyash Grout or Cellular Grout as applicable, in tunnels.

## 1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity. Preconstruction submittals detailed below shall be submitted for approval as a single package.
1. Qualifications of pipe Installation and Backfill Grouting Experts (may be the same person).
  2. Descriptions and shop drawings describing and illustrating methods and equipment proposed for installation of the Carrier Pipe in the tunnel. The submittal will address, as a minimum, pipe:
    - a. Transportation,
    - b. Section joining,
    - c. Line and grade surveying, and
    - d. Line and grade control.
  3. Methods, procedures, and equipment for monitoring, controlling, and adjusting the alignment of the Carrier Pipe in the tunnel prior to Backfill Grouting.
  4. Descriptions, Shop Drawings, and calculations for securing the pipe during Backfill Grouting. Submit calculations which evaluate:
    - a. Theoretical annulus volume for actual Initial Support ID and Carrier Pipe OD with adjustments for bells and spacers.
    - b. Buoyant force(s) generated during backfilling of each stage.
    - c. Loads and deflection of tiedowns, bracing, and spacers.
    - d. Bearing stresses on the pipe and the tunnel walls from the tiedowns or braces.
    - e. Bending stresses on the pipe between tiedowns or braces.
    - f. Maximum allowable backfill injection and head pressure (if a pump is used)
    - g. The calculations shall be prepared, stamped, and signed by a Professional Engineer registered in the State of Colorado.
  5. Description of equipment and methods proposed to mix Backfill Grout including:
    - a. Mix design and results of preconstruction tests for the Backfill Grout. Results of tests on trial batches conducted as part of grout mix design and pre-grouting verification testing.
    - b. Mixing equipment
    - c. Quantity controls
    - d. Instrumentation
    - e. Description of trial batches, trial batch testing and proof of acceptable delivery and placement of Backfill Grout in the tunnel.
  6. Description of injection methods for Backfill Grout including:
    - a. Pumping equipment
    - b. Delivery equipment (hoses, valves)
    - c. Pumping distances and delivery points
    - d. Flow rates
    - e. Pressures
    - f. Bulkhead details
    - g. Proposed orientation of all grout and ventilation pipes.



- h. Methods and description of instrumentation to monitor and control placement of the backfill, and procedures to be used to verify backfill volumes.
  - i. Method and procedures to handle excessive flowing water if criteria in Section 3.07.L herein, are met.
7. Pipe manufacturer certification letter stating that the proposed backfill materials and methods are acceptable for the carrier pipe type.
8. Trial batch results demonstrating the same mix design that includes:
- a. Date of mix performed and reported
  - b. Mix number
  - c. Materials
  - d. Sources
  - e. Physical properties
  - f. Compressive strength results

- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
- 1. Survey results. Surveys will be conducted and submitted as specified herein.
  - 2. Daily Field Reports.
  - 3. Field installation logs having as a minimum, stations and length of Carrier Pipe installed and volume of Backfill Grout delivered; Submit logs daily. Provide copies of reports as required by public authorities to the Engineer within 24 hours following preparation and submittal to third party authority. These reports are for record purposes only.
- C. Postconstruction Submittals:
- 1. Survey of the line and grade of the Carrier Pipe in the tunnel.
  - 2. Compressive strength results of Backfill Grout.

## PART 2 EQUIPMENT, PRODUCTS AND MATERIALS

### 2.01 MATERIALS

- A. Carrier Pipe: as shown on the Contract Drawings and as specified in the Contract Documents.
- B. Backfill Grout will have the following properties:
- 1. Flowable through delivery lines and in tunnel annulus
  - 2. Have a heat of hydration that will not weaken or otherwise harm pipe materials.
  - 3. Viscosity is to be low enough to allow grout to completely fill all voids in the annulus between the Carrier Pipe and the Casing Pipe.
    - a. Efflux time through a Flow Cone per ASTM C 939 will be no greater than 22 seconds.

4. Minimum 28-day compressive strength of 300 psi. Test in accordance with ASTM C 495.
  5. Minimum wet density of 45 pcf unless water is present in the tunnel at which point a minimum wet density of 65 pcf is required, or per the direction of the Engineer.
  6. Additives may be used only with review per approval of the Engineer.
  7. Non-shrink mix.
  8. Grout will be a mix of potable water and cement and/or flyash or foamed Cellular Grout. No aggregates are allowed.
    - a. Cellular Grout:
      - 1) Cement: Portland Type I/II.
      - 2) Foaming agent for Cellular Grout: in accordance with ASTM C 869.
        - a) Test in accordance with ASTM C 796.
    - b. Flyash Grout:
      - 1) Flyash Grout is to composed of:
        - a) Type C Flyash, water, and a set retarder, or
        - b) Type F Flyash, cement, water, and a set retarder. Cement to Flyash ratio is not be greater than 0.25:1 by weight.
- C. Pipe Securement: secure pipe using prefabricated spacers or other approved bracing.
1. Spacers:
    - a. Specifically designed for placing Carrier Pipe in tunnels and as skids for the pipe to ride on during installation.
    - b. Variable in size or adjustable to place the position of the Carrier Pipe taking into account variations of the tunnel and Initial Support.
    - c. Design to have sufficient contact points with the Carrier Pipe and the tunnel Initial Support to resist damage/deformation to carrier from buoyancy caused by Backfill Grouting.
  2. Bracing: wood, steel, or other system that is rigid under the imposed loads and does not damage the Carrier Pipe.
- D. Bulkhead Closure:
1. Provide Bulkheads at the ends of the pipe to prevent spillout of the Backfill Grout and not damage or degrade the Initial Support or Carrier Pipe during installation or over the life of the structure.
  2. Provide venting at the crown of the annulus between Carrier Pipe and Initial Support at the highest elevation to ensure the tunnel is fully evacuated of water/air and filled with grout.
  3. Brick and mortar, concrete, or Engineer approved equivalent will be used for the Bulkhead.



## PART 3 EXECUTION

### 3.01 GENERAL

- A. The Carrier Pipe is to be internal braced, if necessary, to protect the pipe and control deflections including out-of-round distortions during transportation, handling, and installation.
- B. Pipe installation and Backfill Grouting is to be conducted under the direct supervision of the Installation and Backfill Grouting Expert(s).

### 3.02 PREPARATION

- A. Do not commence with pipe installation until the tunnel is prepared for pipe installation in accordance with the following requirements:
  - 1. The tunnel excavation has been stabilized and Contact Grouting has been completed outside the Initial Support as specified in Section 02430 – Contact Grout.
  - 2. The alignment of the tunnel has been surveyed and has been verified to allow for installation of the Carrier Pipe to the specified tolerances and clearances.
  - 3. The tunnel has been cleaned as specified herein.

### 3.03 SURVEYS

- A. Surveys are to be at intervals not exceeding 20 ft and will be for both line and grade to an accuracy of 0.01 ft or better.
- B. Conduct the following surveys:
  - 1. Completed tunnel Initial Support prior to installation of the Carrier Pipe.
  - 2. Carrier Pipe invert prior to Backfill Grouting.
  - 3. Carrier Pipe invert after Backfill Grouting.

### 3.04 QUALITY CONTROL

- A. Test methods are to be in accordance with ASTM C 495.
  - 1. Cast the specimens into cylinders at least 3 inches in diameter and 6 inches tall.
  - 2. Separate and remove the specimens for testing by cutting and trimming the forming material surrounding the cylinders.
- B. Backfill Grout Mix Design:
  - 1. Two sets of compression test specimens will be made.
  - 2. Test one set of specimens at an age of 7 days and the other set at an age of 28 days.
  - 3. Test mix for unit weight at the time of cylinder casting.

- C. Index Testing of Backfill Grout:
  - 1. Conduct set of index tests from the first batch of Backfill Grout mixed each day, after a change in mix design, and from each batch of Backfill Grout from which compression test specimens are made.
  - 2. Conduct index tests a maximum of every two hours from each batch to verify the grout properties.
  - 3. Include as a minimum the following index tests at the time of placement:
    - a. Wet unit weight (wet density)
    - b. Ambient temperature
    - c. Grout temperature
    - d. Efflux time through Flow Cone
- D. Compression Testing of Backfill Grout:
  - 1. Make a minimum of one set of 5 specimens each day when up to 25 cubic yards of Backfill Grout is placed.
  - 2. Make at least one additional set of specimens from each additional 50 cubic yards, or major fraction thereof, placed in any one day, but no more than three sets of specimens for each day.
  - 3. Test two specimens of each set at an age of 7 days and 2 specimens at an age of 28 days.
    - a. Hold one specimen in storage.

### 3.05 TOLERANCES AND CLEARANCES

- A. The Carrier Pipe is to be installed to the line and grade specified in the Technical Specifications and Drawings.
- B. The Carrier Pipe will have a clearance of at least 3 inches between the outside of the pipe and the closest point of the Initial Support system in all directions.
- C. Changes in Carrier Pipe alignment and grade will be made gradually such that pipe joints are mated within the pipe manufacturer's specifications, fully functional, and not compromised in any way.
- D. Reverse grades will not be allowed.
- E. If the Carrier Pipe is off line and/or grade by more than the specified tolerances, the Contractor will make adjustments, repairs and changes as necessary to achieve the specified tolerances.
- F. If the Carrier Pipe is off line and/or grade by an amount that requires, in the opinion of the Engineer, re-design of any structure, the Contractor will be responsible for all redesign costs.



### 3.06 INSTALLATION METHODS

- A. Install the pipe into the tunnels by sliding an assembled pipe string into the tunnels by jacking or pulling, or both. Alternatively, individual sections of pipe may be carried into the tunnel and mated in place.
- B. Complete each joint by mating per the manufacturer's requirements and the Contract Documents.
- C. Adjust the position of the Carrier Pipe within the spacers as necessary to achieve proper line and grade when the pipe is at the final position.
- D. Securing: Ensure that the pipe and each pipe segment is firmly secured to prevent flotation, settlement, lateral and axial movement, and pipe deflection during Backfill Grouting.

### 3.07 BACKFILLING METHODS

- A. Before placement of Backfill Grout in the tunnel, demonstrate, using trial mixes of the same design as those proposed for use and the same equipment proposed for placement, the ability to produce Backfill Grout of the required density and strength. Demonstrate the ability to pump the Backfill Grout mix the distances proposed without loss of Backfill Grout quality; may be based on previous projects.
- B. Completely backfill the annulus between the Carrier Pipe and the Casing Pipe with Backfill Grout. Placement methods will facilitate complete filling of the spaces below the Carrier Pipe and around the Carrier Pipe support system components.
- C. Place Backfill Grout in multiple lifts to prevent pipe flotation unless stiffeners or pipe supports, and closely spaced blocking of sufficient structural rigidity are provided to prevent pipe flotation, movement, or damage to the pipe. Lift thickness required to prevent flotation and damage to the pipe will be determined by the Contractor as represented in the required submittal calculations.
- D. Do not subject the Backfill grout to free fall greater than 10 feet.
- E. The pressure of the backfill against the Carrier Pipe must not exceed manufacturer limitations at any time and at any location.
- F. If the grout is to be pumped, create a pressure break between the pump and the injection point to prevent grout being pumped directly into the liquid grout pool inside the tunnel annulus.
- G. The Contractor may elect to inject Backfill Grout into the tunnel at the shaft(s) or from within the tunnel depending on the pipe installation method. Spacing of discharge points is specified in Section 1.05 to assure continuity between discharge points.
- H. Backfill grout is to be injected from the top of the shafts or pumped from the base of the shaft.
  - 1. Vertical drop holes along the tunnel length will not allowed.

- I. If the complete filling of the annulus and voids is not verified during backfilling, conduct a secondary grouting program to fill the remaining annulus and voids.
- J. Maintain a supply of swabs and compressed air at the tunnel at the location of the backfilling operations or the bulkhead as appropriate to facilitate cleaning of injection lines or outlets as necessary.
- K. To prevent contamination of the Backfill Grout, do not introduce water into the tunnel through injection lines.
- L. Flowing Water
  - 1. If water is inflowing from the ground into the tunnel at a rate greater than one gallon per minute at any location, it must be directed to the invert and controlled in a manner that prevents backfill grout washout.
  - 2. Develop a plan to direct water using panning, drain pipes, drain rock, etc. prior to grouting.
  - 3. Fill drain pipes, drain rock, etc with grout once the primary annulus backfill grouting is complete.

### 3.08 CONSTRUCTION RECORDS

- A. The Contractor shall maintain Daily Field Reports for pipe installation and annular sealing. The Field Reports shall be signed by the site superintendent or shift foreman and shall contain the following:
  - 1. Crews and subcontractors onsite with their personnel and equipment, and the work performed. The reports shall be broken down into work time and down/standby time for each crew and subcontractor;
  - 2. Record of pipe installed;
  - 3. Pipe joining reports;
  - 4. Record of annular sealing materials, and configuration of the seals;
  - 5. Quantity of Backfill installed;
  - 6. Materials testing agency including index testing and specimens;
  - 7. Problems or unusual conditions encountered and actions taken to address these situations.

END OF SECTION



## SECTION 02470

### GEOTECHNICAL INSTRUMENTATION AND MONITORING

#### PART 1 GENERAL

##### 1.01 WORK INCLUDED

- A. This section presents requirements for installation, monitoring, and removal of instrumentation for monitoring of ground movements before, during, and after tunnel construction.
- B. Requirements in this Section apply to the tunnel crossing of the Regional Transportation District (RTD), Burlington Northern Santa Fe (BNSF), and Union Pacific Railroad (UPRR) railroad lines for the project.

##### 1.02 RELATED WORK

- A. Related Specification Sections include but are not limited to:
  - 1. 02411 – Tunnel Excavation and Initial Support
  - 2. 02430 – Contact Grout
  - 3. 02450 – Carrier Pipe Installation and Backfill
  - 4. 02444 – Construction Shafts
  - 5. Geotechnical Baseline Report (GBR), Lithos Engineering
  - 6. Geotechnical Data Report (GDR), Lithos Engineering

##### 1.03 DEFINITIONS

- A. GOVERNING AGENCY: Agency which owns and/or operates the property in which the tunnel work will be conducted.
- B. INSTRUMENT SPECIALIST: Party responsible for the installation, maintenance, and monitoring instrumentation.
- C. INSTRUMENTATION SURVEYOR: Party responsible for performing survey and establishing baseline readings for surface survey points, monitoring point arrays, and utility monitoring points.
- D. MONITORING POINT: General terminology referencing a Surface Survey Point and/or Utility Monitoring Point.
- E. MONITORING POINT ARRAY: A series of Surface Survey Points arranged in a row to monitor surface movement.
- F. RESPONSE VALUES: Recorded differential movement at which point a necessary change to the construction means and methods needs to be implemented to prevent damage to overlying or adjacent existing road surfaces or utilities.

- G. SURFACE SURVEY POINT: Monitoring locations at which the roadway and or rail lines will be monitored for horizontal and vertical movement during tunnel and shaft construction.
- H. PAVEMENT OR SIDEWALK SURVEY POINT: Monitoring locations at which the roadway will be monitored for horizontal and vertical movement during tunnel and shaft construction. Referred to as Surface Survey Point throughout.
- I. UTILITY MONITORING POINT: Location at which utilities will be monitored for vertical movement during tunnel and shaft construction.
- J. See Related Specification Section 02411 – Tunnel Excavation and Initial Support for additional definitions.

#### 1.04 GENERAL

- A. The Contractor shall monitor, at a minimum, all locations noted on the Geotechnical Instrumentation and Monitoring sheets of the Contract Drawings for movement during and after tunnel construction.
- B. Minimum requirements are presented herein. It is the Contractor's responsibility to implement the monitoring plan as specified herein or as necessary to ensure the safe completion of the work and prevent damage to existing infrastructure.

#### 1.05 REQUIREMENTS

Minimum instrumentation and monitoring requirements are presented herein.

- A. Designate an Instrumentation Specialist to oversee installation and monitoring of instrumentation. The Instrumentation Specialist will develop the instrumentation plan then supervise and be responsible for the instrument installation, maintenance, and monitoring. As built and baseline surveys associated with the instrumentation shall be under the direction of and reviewed by the Instrumentation Surveyor.
- B. Positively identify all utilities within the project location.
- C. Obtain applicable permits from Governing Agencies and utility owners to perform instrumentation and monitoring work.
- D. Remove or abandon in place all instrumentation in accordance with applicable laws, regulations, and guidelines following completion of construction.
- E. As a minimum install all instrumentation as shown in the Contract Drawings and in accordance with this specification.



## 1.06 QUALIFICATIONS

- A. Instrumentation Specialist: The Instrumentation Specialist shall have experience working on tunneling projects where installation, maintenance and monitoring of geotechnical instrumentation similar to those specified herein are required. The Instrumentation Specialist will have had direct involvement in directing or installing instrumentation and monitoring and working with the Instrumentation Surveyor to monitor and collect survey data. The Instrumentation Specialist shall have served in a similar capacity on a minimum of two (2) tunnel projects in the previous five (5) years.
- B. Instrumentation Surveyor: The Instrumentation Surveyor shall be a licensed Professional Surveyor in the State of Colorado and shall have served in a similar capacity on a minimum of two (2) tunnel projects in the previous five (5) years

## 1.07 SUBMITTALS

- A. Preconstruction: Submit to the Engineer the following a minimum of two (2) weeks before the scheduled start of the applicable activity:
  - 1. Qualification Documentation. Submit Instrumentation Specialist and Instrumentation Surveyor as stated in Section 1.06 Qualifications.
  - 2. Geotechnical instrumentation and monitoring work plan:
    - a. Description of methods and materials for installing and protecting instruments and monitoring points.
    - b. Submit all applicable Manufacturer literature describing operation and maintenance of survey and monitoring equipment. Provide Manufacturer brochures, product descriptions and drawings of all equipment. Manufacturer literature should indicate the equipment to be used can perform to the specified accuracy and observation frequency stated in Sections 3.05 and 3.06 specified herein. A certificate issued by the instruments Manufacturer stating that the Manufacturer has inspected, calibrated, and tested each instrument before it leaves the factory is to be included.
    - c. For all instruments installed in boreholes and potholes:
      - 1) Detailed step by step procedures for installation.
      - 2) Post installation acceptance test.
      - 3) Sample installation record sheet.
  - 3. Location of any monitoring points and instruments to be installed, highlighting any points and instruments that are not included in the contract drawings.
  - 4. Permits. List permits, third party approvals including but not limited to roadway, traffic control plans if within roadways, and approval contract submittals required to perform the work.
- B. Construction: Submit the following to the Engineer during construction within the specified time restrictions:
  - 1. Installation Records. Within five days of installation of each instrument and prior to the start of tunnel construction, submit documentation including:

- a. The installed instrument location, instrument identification number, instrument type, installation date, initial baseline elevations and coordinates, and offset and stationing to alignment.
  - b. Furnish details of installed instruments showing all dimensions and materials used, a separate statement describing installation procedures for each instrument, and as-built drawings of each instrument including lengths, elevations, and dimensions.
2. Data. Provide results of initial baseline readings within 2 days of measurement. Provide initial monitoring results to the Engineer verbally immediately following measurement. Monitoring measurements shall then be provided to the Engineer in writing within 1 day of measurement.

## PART 2 EQUIPMENT, PRODUCTS AND MATERIALS

### 2.01 GENERAL

- A. Surface Survey and Utility Monitoring Points shall be flush or countersunk with the ground or roadway surface in areas where the instrument may be damaged or be an impediment to other activities.
- B. On-Rail Optical Survey Targets shall be mounted by the Instrumentation Specialist to either the railroad ties or rails in accordance with the Governing Agency of the railroad. These targets are to be mounted in a way such as to provide for accurate reading while not interfering with Railroad operations.

### 2.02 PRODUCTS

- A. Surface Survey Points: Surface survey points indicated on the drawings installed in pavement are to consist of one PK nail. Each Surface Survey Point is to be tagged or marked to indicate the identification number, tunnel station and offset from centerline..
  1. PK nails installed in pavement are to be nails that are driven or drilled and grouted into the pavement.
- B. Utility Monitoring Points: Each utility monitoring point shall consist of a pipe casing that exposes the utility and retains the ground to allow for multiple readings throughout the work
  1. Utility Monitoring Points may be a Geo Instruments Utility Monitoring Point or approved equivalent and installed as shown on the contract drawings and per Manufacturer's recommendations.
  2. Utility Monitoring Points shall be monitored using an AMTS or a displacement sensor that automatically transmits measurements to a gateway via wireless logger.
  3. Utility Monitoring Points can consist of a survey rod placed on the utility for each reading or approved equivalent and installed as shown on the contract drawings and per Manufacturer's recommendations
- C. Survey Equipment: The selected survey equipment shall have an accuracy of 0.01 feet.



## PART 3 EXECUTION

### 3.01 GENERAL

- A. Installation. Instrumentation shall be installed at the locations shown on the Contract Drawings or as directed or approved by the Engineer. All instrumentation shall be installed, and the initial readings recorded a minimum of 2 weeks prior to the start of tunnel construction, as described in section 3.05.
- B. Access. Provide and facilitate safe access to the instrumentation for the Instrumentation Surveyor and Engineer.
- C. Existing Conditions. Locate conduits and underground utilities in all areas where utility monitoring points are to be installed.
- D. Identification. All instruments shall be clearly marked, labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public.
- E. Instrument Designation. A unique instrument identification number shall be assigned to each survey point. The instrument identification number shall be clearly marked on each instrument.
- F. Surveying. Following installation, the location of the top of all survey points shall be surveyed to provide baseline horizontal and vertical coordinates. Data shall be provided to the Engineer. Re-surveying from control points shall be required monthly or more frequently to address potential disturbance or resolve conflicting data as directed by the Engineer.

### 3.02 QUALITY CONTROL

- A. Perform all work in accordance with all current applicable regulations and codes of federal, state, and local agencies. In the event of conflict, comply with the strictest or most restrictive applicable requirements.
- B. Installation:
  - 1. Written notice shall be provided to the Engineer at least 24 hours before installing monitoring instrumentation.
  - 2. Should actual field conditions prevent installation of instruments at the location and elevations shown on the Contract Drawings or specified herein, obtain prior acceptance from the Engineer for new instrument location and elevation.

### 3.03 SAFETY REQUIREMENTS

- A. Methods of installing the instrumentation are to be such as to ensure the safety of the work, project participants, the public, third parties, and adjacent property, whether public or private.
- B. Safe access to instrumentation is to be maintained for the Instrumentation Surveyor and Engineer at all times as necessary to satisfy the monitoring requirements specified herein.

### 3.04 INSTALLATION

- A. Surface Survey Points: Install surface Survey Points at locations as shown on the Contract Drawings or as approved or directed by the Engineer. Monitor surface survey points for movement in the x, y, and z directions for each reading.
- B. Utility Monitoring Points:
  - 1. Utility Monitoring Points shall be installed per manufacture recommendation or as shown on the Contract Drawings.
  - 2. The Instrument Specialist shall be responsible for any damage to the utility during installation of the Utility Monitoring Points and shall replace or repair as necessary to facilitate monitoring.
  - 3. Use one of two options to measure the elevation of each utility
    - a. A rod shall be lowered into the hole until it rests on the utility. Place centralizers around the rod to prevent it from moving in the hole. Take survey readings from the top of the rod.
    - b. Temporarily lower a survey rod down the pipe casing until it rests on the utility. Take survey readings from the rod.
  - 4. Monitor utility monitoring points for movement in the z direction only for each reading.
- C. After completion of installation, as-built location of all instruments and monitoring points shall be determined and provided to the Engineer. Horizontal positions shall be determined to an accuracy of  $\pm 0.01$  ft and the elevations to an accuracy of  $\pm 0.01$  ft.

### 3.05 MONITORING

- A. Initial Readings: The Contractor shall take initial readings of all instruments to establish a baseline and provide the Engineer with this data a minimum of 2 weeks prior to the start of tunnel construction.
- B. Frequency:
  - 1. The Contractor shall provide the Engineer with these data within 1 working day of data collection.
  - 2. At a minimum, the Contractor shall maintain the following reading schedule:



Instrument Type	Instrument Reading Schedule		After Tunneling Completion <sup>(b)</sup>
	During Shaft Construction	During Tunneling <sup>(a)</sup>	
Surface Monitoring Points	Twice Weekly	Once Daily	Weekly
Utility Monitoring Points	Twice Weekly	Once Daily	Weekly

Notes:

- a. Daily readings must be taken around the same time each day and no more than 4 hours apart, i.e. between 8 am and 12 pm for each reading.
  - b. Weekly measurements shall occur until movement between successive measurements is negligible as determined by the Engineer and monthly thereafter until the Tunnel Contractor demobilizes from the site. A minimum of two weekly readings shall be recorded after tunneling completion.
3. Perform additional monitoring as necessary to control construction and to ensure safe work completion. Closer interval readings shall be taken during periods of high precipitation or as instructed by the Engineer.
- C. Reporting: Provide final data from readings of all monitoring locations to the Engineer within 1 working day of the recorded measurements. When available, copies of field instrumentation data shall be provided verbally to the Engineer immediately after the data are collected in the field. The data shall include, but are not limited to, the following:
1. A copy of the data sheets containing a cumulative history of readings and proximity of tunnel excavation to the instrument location at the time of each reading.
  2. A copy of the plot of measured values versus time, including a time history of construction activity likely to influence such readings if readings begin to approach Response Values, as determined by the Engineer.
- D. Interpretation: The Contractor shall provide interpretations of monitoring data and submit them to the Engineer along with the data. Data or interpretations shall not be published or disclosed to other parties without advance written permission of the Owner or Engineer. The Engineer may make his/her interpretations of the data available to the Contractor.

3.06 RESPONSE VALUES:

- A. Abide by the following response values:

Instrument Type	Response Values	
	Threshold Value	Shutdown Value
Surface Monitoring Points	0.01 feet in Z 0.2 feet in any of X or Y	0.02 feet in Z 0.4 feet in any of X or Y
Utility Monitoring Points	0.04 feet in Z	0.08 feet in Z

- B. When a given response value is reached, respond in accordance with the following:
1. Threshold Value: Notify the Engineer immediately. Meet with the Engineer and Owner to: 1) review interpretation of the data and results, 2) review the construction means and methods, and 3) determine what changes, if any, shall be made to better control movement.
  2. Shutdown Value: Notify the Engineer immediately. Safely secure the tunnel taking all measures to prevent further settlement, completely close all openings at the excavation face, and stop all work inside the tunnel immediately upon closing the face and meet with the Engineer and Owner and notify affected parties including Governing Agencies and other property Owner(s) to develop a plan of action before work is resumed. Work inside the tunnel can continue if a plan of action is agreed upon by all affected parties and if substantial risk to monitored facilities is determined to not increase with further construction activity.

### 3.07 MAINTENANCE

- A. Damaged Instruments: Protect the instruments from damage. Damaged installations shall be replaced or repaired by the Instrument Specialist and approved by the Engineer prior to continuing construction at the Instrument Specialist expense. Provide new baseline readings if instruments are substantially damaged by as determined by the Engineer.
- B. Maintenance: Maintain survey monitoring locations by ensuring survey point identification tags or nomenclature is legible.

### 3.08 FINAL DISPOSITION

- A. Surface Survey Points. Remove all Surface Survey Points in accordance with applicable laws, regulations, and guidelines.
- B. Utility Monitoring Points. Remove all Utility Monitoring Point materials. Utility Monitoring Point locations shall match the previous conditions prior to Utility Monitoring Point installation.

END OF SECTION



## SECTION 02510

### WATER SYSTEM PIPING AND ACCESSORIES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes: Furnish and install all piping, including fittings, valves, and accessories as shown on the Drawings, described in the Specifications and as required to completely interconnect all piping for a complete and operable systems.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 400.
- B. American Association of State Highway and Transportation Officials (AASHTO)
- C. American National Standards Institute (ANSI)
- D. American Society of Mechanical Engineers (ASME)
- E. ASTM International (ASTM)
- F. American Water Works Association (AWWA)
- G. NSF/ANSI Standard 61 Drinking Water System Components (NSF 61)
- H. NSF/ANSI Standard 600 Drinking Water System Components (NSF 600)

##### 1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Shop Drawings:
  - 1. Layouts and schematics: Submit detailed installation drawings of all piping and connected equipment. The drawings shall include each pipe, all fittings, valves, and other appurtenances.
  - 2. Submit data to show that the following items conform to the Specification requirements:
    - a. Pipe, fittings, and accessories.
    - b. Restrained joints.
    - c. Valves.
    - d. Linings and coatings, as applicable
  - 3. All items that are submitted for use on potable water or reclaimed water pipelines including, but not limited to, piping and valve linings, solvent cements, welding materials, gaskets and gasket lubricants, and additives in concrete or cement mortar shall be NSF certified for use in water systems. Submit proof of NSF certification for each item submitted including updated NSF 600 requirements, as applicable, effective as of January 1<sup>st</sup>, 2023.
- C. Manuals: The Contractor shall furnish manufacturer's installation and operation manuals, bulletins, and spare parts lists for the following items:
  - 1. All valves over 4-inch size.
- D. Affidavits: Submit affidavits from the manufacturer of the following valves:
  - 1. Gate valves.

- E. Certified testing results for pipeline pressure and bacteriological tests, see Section 02516.
- F. The preceding submittals shall be in the Product Information Category except where noted.

#### 1.04 QUALITY ASSURANCE

- A. All materials and equipment furnished under this Section shall: (1) be of a manufacturer who has been regularly engaged in the design and manufacture of the materials and equipment for at least 5 years; and (2) be demonstrated to the satisfaction of the Engineer that the quality is equal to the materials and equipment made by those manufacturers specifically named herein, if an alternate product manufacturer is proposed.
- B. Factory Quality Control: The Contractor shall test all products as noted herein and by the reference specifications.

#### 1.05 POTHOLING

- A. Do not prepare any shop drawings for, or make final order for, or design any pipe materials for any particular section of pipeline until all utilities in that section of pipeline have been exposed, as specified in Section 02300 and until such time as no interferences are found between said existing utilities and the proposed pipeline alignment. If interferences are found in any particular section of pipeline, notify the Engineer so that a solution for avoiding the conflict can be identified prior to the ordering of materials.

#### 1.06 CONSTRUCTION SCHEDULING/SEQUENCING

- A. Construction under this Contract involves modification of the existing potable water system which must continue to provide water service during construction.
- B. Connections and utilities changes must be programmed to provide the least possible interruptions of service. Prior to any shutdown, all materials, fittings, supports, equipment, and tools shall be on the site and all necessary labor scheduled prior to starting any connection work. The Contractor shall notify the water service customers at least 48 hours in advance of any required shutdowns. All temporary piping shall be disinfected in accordance with Section 02516 before being put into service.
- C. All work under this Contract shall be conducted in a manner which will minimize shutdowns, open roadways, or traffic obstructions caused by the construction. Shutdowns causing damage to adjacent public and private property shall not be permitted, and any damage resulting shall be the sole responsibility of the Contractor.
- D. Planned utility service shutdowns shall be accomplished during periods of minimum use. The Contractor shall program his or her work so that service will be restored in the minimum possible time and shall cooperate with the Owner in reducing shutdowns of the utility system to a minimum.



## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. All materials provided for a complete potable water system shall meet the requirements of these specifications and Section 400 of the Arvada Code of Engineering Standards and Specifications, whichever is more stringent.
- B. Pipe and valve sizes are nominal inside diameter unless otherwise noted.
- C. All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.
- D. Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the completed product. Acceptance of installed piping systems shall be based on inspection and leakage and bacteriological tests as specified in Section 02516.
- E. Bolts: Unless specified otherwise herein, flange bolts and nuts, coupling bolts and nuts, and other hardware shall be as follows:
  - 1. Buried: Type 304 stainless steel, minimum tensile strength: 60,000 psi.
  - 2. Apply an anti-gauling compound to the threads of stainless steel bolts.

### 2.02 PIPING MATERIALS

- A. See the Pipe Schedule on the Drawings for general piping requirements and material designations.
- B. Pipe Systems: Each designation identifies not only the pipe itself, but the entire system as well as including the associated fittings, appurtenances, and installation and test procedures.
- C. Copper Pipe:
  - 1. Pipe: Copper, ASTM B88
    - a. Buried: Type K (soft drawn).
  - 2. Service Line Transition Fittings
    - a. Manufacturer: Mueller Flared fitting, Ford flared fitting, Mueller #110 compression fitting, Ford Quick Joint or equal
- D. Polyvinyl Chloride Pipe:
  - 1. Pipe: Polyvinyl chloride pressure pipe, cast-iron pipe outside dimensions. Pipe shall be UL listed or Factory Mutual Approved.
    - a. 4-inch through 12-inch: AWWA C909
  - 2. Minimum Pressure Class: 235 psi
  - 3. Fittings:
    - a. Distribution and transmission line fittings for PVC shall be ductile iron and in accordance with AWWA C153 and AWWA C110. Fittings shall have a three-hundred fifty (350) psi pressure rating. Fittings shall be coated both internally and externally with fusion bonded epoxy in accordance with AWWA C116. The fittings shall be furnished with mechanical joint ends in accordance with AWWA C111 and, in addition, the tee-head bolts and hexagon nuts shall conform to ASTM F3125, Grade A325 Type 3 and be fabricated from "Cor-Blue", a high strength, low alloy steel. 4" through 12" diameter fittings may also be ductile iron One-Bolt type with integral restrained joints as manufactured by One-

- Bolt, Inc. All metallic fittings shall be encased in polyethylene wrap per AWWA C105, regardless of soil conditions.
- b. T-Head Bolts and Nuts manufacturers shall be TriPac 2000, CoreBlue by NSS Industries, or Blue Bolt by Birmingham Fasteners, no equal.
  - a. All metallic fittings shall be coated per AWWA C116 and be encased in polyethylene wrap per AWWA C105, regardless of soil conditions.
4. Joints:
- a. Unrestrained joints: Bell and spigot, gasketed; or twin gasket coupling.
  - b. Restrained joints: Bell and spigot (push-on) gasketed, or mechanical joints; both using ductile-iron clamp-on restraining devices.
    - 1) Restrained joints are required at all valve, bends, and fittings with mechanical connections and dead ends at a minimum.
    - 2) Contractor shall identify all areas where restrained joints are required in the field and include as part of the product submittal package.
    - 3) Restraining devices: Ductile-iron with ductile-iron or cor-ten rods and bolts. Pressure rating a minimum of 150 psi. Series 2000PV by EBBA Iron; Uni-Flange Series 1500; or Star Pipe Product Stargrip Series 4000.
    - 4) Protection for buried restraining devices: Double-wrap with polyethylene encasement, AWWA C105 and tape the edges of the encasement with PVC tape. The polyethylene seams and overlaps shall be wrapped and held in place by means of two (2) inch wide plastic-backed adhesive tape. The tape shall have adhesive that shall bond securely to both metal surfaces and polyethylene film. Manufacturer shall be Polyken #900, Scotchrap #50, or approved equal.
5. Gaskets: SBR rubber.
- E. Corrosion Protection
1. When soil resistivity is less than 10,000 ohm-centimeters (OHM-CM), metallic pipe and fittings shall be protected against corrosion in accordance with Section 420.19 of the Arvada Code of Engineering Standards and Specifications.
    - a. Mechanical Joint Tees, Bends, Caps, Plugs and all other fittings shall be furnished from the manufacturer with cement mortar lining and coating system to match adjacent piping. T-head bolts and nuts shall be corrosion resistant. Any bare fittings or components shall be wrapped with a non-firming, wax based anti-corrosion wrap system. The wax wrap system shall be Trenton anti-corrosion materials or approved equal.
    - b. Mechanical Joint Restraint (Wedge action, self-actuating, such as Megalugs) for ductile iron pipe shall be furnished from the manufacturer with a bituminous or epoxy coating. Mechanical joint restraint for PVC pipe shall be furnished from the manufacturer with red primer coat. T-head bolts and nuts shall be corrosion resistant. Mechanical joint restraint shall be wrapped with a non-firming, wax based anti-corrosion wrap system. The wax wrap system shall be Trenton anti-corrosion materials or approved equal.
  2. The cathodic protection system shall be designed by a Colorado Licensed Professional Engineer, accredited by the National Association of Corrosion Engineers (NACE) as a Cathodic Protection Specialist (CP4). See Section



420.19 of the Arvada Code of Engineering Standards and Specifications for further detail.

3. Polyethylene encasement:
  - a. All polyethylene encasement material shall be manufactured in accordance with ANSI/AWWA Standard C105/A21.5.
  - b. Polyethylene encasement shall be the V-Bio Enhanced Polywrap consisting of three layers of co-extruded linear, low-density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils. The inside surface of the polyethylene wrap to be in contact with the fitting exterior shall be infused with a blend of antimicrobial compound to mitigate microbiologically infused corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
  - c. The raw materials used to manufacture polyethylene film shall be Type I, Class A, Grade E 1 in accordance with ASTM D1250.
  
- F. Mechanical Couplings:
  1. Mechanical couplings shall meet the requirements as outlined in Section 420.04 of the Arvada Code of Engineering Standards and Specifications.
  2. Sleeve: Cast-iron or fabricated steel.
  3. Followers: Cast-iron, ductile-iron, or steel.
  4. Sleeve bolts: Type 304 stainless steel
  5. Coating: Fusion epoxy line and coat sleeve and followers.
  6. Pressure rating: The test pressure of the applicable service or 150 psi, whichever is greater.
  7. Performance: Longitudinal movement and angular deflection capabilities shall meet AWWA C-219.
  8. Manufacturers:
    - a. Romac XR501
    - b. Viking Johnson MaxiFit
    - c. Viking Johnson MaxiStep
    - d. Powerseal PowerMax
    - e. Or approved equal
  9. Gaskets: SBR rubber.
  10. Joint restraint: Provide joint harnesses (attachment plate assemblies) across couplings. Design restraint in accordance with AWWA M-11 for 150 psi.
  11. Protection for buried connectors and adaptors: Polyethylene wrap encasement. See Section 2.02.E for requirements.

## 2.03 VALVES AND ACCESSORIES

- A. General Requirements for Valves:
  1. All valves of each type shall be the product of one manufacturer.
  2. All valves shall be furnished with control assembly, operators, and suitable type wrench including handles as specified herein or as shown on the Drawings.
  3. All threaded stem valves shall open by turning the valve stem counter-clockwise.
  
- B. Valves and Accessories:
  1. Gate Valves:
    - a. All gate valves shall open left (counter-clockwise). Gate valves in sizes four (4) inches to twelve (12) inches shall be of the ductile iron body, non-rising stem, open left, resilient seated type with an AWWA standard two (2) inch square operating nut, manufactured in accordance with

- AWWA C509 or AWWA C515. Class designation shall be compatible with the pipe class designated for the project. Valves shall comply with the requirements of NSF 61.
- b. Rating: 200 psi water
  - c. Type: Resilient seated, non-rising stem, AWWA C509 or AWWA C515, as modified herein
  - d. Gate: The valve gate shall be ductile iron, fully encapsulated with EDPM rubber, and shall be capable of a drip-tight shutoff with flow in either direction. The EDPM shall be permanently vulcanized to the gate.
  - e. Connection: Mechanical Joint
  - f. Bolts: all bolting shall be stainless steel AISI grade 304. If nuts are used on the bolts the nuts shall be 304 stainless steel and the bolt threads shall be coated with an anti-gauling compound. Coat bolts and nuts with an epoxy coating.
  - g. Stem: Valve stems shall be made of stainless steel or bronze with a minimum yield strength of 40,000 psi. Stems shall be provided with separate or integral bronze thrust collars. Bronze valve stems shall contain no more than five percent (5%) zinc, no more than two percent (2%) aluminum, and no more than one percent (1%) lead. Stainless steel stems shall contain a minimum of sixteen percent (16%) chrome.
  - h. Stem seal and Gaskets: Valve stem seals shall be an o-ring type, with not less than one (1) o-ring below the thrust collars and two (2) o-rings above the thrust collars. If an o-ring groove is cut into the stem, the diameter of the groove shall not be less than the root diameter of the stem threads. O-rings and gaskets shall be made of an NBR rubber to help prevent the effects of permeation. Bonnet gaskets shall be an o-ring type that completely encircles each individual bonnet bolt so that the bolts are isolated from internal or external water sources.
  - i. Interior/Exterior Coating: Fusion epoxy in accordance with AWWA C550
  - j. Manufacturers:
    - 1) American AVK with stainless steel stem
    - 2) American Flow Control
    - 3) Clow
    - 4) Kennedy
    - 5) Mueller
    - 6) J&S Valve
    - 7) Or approved equal
  - k. Valves shall comply with the requirements of ANSI/NSF 61.
2. Valve boxes, adjustable screw type:
- a. Materials: gray cast iron, ASTM A48 Class 35B, three (3) piece adjustable screw boxes with a round or oval base and a five and one-fourth (5¼) inch screw-type shaft suitable for depth of cover as required. Castings shall be heavy duty Class 35B. See City of Arvada standard detail 400-6 for additional requirements.
  - b. All valves set at greater than normal depth shall have an extension stem provided and installed with the valve box so that the valve may be operated with a standard seven (7) foot valve key. A valve operating nut at six (6) feet or greater below final grade shall have an extension stem provided to bring the operating nut to a depth of four (4) feet below final grade. Coatings shall comply with AWWA C116 and polyethylene wrap per AWWA C105, regardless of soil conditions. Valves set greater than



- eight (8) feet below final grade may require a manhole over the valve operator as determined by the Engineer or Owner.
- c. Manufacturers: Star brand VB002 CL 35 and Castings, Inc. Series 6850 or approved equal

## 2.04 SERVICE CONNECTIONS

- A. General: All corporation stops, service clamps or saddles, and service connection accessories shall be the product of one (1) manufacturer.
- B. Corporation Stops:
  1. Rating shall be 100 psi water for normal pressure service line. If pressure greater than 100 psi is expected, a high-pressure corporation stop rated at 150 psi shall be utilized.
  2. Type: Thread inlet; compression connection outlet; complies with ANSI/ASME B1.20.1
    - a. Two spiral wraps of three (3) mil PTFE (Teflon) tape shall be wrapped clockwise around the inlet threads on the closed corporation stops.
  3. Manufacturer: Mueller Co. Model H-10003
  4. Provide insulation for corporation stops as necessary.
    - a. Manufacturer: Ford Service Insulators
- C. Water Service Saddles
  1. Water service saddles shall be required for all AWWA C909 PVC water lines for water service taps. Service saddles shall be brass or bronze and shall comply with AWWA C800.
- D. Tapping Saddles (Non-Service Type)
  1. Tapping Saddles for Wet Taps of Distribution and/or Transmission Mainlines shall be manufactured by ROMAC or approved equal. Tapping Saddles shall conform to all the requirements set forth in Section 420.27 City of Arvada Standards.
  2. Tapping Valves: Tapping valves shall conform to all the requirements set forth in Section 420.27 City of Arvada Standards.
  3. Tapping Sleeves: All tapping sleeves for use on PVC water mains shall be designed for an operating pressure of one-hundred fifty (150) psi and shall be fabricated using Type 304 (18-8) Stainless Steel.

## 2.05 APPURTENANCES

- A. Provide all necessary assembly bolts, washers and nuts, thrust blocks, supports, gaskets, flanges, and all other appurtenant items shown on the Drawings, specified or required for the proper installation and operation of the piping, and devices included in or on the piping, equipment, and piping accessories.
- B. End Seals for Casing Pipe: A one-eighth ( $\frac{1}{8}$ ) inch thick synthetic rubber wrap around end seals with stainless steel bands shall be installed on the casing pipe after carrier pipe insertion. End seals shall be Model W wrap around end seal or Link Seal. End seals shall be watertight. Link seals may be used and shall be manufactured by GPT Industries S-316.
- C. Gasket Pipe Lubricant: Whitlam Plumb-Pro Blue Lube or approved equal.

## 2.06 CORROSION PROTECTION SYSTEMS

- A. When soil resistivity is less than 10,000 ohm-centimeters (OHM-CM), metallic pipe and fittings shall be protected against corrosion. See City of Arvada Standard Engineering Code and Specifications Section 420.19 for details.

## PART 3 - EXECUTION

### 3.01 PIPING INSTALLATION

- A. General Handling and Placing:
  - 1. Exercise great care to prevent injury to or scoring of the pipe lining and coating, as applicable, during handling, transportation, or storage. Pipe shall not be stored on rough ground and rolling of the pipe on the coating will not be permitted. Repair any damaged pipe sections, specials, or fittings or replace at the direction of the Engineer.
  - 2. Inspect each pipe, fitting, valve, and accessory carefully before installation. Inspect the interior and exterior protective coatings and patch all damaged areas in the field or replaced at the direction of the Engineer.
  - 3. Place or erect all piping to accurate line and grade and backfill, support, hang, or brace against movement as specified or shown on the Drawings, or as required for proper installation. Remove all dirt and foreign matter from the pipe interior prior to installation and thoroughly clean all joints before joining.
  - 4. Connections between ferrous and non-ferrous piping and accessories shall be made using a dielectric coupling, union, or flange.
  - 5. Pipe installation shall comply with Section 421 of the City of Arvada Standard Engineering Code and Specifications.
- B. General Buried Piping Installation:
  - 1. Trenching, bedding, and backfill for buried piping shall be as shown on the Drawings and as specified in Section 02300.
  - 2. Where no grade elevations are shown on the Drawings, buried piping shall have at least 4 feet of cover. Where pipe grade elevations are shown on the Drawings, install the pipe with straight grades between the indicated elevations.
  - 3. Provide each pipe with a firm, uniform bearing for its full length in the trench except at field joints. Do not lay pipe in water or when trench conditions or weather are unsuitable for such work.
  - 4. Protect buried piping against thrust by use of restrained pipe joints. Securely brace all exposed free pipe ends. Cap or plug pipe ends that are left for future connections as shown on the Drawings and in a manner favorably reviewed by the Engineer.
  - 5. Do not pull bell and spigot, gasketed joints more than 75% of the maximum deflection permitted by the pipe manufacturer.
  - 6. Where piping leaves concrete encasement, provide a joint capable of angular deflection within 12 inches of the encasement.
  - 7. Snake buried PVC pressure pipe from side to side in the trench in long sweeps.
  - 8. Wrap metallic appurtenances with polyethylene encasement and tape the encasement tightly closed to the pipe.
- C. Water Service Lines:



1. Connection of copper to all metallic water mains shall be electrically insulated by means of an approved insulator fitting installed on the corporation stop. After installation, the fitting shall be cleaned and wrapped with a double layer of eight (8) mil polyethylene before backfilling. An insulator fitting shall also be installed on the outlet side of the meter setter.
  2. A water service line crossing over a foreign line (storm sewers, water transmission lines, etc.) shall be insulated through areas and at points where its bury is less than four (4) feet. Butt joints between sections and side slits in insulation shall be duct or mole taped upon placement around the service line.
  3. Service line trenches cut through surfaced streets or adjacent to existing curbs, gutters, and sidewalks in public ROW shall be bedded and backfilled in accordance with Section 02300.
- D. Water Main Installation:
1. The Contractor is advised that precautions taken to keep the pipeline clean during construction will facilitate achieving the disinfection requirements of this project with a minimum of effort and expense. Compliance with these suggested minimum procedures will not relieve the Contractor of the disinfection requirements.
  2. Prior to installation, thoroughly clean the interior of each length of pipe and each fitting or valve and inspect to ensure that no foreign material remains. Cover both ends with plastic and do not uncover them until just prior to completing the joint.
  3. Whenever pipe laying is discontinued for short periods, or whenever work is stopped at the end of the day, close the open ends of the pipe with watertight plugs or bulkheads.
  4. Provide adequate trench pumping to ensure against groundwater contacting the inside of the pipeline at any time. Do not lower any pipe or fitting into a trench where groundwater is present and may enter the pipe. When necessary, pump the water from trenches and keep the trench dry until the joints have been completed and the open ends of the pipe have been closed with a watertight plug. Do not remove the plug until the trench has again been pumped dry.
  5. Keep new pipe sections clean and dry.
  6. When making the connection between a new pipeline and an existing pipeline, or when repairing a damaged pipe, take the following extra precautions:
    - a. Clean the exterior of the existing pipeline of all dirt and debris, and spray or swab with a standard 5.25% or stronger chlorine solution (as specified) in the immediate vicinity of the work. Clean equipment and materials, including new pipe and fittings, to be used in making these connections of all dirt and debris and disinfect them. Allow at least 30 minutes contact time for disinfection before the chlorine solution is diluted or rinsed off. Provide sufficient trench pumps to prevent flooding of the trench.
    - b. When an old line is opened, either by accident or by design, the excavation may be wet or badly contaminated from groundwater. Apply liberal quantities of standard chlorine solution or tablets to the open trench areas to lessen the danger from such pollution. Tablets are recommended because they dissolve slowly and continue to release hypochlorite as water is pumped from the excavation. Scatter liberally

around and locate the tablets so that flow entering the work site will contact the disinfecting agent. Trench application should be done very carefully to avoid contact by skin and clothing with chlorine solution. Minimally, safety dictates wearing safety goggles and rain gear.

- c. When excavating a leaking or broken pipeline, "valve-off" the system gradually to less than watertightness. This is to prevent causing areas of zero pressure which would allow entry of foreign material. A flow should be maintained which is slightly less than trench pump capability. Once the break is exposed and cleaned to disallow site contamination, the valving can then be made watertight.

#### E. Service Taps

1. All service taps shall be wet taps. Shutting down any portion of the water system shall only be allowed when uncontrolled circumstances do not permit a wet tap. Any shut down of the water System must be approved in writing by the Owner.
2. Tapping of PVC pipe shall be made with a Tapping Saddle.
3. Arvada's Water Utility Department, unless otherwise approved by the Owner, shall complete tapping of all water lines up to and including two (2) inch diameter taps. Notification shall be given to the Water Utility Department two (2) working days (forty-eight [48] hours) in advance of the tap in order to provide ample time to schedule the work. In those instances where Arvada crews are not available to complete taps in a timely manner or when the tap is over two (2) inches in diameter, the tap may be installed by a contractor or plumber licensed by Arvada who specializes in the installation of water taps.
4. Service saddles and corporation stops meeting the standards shall be supplied and installed by the contractor.

#### F. Tracer Wire

1. Per Colorado Senate Bill 18-167, all new underground facilities, including mains and laterals up to the structure or building being served, require tracer wire.
2. Tracer wire to be installed in accordance with Section 02300.

#### G. Installation Specifics

1. Copper Pipe:
  - a. Bends shall be made in a manner that does not crimp or flatten pipe.
  - b. Pipe shall have joints squarely cut clean, properly fluxed and heated before solder is placed in the joint. Joints must be driven up tight before solder is added. Compression and flared joints shall be made up in accordance with the manufacturer's instructions. Brazing shall be in accordance with ANSI B31.1.
2. Polyvinyl Chloride Pipe: Installation shall conform to AWWA M23, Chapters 6 and 7, as modified herein.

### 3.02 COUPLING INSTALLATION

- A. Flexible Couplings: Prior to installation, thoroughly clean oil, scale, rust, and dirt from the pipe to provide a clean seat for the gasket. Care shall be taken that the gaskets are wiped clean before they are installed. If necessary, flexible coupling gaskets may be lubricated with soapy water or manufacturer's standard lubricant before installation on the pipe ends. Install in accordance with the manufacturer's recommendations. Bolts shall be tightened progressively, drawing up bolt on opposite sides a little at a time until all bolts have a uniform tightness. Workers



tightening bolts shall be equipped with torque-limiting wrenches or other favorably reviewed type.

- B. Tie Rods: Except where double-nutting is required, install the nuts snug. Tighten the nuts gradually and equally at opposite sides of the pipe until snug to prevent misalignment and to ensure that all rods carry equal loads. If double-nutting is required, double-nut each end of each tie rod. The space between the pairs of nuts shall be ½-inch greater than the distance between the lugs. Provide double-nutting at buried locations and where otherwise required on the Drawings.

### 3.03 INSTALLATION OF VALVES AND ACCESSORIES

- A. Buried installations:
  - 1. Install in the closed position.
  - 2. Support valve in trench to prevent settling and excessive strain on the connection to the pipe.
  - 3. Install polyethylene encasement in accordance with AWWA C105.
  - 4. Place valve boxes directly over valves with top of box being brought to surface of finished grade or as indicated on the Drawings.
  - 5. After installation, carefully backfill and compact on each side of box.
  - 6. Valve Boxes not located within a pavement section shall be provided with an 18-inch square by 8-inch deep concrete collar.

### 3.04 FIELD QUALITY CONTROL

- A. Factory Quality Control: The Contractor shall test all products as required herein and by the reference specifications.
- B. The Contractor shall:
  - 1. Perform leakage tests.
  - 2. Perform bacteriological tests.
  - 3. Be responsible for the costs of additional inspection and retesting resulting from non-compliance.

### 3.05 INTERRUPTION OF WATER SERVICE

- A. The Contractor must, in writing, advise affected users forty-eight (48) hours prior to performing work on a service, distribution or transmission line which will interrupt a customer's supply of water. Contractor prepared notices shall be hand delivered to each customer or occupant. If the occupant cannot be contacted, the written notice shall be left attached to the door knob or screen.
- B. In addition, the Contractor must contact Arvada's Engineering Inspection Department through the City's permit system and as directed by the assigned inspector to schedule the closing of valves necessary to isolate the line or lines on which work is to be performed. Only City personnel are to operate existing system valves or new valves if they are connected to the City system. Also, it is the Contractor's responsibility to advise the governing fire district as to time and interval the system will be down and also the location of all fire hydrants that will be out of service.
- C. A normal outage shall be a maximum of four (4) hours and between the hours of 8:30 a.m. and 3:00 p.m. If the outage will be greater than four (4) hours, the work shall be done in a manner to minimize the inconvenience to users, such as working at night in a continuous operation until service is restored. A connection which will require an outage longer than four (4) hours shall be subject to review by the

Owner as to the appropriate time for the connection. If in the process of installing a connection there exists a customer, industry, or building in the area that cannot be out of water such as a hospital, school, etc., the Contractor shall take appropriate means to provide and convey potable water to them at all times during the performance of the work.

- D. Whenever a fire line serving a fire protection system is out of service, the respective fire protection district shall be notified a minimum of forty-eight (48) hours before the shut down.

### 3.06 ABANDONMENT OF WATER MAIN AND WATER VALVES

- A. Water mains to be abandoned shall be removed and properly disposed of off site.
- B. Water valves to be abandoned shall be removed in their entirety with a blind flange installed at the tee. Water valves that would connect to abandoned water main or no water main shall not be left in place.

END OF SECTION



## SECTION 02516

### DISINFECTION AND TESTING OF WATER LINES

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section includes disinfection and testing of potable water distribution systems.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 400.
- B. American Water Works Association:
  - 1. AWWA B300 - Hypochlorites
  - 2. AWWA B301 - Liquid Chlorine
  - 3. AWWA B303 - Sodium Chlorite
  - 4. AWWA C605 – Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
  - 5. AWWA C651 - Disinfecting Water Mains.

##### 1.03 QUALIFICATIONS

- A. Testing Laboratory: Independent testing laboratory specializing in testing potable water systems, approved by the local health authority.
- B. Submit bacteriologist's signature and authority associated with testing.

##### 1.04 QUALITY ASSURANCE

- A. Notify the Owner's Inspector a minimum of 24 hours in advance of testing. All testing shall be made in the presence of the Owner's Inspector.
- B. Disinfection shall be accomplished under the supervision of the Contractor by a person skilled and experienced in the operation of water systems.

##### 1.05 SUBMITTALS

- A. Testing Schedule, including proposed plans and locations for water conveyance and discharge, submitted in writing to the Engineer for approval a minimum of 14 Calendar Days before testing is to start. Testing shall be coordinated with the Owner's Inspector.

#### PART 2 - PRODUCTS

##### 2.01 DISINFECTION CHEMICALS

- A. Chemicals
  - 1. AWWA B300: Hypochlorite
  - 2. AWWA B301: Liquid Chlorine
  - 3. AWWA B303: Sodium Chlorite

- B. Hypochlorite Tablet Adhesive
  - 1. Certified to NSF Standard 61
  - 2. Permatex RTV Clear or approved equal.

## 2.02 HYDROSTATIC TESTING MATERIALS

- A. All test equipment, temporary valves, temporary blow-offs, temporary bulkheads and blind flanges, temporary manual air release valves, or other water control equipment and materials shall be determined and furnished by the Contractor. No materials shall be used which would be injurious to the pipeline or its future function. The Contractor shall be held solely responsible for ensuring that a sufficient water source is available for all operations.
- B. Temporary manual air-release valves shall be provided as necessary for pipeline test. The pipe outlet shall be constructed in the same manner as for a permanent air valve and after use, sealed with a blind flange, pipe cap, or plug.
- C. Air-release and water drainage connections shall be included.

## PART 3 - EXECUTION

### 3.01 SEQUENCE

- A. Disinfection / Chlorination
- B. Hydrostatic Testing
- C. Flush Line, Dechlorinate Discharged Water, Refill
- D. Clearwater / Bacteriological Testing

### 3.02 DISINFECTION / CHLORINATION

- A. All potable waterlines shall be chlorinated in accordance with the requirements of the Colorado Department of Public Health and Environment and shall comply with AWWA C651.
- B. The chlorination of the finished pipeline shall be done prior to the hydrostatic testing.
- C. Before filling the pipe with water, the pipe shall be clean and free of debris to the satisfaction of the Engineer.
- D. Chlorine tablets may be used for disinfection in 16-inch and smaller pipe when the line cannot be flushed prior to chlorination. Tablets shall be attached to the inside top of the pipe with an acceptable, food grade approved, adhesive prior to the pipe installation in the trench. Continuous Feed Method shall be used when it is necessary to flush the line prior to chlorination or for rechlorination.
- E. The tablet method shall not be used when trench water or foreign materials have entered the water line during installation or the ambient temperature is below forty-one (41) degrees Fahrenheit. The tablets shall be secured to the crown of each pipe section, as it is installed in the trench, with "red" PERMATEX or other approved adhesive. Under normal conditions to obtain the twenty-five (25) MG/L residual chlorine concentration, after twenty-four (24) hour solution time, will



require the use of the number of tablets called for under pipe diameter and opposite pipe joint length as listed below.

Pipe Diameter Inches	Tablets Required for 20 ft.	CL Residual in 20 ft. Pipe mg/L
3	1	116.97
4	2	131.59
6	3	87.73
8	6	98.69
12	12	87.73
14	17	91.31

- F. Chlorinated water shall be held in contact with the pipe for 24 hours.
- G. Perform chlorination testing: Upon completion of the 24-hour retention period required for disinfection, the water in the pipeline shall be tested and have a residual chlorine content of not less than 50 mg/l at all hydrants and blow-offs. If the test is unsatisfactory, disinfection shall be repeated until a 50 mg/l free chlorine residual is obtained.
- H. Obtain one (1) test sample for every 1,000 linear feet of pipe.
- I. For continuous feed method, slug method, or cut and repair method, see Arvada Engineering Code of Standards and Specifications Section 421.13.

### 3.03 HYDROSTATIC TESTING

- A. Conduct hydrostatic testing accordance with AWWA C600.  
Hydrostatic testing shall be completed after chlorination testing and prior to the clearwater / bacteriological testing and final connection to the existing system. Hydrostatic testing shall only be performed after the line has been cleaned of debris, concrete anchor blacks have cured, and all backfill is in place. Water Operations Division personnel shall be the sole operators of existing valves through which water for testing, disinfecting, and flushing is obtained. The Contractor shall be responsible for metering and paying the Owner for water used for testing, disinfecting, and flushing.
- B. Before applying test pressure, completely expel air from section of piping under test without causing surges or damage to the line and its appurtenances. Provide temporary blow-off(s) or use fire hydrant(s) as necessary so air can be expelled as pipeline is filled with water. All air within the pipe shall be purged therefrom, and 24 hours lapsed time allowed for water adsorption into the pipe lining, before pressure testing.
- C. Test Pressure: The hydrostatic test pressure shall be one-hundred fifty (150) psig at the lowest point in the line of the section under test or working pressure plus 50 psi, whichever is greater. Fire lines shall be tested at two-hundred (200) psig. When directed by the Project Engineer, a higher test pressure may be required.
- D. Slowly bring piping to test pressure and allow system to stabilize. Do not open or close valves at differential pressures above rated pressure.
- E. Conduct hydrostatic test for at least a 2-hour duration.

- F. Examine exposed piping, fittings, valves, hydrants, and joints carefully during hydrostatic pressure test. Repair or replace damaged or defective pipe, fittings, valves, hydrants, or joints discovered, following pressure test.
- G. Leakage Allowance:
  - 1. Leakage shall be defined as the quantity of water that must be supplied into the newly laid pipe, or any valves section thereof, to maintain the specified leakage test pressure after the air in the pipeline has been expelled and/or displace with water. No pipe installation will be accepted if the leakage in U.S. gallons per hour is greater than set forth herein below in accordance with AWWA C600, C604, C605 and M11: Allowable leakage for steel pipe is for o-ring rubber gasket joints only. The allowance shall be zero (0) on all welded or mechanically couple steel pipe and for all fire lines.

<b>DIP or PVC Pipe Diameter (Inches)</b>	<b>Nominal Allowable Leakage US Gallons per Hour per 1,000 feet per 24 hours</b>
4	0.33
6	0.50
8	0.66
12	0.99
14	1.16

- H. The Owner reserves the right to substitute its own calibrated meter and/or pump for the Contractor's meter or pump for testing.
- I. When leakage exceeds specified acceptable rate, locate source and make necessary repairs. Repeat test until specified leakage requirements are met.

**3.04 CLEARWATER / BACTERIOLOGICAL TESTING**

- A. Upon completion of passing chlorination and hydrostatic tests, the pipeline shall be thoroughly flushed through all hydrants and blow-offs until the water runs clear with no chlorine residual in excess of that carried in the existing system. As a minimum, the total volume of the water line being tested shall be flushed. The Contractor shall be responsible for metering and paying the Owner for water used for flushing.
- B. The Owner's Inspector shall be present and operate all valves during flushing and dechlorination of lines.
- C. The contractor shall take all necessary precautions to prevent the flow of strong chlorine solution into existing water facilities and shall be responsible for damaged done by heavily chlorinated water. Sodium thiosulfate shall be used when flushing water on the ground and to waterways that do not contain fish. Vita-D-Chlor Neutral, or approved equal, shall be used when flushing to waterways with fish. Flushing to the sanitary sewer shall only be allowed if it meets the requirements as set by Metro Water Recovery in the dewatering discharge permit, if applicable.
- D. The line shall be visually inspected for turbidity. If the inspection is unsatisfactory, the line shall be flushed again. If the turbidity test fails a second time, the line shall be re-chlorinated and then re-flushed.



- E. Refill water line. Before the new water main is finally connected to the distribution system for use, conduct clearwater / bacteriological testing.
- F. Prior to placing any new water main in service, a bacteriological analysis of the water in the new main shall be performed by the Owner. A minimum of sixteen (16) hours after the new main is flushed of the high chlorine residual a bacteriological sample shall be obtained. Results of the bacteriological analysis shall be available twenty-four (24) hours after the sample was obtained. If the bacteriological analysis turns up positive a second test shall be taken. If the second test turns up positive the main shall be re-flushed and the process started over until a negative bacteriological analysis is obtained. Only after a negative bacteriological analysis is obtained can a new water main be placed in service and water is transferred to the new main.

### 3.05 TEST RESULTS

- A. Chlorination Testing Report
  - 1. Type and form of disinfectant used
  - 2. Date and times of disinfectant injection
  - 3. Test locations
  - 4. Name of person collecting samples
  - 5. Initial and 24 hour disinfectant residuals in treated water in mg/l for each outlet tested
  - 6. Date and times of flushing
  - 7. Disinfectant residual after flushing in mg/l for each outlet tested
- B. Hydrostatic Testing Report
  - 1. Length of pipe tested
  - 2. Test Pressure
  - 3. Duration of the test
  - 4. Amount of make-up water
  - 5. Owner's Inspector and the Contractor shall sign report
- C. Clearwater / Bacteriological Testing Report
  - 1. Date issued, project name, and testing laboratory name, address, and telephone number.
  - 2. Time and date of water sample collection.
  - 3. Name of person collecting samples.
  - 4. Test locations.
  - 5. Initial and 24 hour disinfectant residuals in mg/l for each outlet tested.
  - 6. Coliform bacteria test results for each outlet tested.
  - 7. Certify water conforms, or fails to conform, to absence of coliform bacteria.

### 3.06 PLACING LINE IN SERVICE

- A. Connection to the water distribution system shall be in a neat and workmanlike manner. An Owner's Inspector shall be present at all times during the construction of the connection. Under no circumstances shall a non-disinfected main, which cannot be isolated, be connected to an existing disinfected main. Disinfection of the line shall meet the requirements of the Colorado Health Department.
- B. The Owner is not responsible for water tightness of its valves and existing facilities. If existing valves leak, the Owner will assist in reducing the influx of water, but the

contractor must use methods at his or her own disposal to work with the resulting leakage.

- C. When connecting lines to the water distribution system, it may be necessary to operate new and existing valves. Valves on or connected to the system must be operated by the Owner's personnel only. The Contractor shall give the Owner's Inspector forty-eight (48) hours notice to arrange for operating the valves. Both the Contractor and the Owner's Inspector shall be present when the valves are being operated.
- D. Super chlorinated water in the line must be fully dechlorinated prior to release to streets or into storm sewers, ditches, streams and/or their tributaries. Contractors' proposed method of dechlorination must be approved by the Project Engineer and be performed within the limits set forth in the NPDES permit, as issued to the City by the Colorado Department of Health. Sodium Thiosulfate Pentahydrate XTL can be used as a dechlorinator, available from Van Waters & Rogers, Inc. If the super chlorinated water is released to a dirt area that will not run to a receiving water then the requirement to dechlorinate may be waived by a representative of the City's Water Quality department.
- E. Placing Line in Service: A line will only be accepted for tapping and/or placing in service after all of the following conditions have been met
  1. The main has been installed to the satisfaction of the Owner's Inspector and all pertinent notes and measurements have been made.
  2. The main has been successfully filled, chlorinated, dechlorinated and pressure tested to the requirements of the City of Arvada.
  3. A bacteriological sample has been collected and results indicate that no E. Coli or total coliform bacteria are present

END OF SECTION



## SECTION 02530

### SANITARY GRAVITY PIPING

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section Includes: Furnish and install all piping as shown on the Drawings, described in the Specifications, and as required for a complete and operable system. The work includes replacement of existing sanitary sewer mains.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 500.
- B. American Society for Testing and Materials (ASTM):
  - 1. C923 Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals
  - 2. D3034 Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
  - 3. D3212 Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
  - 4. D3262 Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
  - 5. D4161 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
  - 6. D3681 Standard Test Method for Chemical Resistance of "Fiber glass" Pipe in a Deflected Condition
  - 7. F679 Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings
  - 8. F77 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

##### 1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Submit the following for review:
  - 1. Potholing Report: Verify by excavation, inspection, and measurement all installation conditions, including existing utilities and structures, for buried pipe before preparation of Shop Drawings. Submit field measurements, elevations, station locations, and photos. See Section 02300 for additional requirements.
  - 2. Shop Drawings: Submit data to show that the products specified in this Section conform to the Specification requirements.
  - 3. Design calculations:
    - a. Pipe loading calculations
    - b. Buoyancy calculations assuming water elevation is at grade
  - 4. CCTV footage of the installed sanitary pipeline, see Section 02951.
  - 5. Leakage Testing Plan
  - 6. Test Results: As required herein.

## 1.04 QUALITY ASSURANCE

- A. All materials and equipment furnished under this Section shall be of manufacturers who have been regularly engaged in the design and manufacture of the materials and equipment for a period of at least 5 years.
- B. Factory Quality Control: The Contractor shall test all products as required herein and by the reference specifications.
- C. Field Quality Control:
  - 1. The Contractor shall:
    - a. Perform jet cleaning on 100% of the new system
    - b. Perform CCTV on 100% of the new system
    - c. Perform leakage tests on 100% of the new system
    - d. Perform mandrel tests, if required by Owner
    - e. Be responsible for the costs of additional inspection and retesting by the Owner resulting from non-compliance or concerns with pipe installation.

## 1.05 POTHOLING

- A. Do not prepare any shop drawings for, or make final order for, or design any pipe materials for any particular section of pipeline until all utilities in that section of pipeline have been exposed, as specified in Section 02300, and until such time as no interferences are found between said existing utilities and the proposed pipeline alignment. If interferences are found in any particular section of pipeline, notify the Engineer so that a solution for avoiding the conflict can be identified prior to the ordering of materials.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Pipe sizes are nominal inside diameter unless otherwise noted.
- B. All materials delivered to the job site shall be new, free from defects, and marked to identify the material, class, and other appropriate data such as thickness for piping.
- C. Acceptance of materials shall be subject to strength and quality testing in addition to inspection of the completed product. Acceptance of installed piping systems shall be based on inspection and leakage tests as specified hereinafter.
- D. See the Pipe Schedule on the Drawings for general piping requirements and material designations.

### 2.02 FIBERGLASS REINFORCED PIPE (FRP)

- A. Pipe:
  - 1. All pipes shall be designed and furnished under the requirements of ASTM D3262 by centrifugally casting (CCFRPM) or TopFibra Enhanced Filament Winding (EFW) process and using premium composite components resulting in a dense, nonporous, corrosion-resistant, consistent composite sandwich structure. The interior surface of the pipes (liner) shall be manufactured using a nominal 40-mil (0.040") premium made flexible polyester resin and capable of handling flow velocities of 18 ft/sec for flow without solids present. The

interior surface shall provide corrosion, crack, and abrasion resistance membrane. The exterior surface of the pipes shall be comprised of 10-mil (0.010") compressed smooth sand and or resin-glass layer which provides short-term UV, impact, and abrasion protection to the exterior. The exterior layer thickness is not to be used for calculations towards pipe strength and pipe stiffness.

2. Inside Diameter: See Drawings. The nominal ID and tolerances for open-cut pipes shall be per dimensions as published in Table 1 of ASTM D3262 in US customary units.
  3. Nominal Stiffness (SN): 46 for 25' or less earth cover and 72 for all others.
  4. Minimum Pressure Class (PN): 50 psi
  5. The pipe and fittings shall be free from visible cracks, holes, foreign inclusions or other injurious defects. The pipe and fittings shall also be as uniform as commercially practical in color opacity, density, and other physical properties.
  6. The manufacturer shall provide written confirmation to the Engineer that the pipe and fittings supplied under the terms of this specification meet or exceed these specifications herein.
- B. Joints: Elastomeric gasket joints, ASTM F477.
1. Unless otherwise specified, the coupling shall be a structural filament wound coupling (FWC) or U-Reka sleeve with machined grooves to house the EPDM gasket. The joints must meet the pressure performance requirements of ASTM D4161. The coupling shall have the same corrosion rating as the FRPM pipe or higher.
  2. Fittings, Flanges, elbows, reducers, tees, wyes, laterals and other fittings shall be capable of withstanding all operating conditions when installed. They may be contact molded or manufactured from mitered sections of FRP or steel pipe.
  3. Lengths: Pipe shall be supplied in nominal lengths of 20, 40, and 48 feet. Actual laying length shall be nominal  $\pm 2$  inches.
  4. Inside Diameter: See Contract Drawings
  5. Stiffness: Joints to match the appropriate pipe stiffness specified
  6. Roundness: Pipe shall be round within 0.2% of the outside diameter.
  7. Wall Thickness: The minimum wall thickness shall be the stated design thickness.
  8. End Squareness: Pipe ends shall be square to the pipe axis within  $\pm 1/8$ ".
- C. Factory Testing:
1. Pipe shall be manufactured and tested in accordance with ASTM D3262.
  2. Joint shall meet the requirements of ASTM D4161.
  3. Minimum pipe stiffness when tested in accordance with ASTM D2412 shall normally be SN36 psi minimum or if over 25 feet deep, SN72 psi shall be used. The inner liner and outer UV shell thickness are excluded from stiffness as required by AWWA M45 load calculation parameters.
  4. Gasket Tests: Test 3 gaskets of each size for all properties noted in Section 7 of ASTM F477.
- D. Approved Manufacturers
1. HOBAS Pipe



## 2.03 POLYVINYL CHLORIDE PIPE (PVC)

- A. Pipe and Fittings: Polyvinyl chloride sewer pipe.
  - 1. Four-inch through 12-inch nominal size: ASTM D3034, SDR 35.
- B. Joints: Elastomeric gasket joints, ASTM D3212.
  - 1. Joints shall provide a watertight seal.
- C. Gaskets: Nitrile, ASTM F477.

## 2.04 APPURTENANCES

- A. Furnish and install all necessary guides, inserts, anchors, and assembly bolts; washers and nuts, hangers, supports, gaskets, and flanges; all other appurtenant items shown on the Drawings, specified or required for the proper installation and operation of the piping; devices included in or on the piping equipment; and piping accessories.
- B. Link seals may be used to connect pipeline to structures as necessary and shall be manufactured by GPT Industries S-316.

## PART 3 - EXECUTION

### 3.01 PIPING INSTALLATION

- A. General
  - 1. Proper equipment, tools and facilities shall be provided and used by the Contractor for safe and efficient performance of the work. All pipe and sanitary sewer appurtenances shall be carefully lowered into the trench in such a manner as to prevent damage to pipe materials and to protect coatings and linings. Under no circumstances shall pipe or fittings be dropped or dumped into the trench. Any pipe or fittings that are dropped or dumped shall be removed from the work site and shall not be used.
  - 2. When buried, all ductile iron pipe fittings and appurtenances shall be protected with polyethylene wrap.
  - 3. The Owner's Inspector shall be notified at least one working day (twenty-four [24] hours) in advance of when pipe is to be installed in any trench. No pipe shall be covered until the Owner's Inspector has inspected the installation.
- B. Storage and Handling:
  - 1. Great care shall be exercised to prevent damage to the pipe during handling, transportation, and storage. Pipe shall not be stored on rough ground and rolling of the pipe on the coating will not be permitted. Any damaged pipe sections shall be repaired or replaced at the expense of the Contractor as satisfactory to the Engineer.
  - 2. All pipe handling and storage shall be strictly in accordance with the pipe manufacturer's recommendations.
  - 3. Each pipe section shall be carefully inspected before installation, and all damaged areas patched in the field or replaced as satisfactory to the Engineer.
  - 4. For pipe handling, use textile slings, forklift, or other suitable materials. The use of chains or cables is prohibited.

C. Piping Installation:

1. Trenching, bedding, and backfill for buried piping shall be as shown on the Drawings and as specified in Section 02300.
2. The profile drawings show invert elevations at certain structures and may show pipe slopes. In case of any conflicts the invert elevations shall govern over slopes. Install pipe with straight grades between indicated invert elevations.
3. The Owner's Inspector shall be notified at least one working day (twenty-four hours) in advance of when pipe is to be installed in any trench. No pipe shall be covered until an Owner's Inspector has inspected the installation.
4. Manhole locations are identified on the plan drawings by coordinates and by station. In case of any conflicts the coordinates shall govern over the stations.
  - a. Jointing:
    - 1) Clean ends of pipe and joint components.
    - 2) Apply joint lubricant to pipe ends and elastomeric seals of coupling. Use only lubricants approved by the pipe manufacturer.
    - 3) Use suitable equipment and end protection to push or pull the pipes together.
    - 4) Install gravity pipe from lowest profile elevation to highest profile elevation, with bells facing upstream.
    - 5) Do not exceed forces recommended by the manufacturer for joining or pushing pipe.
    - 6) Provide dewatering system to draw down groundwater level below bottom of the pipe trench. See Section 02140.
    - 7) Any pipe damage during handling and storage or by transport shall be repaired according to the manufacturer's recommendation or removed from the site and replaced at the Owner's Inspector's option, at no additional cost to the Owner. The Inspector's decision regarding rejection shall be final. Rejected pipe shall be clearly and indelibly marked to prevent confusion with pipe in subsequent shipments.
    - 8) If a defective pipe is discovered after it has been installed, it shall be removed and replaced with a sound pipe in a satisfactory manner at no additional cost to the Owner. All pipe and fittings shall be thoroughly cleaned before installation and shall be kept clean until they are used in the Work. In certain cases, the repair of pipes is allowed onsite under the supervision of a factory trained technician.
    - 9) Precautions shall be taken to prevent floatation of the pipe in the trench. Remove and relay any pipe which has floated. Contractor is responsible to prevent the floatation of the pipe during construction. The contractor to submit installation plan to Engineer for review prior to commencement of construction.
    - 10) All areas disturbed by installation of the pipeline shall be restored in accordance with the specification and drawings.

D. Tracer Wire:

1. Per Colorado Senate Bill 18-167, all new underground facilities, including mains and laterals up to the structure or building being served, require tracer wire.
2. Tracer wire to be installed in accordance with Section 02300.

### 3.02 CLEANING

- A. Prior to testing, the inside of each main sewer shall be thoroughly cleaned of all dirt, loose scale, sand, and other foreign material. Cleaning shall be by flushing with water or balling as appropriate for the size and type of the pipe.
- B. Contractor shall capture dirt and debris, remove from sewer system, and dispose of properly.

### 3.03 PERMANENT PLUGS

- A. Clean interior contact surfaces of all pipes to be cut off or abandoned. Construct a concrete plug in the end of all pipe 18 inches or less in diameter. Minimum length of concrete plugs shall be 8 inches. For pipe 21 inches and larger, the plugs may be constructed of common brick or concrete block. The exposed face of block or brick shall be plastered with mortar. All plugs shall be watertight and capable of withstanding all internal and external pressures without leakage.

### 3.04 LEAKAGE TESTS

- A. General:
  - 1. Leakage tests may be required by the Owner for pipelines installed in this project. It is at the discretion of the Owner if leakage tests shall be performed upon completion of CCTV and/or mandrel testing of the sanitary pipelines.
  - 2. Furnish all equipment, materials, personnel, and supplies to perform the tests.
  - 3. Pressure gauges and metering devices shall be of a type, accuracy, and calibration acceptable to the Engineer. The Engineer may require certification of the gauges and meters by an independent testing firm at the Contractor's expense.
  - 4. Leakage tests shall be performed on all piping at a time agreed upon and in the presence of the Engineer.
- B. The leakage test shall be made after all pipe is installed and backfilled, but prior to placing permanent resurfacing. The Contractor may conduct preliminary tests prior to backfill. If the Contractor elects to conduct preliminary tests, he or she shall provide any necessary temporary thrust restraint and shall retest as set forth herein prior to surfacing placement.
- C. Test Procedure: Leakage tests shall be air pressure tests conducted as follows:
  - 1. Furnish all materials, equipment and labor for making an air test. Air test equipment shall be favorably reviewed by the Engineer.
  - 2. The Contractor may conduct an initial air test of the sewer mainline after densification of the backfill but prior to installation of the house connection sewers, if applicable. Such tests will be considered to be for the Contractor's information and need not be performed in the presence of the Engineer.
  - 3. Each section of sewer shall be tested between successive manholes, or in sections if favorably reviewed by the Engineer, by plugging and bracing all openings in the sewer mainline and the upper ends of all building connection sewers. Prior to any air pressure testing, all pipe plugs shall be checked with a soap solution to detect any air leakage. If any leaks are found, the air pressure shall be released, the leaks eliminated, and the test procedure started over again. The Contractor has the option of wetting the interior of the pipe prior to the test.



4. The final leakage test of the sewer mainline shall be conducted in the presence of the Engineer and shall meet the requirements listed in the City of Arvada Engineering Code and Specifications Section 524.01 Air Testing Pipeline.
- D. Correction of Defects: If leakage or infiltration exceeds the allowable, the installation shall be repaired or replaced, and leakage tests shall be repeated as necessary until conformance test requirements specified herein have been fulfilled. All detectable leaks shall be repaired, regardless of the test results.
- E. Reports: Keep records of each piping test, including:
  1. Description and identification of piping tested.
  2. Description of test procedure.
  3. Date of test.
  4. Witnessing by Contractor and Engineer.
  5. Test evaluation.
  6. Remarks, to include such items as:
    - a. Leaks (type, location).
    - b. Repairs made on leaks.
  7. Test reports shall be submitted to the Engineer.

### 3.05 INTERRUPTION OF SANITARY SERVICE

- A. The Contractor must, in writing, advise affected users forty-eight (48) hours prior to performing work on a service or collector line which will interrupt a customer's wastewater line. Contractor prepared notices shall be hand delivered to each customer or occupant. If the occupant cannot be contacted, the written notice shall be left attached to the door knob or screen.
- B. In addition, the Contractor must notify Arvada's Wastewater Division (720-898-7770) of the schedule for plugging and bypassing manholes necessary to isolate the line on which work is to be performed.
- C. The Contractor shall provide all labor, materials and equipment to properly handle and divert all sewage flow when required for construction. See City of Arvada Code 523 for further detail.

### 3.06 SANITARY SEWER MAIN ABANDONMENT

- A. Sanitary sewer mains within the Adams County public right of way shall be removed.
- B. When approved by the Project Engineer, sanitary sewer mains within City of Arvada public right of way may be abandoned in place by filling with concrete or flow fill. Where a pipe is abandoned at a manhole, the pipe shall be plugged at the manhole and removed for a minimum of two (2) feet. Any manholes on abandoned sanitary sewer mains shall have the top cone removed and the remaining manhole hole void space shall be filled with flowable fill with compressible strength of less than 200 psi so that it can be excavated in the future as needed.
- C. Sanitary service connections to City mains that are to be abandoned shall be removed at the main and repaired using a repair clamp. Service lines in the right of way shall be removed. The service may be abandoned in place on private property, with the approval of the property owner, with a minimum of two feet of pipe filled with concrete or flow fill.

- D. Prior to filling with concrete or flow fill any pipe to be abandoned in place shall be flushed with clean water to remove debris. The flushing water shall be properly captured and treated and not released to the storm water system or a natural channel. Flushing water and debris shall not be discharged to downstream sanitary sewer piping.

END OF SECTION

## SECTION 02531

### SANITARY PRESSURE PIPING

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section includes: Poly Vinyl Chloride (PVC) pressure piping sizes 1.5 inches to 4 inches in diameter. Provide all piping, fittings, and accessories as shown on the Drawings, as specified herein, and as required to completely interconnect all piping and equipment for a complete and operable system.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 400.
- B. ASTM International (ASTM):
  - 1. ASTM D1784 Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
  - 2. ASTM D2241 Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
  - 3. ASTM D2774 Standard Practice for Underground Installation of Thermoplastic Pressure Piping
  - 4. ASTM D3139 Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
  - 5. ASTM F477 Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
- C. Uni-Bell PVC Pipe Association:
  - 1. UNI-PUB-9 Installation Guide for Gasketed-Joint PVC Pressure Pipe
- D. American Water Works Association (AWWA):
  - 1. AWWA C605 Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings
  - 2. AWWA C900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. through 60 in. (100 mm through 1500 mm), for Water Transmission and Distribution
  - 3. AWWA M23 PVC Pipe – Design and Installation

##### 1.03 SUBMITTALS

- A. Submit in accordance with Section 01300.
- B. Shop Drawings:
  - 1. Pipe Layouts:
    - a. Shop drawings indicating layout of piping, fittings, valves, and other appurtenances necessary for a completed pipeline.
  - 2. Calculations: Calculations showing compliance under this section.



- C. Product Data:
  - 1. Submit data on the following items showing compliance under this section:
    - a. Pipe, fittings, and accessories
    - b. Gaskets
    - c. Connections to existing pipelines, laterals, and structures
    - d. Flexible couplings and flanged coupling adapters
    - e. Restrained joints
  - 2. Certifications:
    - a. Certified affidavit of compliance with ASTM D2241.
    - b. Certified field test reports specified herein.

#### 1.04 QUALITY ASSURANCE

- A. The Pipe Manufacturer shall be a member of the Uni-Bell PVC Pipe Association.

### PART 2 - PRODUCTS

#### 2.01 PVC PIPE

- A. Sizes: 1.5 to 4 inches in diameter.
  - 1. PVC pipes shall be manufactured and supplied in accordance with AWWA C900 and/or ASTM D2241.
- B. Minimum working pressure:
  - 1. Pressure Class 200 psi, SDR 21
  - 2. Provide wall thicknesses matching the specified pressure class.
- C. Lay length: Pipe furnished shall have normal laying length of 20 feet to 22 feet.
- D. The pipe shall be made of PVC compound having a cell classification of 12454 or 12364 in accordance with ASTM D1784.
- E. Pipe shall be homogenous throughout, free of voids, cracks, inclusions, and other defects.
- F. Pipe for potable water use shall be blue or white in color. Pipe for recycled or reclaimed water use shall be purple in color. Pipe for other non-potable water uses shall be green or white in color.
- G. Pipe outside diameters shall be equal to those of cast iron (cast iron pipe sizes, CIPS) unless otherwise specified by the Owner.
- H. Pipe Identification:
  - 1. Buried pipe markings shall conform to AWWA C900:
    - a. Pipe shall have markings at the ends of each pipe stick
      - 1) Manufacturer's name or trademark and lot code
      - 2) Nominal pipe size and OD (e.g., CIOD or IPS)
      - 3) Legend (e.g., PVC AWWA C900)
      - 4) Dimension ratio
      - 5) Pressure class in psi
      - 6) Hydrostatic integrity test pressure
- I. Acceptable Pipe Manufacturers:
  - 1. Charlotte Pipe and Foundry Company
  - 2. Diamond Plastics Corps.

3. Westlake Chemical Corporation
4. JM Eagle
5. or equal

## 2.02 FITTINGS

- A. Ductile iron fittings shall be manufactured and supplied in accordance with AWWA C110 and/or C153.
  1. External Coating:
    - a. Buried pipe coating shall be an asphaltic coating approximately 1 mil thick in accordance with AWWA C151.
  2. Internal Lining:
    - a. Fittings furnished shall have an Amine Cured Novalac Ceramic Epoxy Lining: Protecto 401, or equal.
    - b. Thickness test linings per SSPC PA 2 using a magnetic film thickness gauge. Test interiors for pinholes with nondestructive 2,500 volt test. Correct all defects before shipment.
  3. Polyethylene encasement:
    - a. All polyethylene encasement material shall be manufactured in accordance with ANSI/AWWA Standard C105/A21.5.
    - b. Polyethylene encasement shall be the V-Bio Enhanced Polywrap consisting of three layers of co-extruded linear, low-density polyethylene (LLDPE), fused into a single thickness of not less than 8 mils. The inside surface of the polyethylene wrap to be in contact with the fitting exterior shall be infused with a blend of antimicrobial compound to mitigate microbiologically infused corrosion and a volatile corrosion inhibitor to control galvanic corrosion.
    - c. The raw materials used to manufacture polyethylene film shall be Type I, Class A, Grade E 1 in accordance with ASTM D1250.
    - d. See Section 02510 for additional corrosion protection requirements.
- B. PVC fittings shall be manufactured and supplied in accordance with AWWA C900.
  1. Fittings shall be made of PVC compound having a cell classification of 12454 or 13343 in accordance with ASTM D1784.
  2. Pipe used in fabricated fittings shall have a wall thickness equal to or greater than the wall thickness of the pipes to which the fitting will be joined.
  3. Acceptable PVC fitting manufacturers shall be the same as identified for pipes.
- C. Fitting Identification
  1. Each fitting shall be clearly labeled. Identify:
    - a. Size
    - b. Pressure class
    - c. Angle deflection, if applicable

## 2.03 JOINTS

- A. Joints: Joints shall be gasket, bell and spigot and push-on type conforming to ASTM D3139.
- B. The bell and coupling shall be the same, or greater, thickness as the pipe barrel.
- C. Deflection at the joint shall not exceed 1 degree or the maximum deflection recommended by the manufacturer, whichever is smaller.

- D. Gaskets: Gasket material shall be NBR (Nitrile or Buna-N) in accordance with ASTM F477.
  - 1. If gaskets are supplied separately from pipe, it is the Contractor's responsibility to ensure that the gaskets supplied are designed for the pipe in use.
- E. Joint lubricant shall be approved by the pipe manufacturer and shall have no detrimental effect on the gasket or pipe.

#### 2.04 JOINT RESTRAINT

- A. Contractor shall provide joint restraints in accordance with ASTM D2774, AWWA C605, and the Pipe Manufacturer's recommendations.

#### 2.05 TRACER WIRE

- A. Per Colorado Senate Bill 18-167, all new underground facilities, including laterals up to the structure or building being served, require tracer wire.
- B. Tracer wire to be installed in accordance with Section 02300.

#### 2.06 BEDDING AND BACKFILL MATERIALS

- A. Bedding: Pipe Bedding shall be as specified in Section 02300, except as indicated on the drawings.
- B. Backfill: As specified in Section 02300.

### PART 3 - EXECUTION

#### 3.01 INSTALLATION

- A. Excavate pipe trench in accordance with Section 02300.
- B. Install mechanical restraint per Manufacturer recommendations.
- C. Install polyethylene encasement for fittings in accordance with AWWA C105.
- D. Install tracer wire and test stations per Section 02300.
- E. Minimum depth of cover over the pipe measured from final grade to the top of the pipe shall be 4.0 feet, unless otherwise noted on the Drawings. Deviations from said depth of cover over the pipe shall be approved by the Owner.
- F. Maintain all water and/or force main lines a minimum of 10 feet horizontal from other utilities, unless otherwise indicated on the plans.
- G. Maintain all water and/or force main lines a minimum of 18 inches vertical from other utilities, unless otherwise indicated on the plans.
- H. Contractor shall install pipe to lines and grades as indicated on the plans. Contractor shall notify the engineer of any deviations for review and acceptance.
- I. Install pipe to allow for expansion and contraction without stressing pipe or joints. Maximum deflection of joints shall not exceed AWWA C600 requirements as listed below:



Pipe Size	Maximum Deflection	Radius of Curvature	
		L=18'	L=20'
4" - 12"	5°	205'	230'

- J. Install restrained joints per manufacturers recommendations. Restrained joints shall be placed at all tees, bends, caps, and reducers.

3.02 FLUSHING

- A. Refer to Section 02516 for flushing requirements.

3.03 PRESSURE TESTING

- A. Refer to Section 02516 for hydrostatic testing requirements.

END OF SECTION

## SECTION 02721

### AGGREGATE BASE COURSE

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Aggregate base course.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 300.
- B. CDOT Standard Specifications for Road and Bridge Construction
- C. American Association of State Highway and Transportation Officials:
  - 1. AASHTO T180 - Standard Specification for Moisture-Density Relations of Soils Using a 10 lb Rammer and an 18-in. Drop.
- D. American Society for Testing and Materials:
  - 1. ASTM D698 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup>).
  - 2. ASTM D1557 - Standard Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (6,000 ft-lbf/ft<sup>3</sup>).
  - 3. ASTM D2922 - Standard Test Method for Density of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth).
  - 4. ASTM D3017 - Standard Test Method for Water Content of Soil and Rock in Place by Nuclear Methods (Shallow Depth).Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, newest version.

##### 1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Engineer may require a Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

##### 1.04 QUALITY ASSURANCE

- A. Furnish each aggregate material from single source throughout the Work.
- B. Materials testing shall be performed in accordance with Minimum Materials Testing Frequencies found in Section 322 of the City of Arvada Engineering Code of Standards and Specifications.

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Materials and construction shall be in accordance with the requirements of Section 304 of the CDOT Standard Specifications for Road and Bridge Construction
- B. Aggregate Base Course: Base course material gradation shall meet the requirements of Class 5 (1½" maximum) or Class 6 (1" maximum), in accordance with Table 703.03 of CDOT Standard Specifications for Road and Bridge Construction.

Sieve Size	Max % Passing
50 mm (2")	100
25 mm (1")	85-100
19 mm (¾")	75-100
12.5 mm (½")	55-90
9.5 mm (⅜")	45-80
4.75 mm (#4)	25-55
1.18 mm (#16)	5-25
75 µm (#200)	0-5

- C. Herbicides
  - 1. As specified in Section 217 Herbicide Treatment, Colorado Department of Transportation Standard Specifications for Road and Bridge Construction.
  - 2. Labels shall be registered with the Colorado Department of Agriculture and the U.S. Environmental Protection Agency.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify substrate has been inspected, gradients and elevations are correct, and is dry.

### 3.02 PREPARATION

- A. Correct irregularities in substrate gradient and elevation by scarifying, reshaping, and re-compacting.
- B. Do not place fill on soft, muddy, or frozen surfaces.
- C. Excessively dry surfaces shall have water applied to them and shall be reprocessed.

### 3.03 AGGREGATE PLACEMENT

- A. Aggregate base course placement shall comply with Section 300 – Soils and Earthwork of City of Arvada Engineering Code of Standards and Specifications.



- B. Placing and spreading shall be done by means of a spreader machine, moving vehicle, motor grader, or by other approved equipment methods. The material shall be placed without segregation. Any segregated areas shall be removed and replaced with uniformly graded material at the Contractor's expense.
- C. The thickness of each base course layer shall not exceed six (6) inches before compaction. If uniform density cannot be obtained by six (6) inch lifts, the maximum lift thickness shall not exceed four (4) inches. Each lift must be compacted with vibratory equipment.
- D. Compact to 95% of the maximum density determined in accordance with AASHTO T180 as modified by CP 23. If uniform density cannot be obtained by 6-inch layers, the maximum thickness shall not exceed 4 inches. The moisture content shall be  $\pm$  2 percent of optimum moisture content.
- E. The prepared base course surface shall be smooth and free of ruts and irregularities and shall be level and contour surfaces to elevations and gradients indicated. The base course shall be maintained in this condition by watering, drying, rolling, and/or blading until the asphalt or concrete flatwork is placed. The surface tolerance of the base course shall be in accordance with Section 304.06 of the CDOT Standard Specifications for Road and Bridge Construction.
- F. Maintain optimum moisture content of fill materials to attain required compaction density.
- G. Use mechanical tamping equipment in areas inaccessible to compaction equipment.

#### 3.04 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Construction Observation
- B. Compaction testing shall be performed in accordance with Section 304 of the CDOT Standard Specification for Road and Bridge Construction. After passing all compaction tests, the base course shall be proof-rolled.
- C. When tests indicate Work does not meet specified requirements, remove Work, replace, and retest.
- D. Frequency of Tests: As specified in Section 322 of the City of Arvada Engineering Code of Standards and Specifications.

END OF SECTION

SECTION 02740  
FLEXIBLE PAVEMENT (ASPHALT)

PART 1 GENERAL

1.01 SUMMARY

- A. Section Includes:
  - 1. Asphaltic concrete paving, wearing, binder, and base course.
  - 2. Surface sealer.

1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 900.
- B. Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, latest edition.
- C. Municipal Government Pavement Engineers Council (MGPEC), Pavement Design Standards and Construction Specification Manual, latest edition.

1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Product Data: Submit product information and mix design.
- C. Engineer may require a Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.04 QUALITY ASSURANCE

- A. Obtain materials from same source throughout.

1.05 ENVIRONMENTAL REQUIREMENTS

- A. Section 01600 - Product Requirements: Environmental conditions affecting products on site.
- B. Hot mix asphalt shall be placed only on properly constructed subgrade and interim lifts that are free from water, snow, ice, and frozen subgrade. The asphalt shall be placed only when weather conditions permit the pavement to be properly placed and finished as determined by the Owner's Inspector. The hot mix asphalt shall be placed only when both the air and surface temperatures equal or exceed the temperatures specified in table below.
  - 1. Air temperature shall be taken in the shade. Surface is defined as the existing base on which the new pavement is to be placed.
  - 2. The Project Engineer may waive minimum temperature requirements for placing prime coats and layers of asphalt below the top layer of the pavement section.

Compacted Layer Thickness (inches)	Minimum Air and Surface Temperature (°F and rising)	
	Top Layer	Layer Below Top Lift
2 to < 3	50	40
3 or more	45	35

## PART 2 PRODUCTS

### 2.01 MATERIALS

- A. Aggregate Base Course: In accordance with Section 02721 Aggregate Base Course and the City or County standards having jurisdiction.
- B. The gradation of the mineral aggregate shall be grading SG (1 inch nominal), S (3/4 inch nominal) or SX (1/2 inch nominal). In no case shall grading SG be used for a permanent final lift of asphalt; however, the Project Engineer may require the use of grading SG in a pavement section. Grading SX (1/2 Inch Nominal) shall be used for the permanent final lift or overlay of all asphalt, unless approved by the Project Engineer.
- C. All asphalt pavement mix designs shall be based off of City and County of Denver Standard Drawing 12.7 -Typical Asphalt Mix Details by Traffic Use or Lift Position.
- D. Aggregate for Hot Bituminous Pavement:
  - 1. Grading S: In accordance with CDOT Section 703.04 *Aggregate for Hot Plant Mix Bituminous Pavement*.

<u>Sieve Size</u>	<u>Percent Passing</u>
1-inch	100
3/4 -inch	90 to 100
No. 8	23 to 49
No. 200	2 to 8

- 2. Grading SX: In accordance with CDOT Section 703.04 *Aggregate for Hot Plant Mix Bituminous Pavement*.

<u>Sieve Size</u>	<u>Percent Passing</u>
3/4 -inch	100
1/2 -inch	90 to 100
No. 8	28 to 58
No. 200	2 to 10

- 3. Grading SG: In accordance with CDOT Section 703.04 *Aggregate for Hot Plant Mix Bituminous Pavement*.



<u>Sieve Size</u>	<u>Percent Passing</u>
1 ½ -inch	100
1 -inch	90 to 100
No. 8	19 to 45
No. 200	1 to 7

- E. Tack Coat: In accordance with MGPEC Item 20.5 Tack Coat.
- F. Seal Coat: In accordance with CDOT Section 409 Chip Seal.

## 2.02 ASPHALT PAVING MIX

- A. Materials shall comply with Section 900 – Asphalt Mix Design and Construction of City of Arvada Standards and Specifications.
- B. Asphalt mixes shall be from the City and County of Denver Approved Hot Mix Asphalt Designs List and shall be submitted to the Project Engineer for approval fourteen (14) days prior to placement.

## 2.03 SOURCE QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Testing, inspection, and analysis requirements.
- B. Submit proposed mix design for review prior to beginning of Work.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify compacted subbase is dry and ready to support paving and imposed loads.
- B. Verify grades and elevations of base are correct.
- C. Verify that manhole frames, valves etc. are installed in correct position and elevation.

### 3.02 ASPHALT CUTS

- A. All cuts to be squared off with a saw-cut or blade-cut prior to restoration.
- B. Maximum width of asphalt cut shall be 12-inches from edge of concrete gutter.
- C. Cuts shall be made so that the asphalt patch extends past the trench wall 24-inches minimum on each side or per City/County requirements.
- D. The Contractor shall place a temporary, cold mix, asphalt patch in all street cuts immediately after completing backfill and compaction if a permanent hot mix asphalt patch cannot be installed. Portions shall not be left on any trench patch at the end of the working day if the depth of the patch is lower than the existing street surface.

- E. When pavement cuts are required, the following conditions shall be met to avoid interference with traffic:
  1. Pavement cuts in streets shall be open only between 9:00 a.m. and 3:30 p.m.
  2. Two-way traffic shall be maintained at all times around the construction area. A Traffic Control Plan (TCP) shall be prepared in accordance with Section 01550.

3.03 BASE COURSE

- A. Aggregate Base Course: Install as required by the City/County having jurisdiction or per the approved pavement design, and as specified in Section 02721 Aggregate Base Course.

3.04 PREPARATION - TACK COAT

- A. Apply tack coat in accordance with MPGEC Item 20.5 Tack Coat.
- B. Apply tack coat to contact surfaces of curbs and gutters.

3.05 PLACING ASPHALT PAVEMENT

- A. Place asphalt pavement in accordance with City/County standards. City of Arvada requires asphalt and placement compaction shall comply with MGPEC Item 20, latest edition.
- B. Place asphalt within 24 hours of applying tack coat.
- C. Unless otherwise required by the City/County or indicated on the Drawings, place asphalt to a total compacted minimum thickness of 6.5 inches.
  1. Place Hot Bituminous Pavement Grading S to 4.5 inches compacted thickness.
  2. Place Hot Bituminous Pavement Grading SX to 2 inches compacted thickness.
- D. The minimum allowable compacted lift thickness shall be two (2) inches. The generally accepted standard for compacted lift thickness is three times (3X) the nominal maximum particle size (NMPS). In no case shall the compacted asphalt layer thickness be greater than four times (4X) the NMPS.

Gradation	Minimum Lift Thickness	Maximum Thickness
SG	3"	4"
S	2.5"	3"
SX	2"	3"

- E. Compact each course by rolling to specified density. Do not displace or extrude pavement from position. Hand compact in areas inaccessible to rolling equipment. See Section 900 - Asphalt Mix Design and Construction of City of Arvada Standards and Specifications for additional compaction requirements.
- F. Perform rolling with consecutive passes to achieve even and smooth finish, without roller marks.

- G. Contractor to repair/replace all traffic signal wires damaged during paving operations.
- H. Contractor to restore all pavement markings per City/County standards.
- I. Contractor shall place asphalt in a T-patch in accordance with Arvada Engineering Code of Standards and Specifications Detail 900-1.

### 3.06 MANHOLE RIM AND VALVE/SURVEY RANGE BOX ADJUSTMENTS

- A. Manholes, valve boxes and survey range boxes shall be adjusted to within one-quarter inch ( $\frac{1}{4}$ " ) below finish grade before the final surface course of pavement is placed. The Contractor shall remove all foreign matter found or introduced into them in the performance of this work, and it shall be their responsibility to ensure proper compaction around them after they have been adjusted. Manholes, valve boxes, and range boxes should be set to final grade just prior to the final lift of asphalt being placed on newly constructed or newly re-constructed streets.
- B. If manholes are not set to grade prior to the final lift of HBP being placed, the Contractor shall vertically and uniformly cut the existing asphalt mat full depth three (3) feet square around the center of the manhole with sides parallel and perpendicular to street centerline. Manholes shall be raised to proper grade using concrete riser rings. If more than twelve inches (12") of concrete riser rings are required to raise the manhole lid to final grade, then a new manhole barrel section must be installed to allow the lid to be set to grade with less than twelve (12") of concrete riser rings. If range boxes and valve boxes are not set to grade prior to the final lift of asphalt being placed, the asphalt mat shall be core drilled full depth twelve (12") diameter centered on the valve box or range box. Auger drilling shall not be allowed. Range boxes shall then be set on compacted subgrade at the proper elevation to match final grade. Adjustable range boxes shall be screw adjusted to within one-quarter inch ( $\frac{1}{4}$ " ) below existing grade. Valve boxes shall also be screw adjusted to within one-quarter inch ( $\frac{1}{4}$ " ) below final grade. Drop in type valve box risers shall not be allowed on newly constructed or newly re-constructed streets. New hot mix asphalt (Grading SX,  $\frac{1}{2}$ " mix) shall be placed and properly compacted in the excavated area. The entire area in the vicinity of the raised manhole, valve box or range box shall then be infrared repaired to blend the Patch with the existing asphalt and to eliminate any vertical joints in the final lift of asphalt.
- C. On streets that are being sealed, the Contractor shall cover the manholes, valve boxes and survey range boxes with roofing paper or other suitable material prior to sealing. The covering shall be left in place for a minimum of forty-eight (48) hours after which it shall be removed and disposed of. All covers shall be clean when work is complete.
- D. In the case of manhole rings, the Contractor shall vertically and uniformly cut the existing asphalt mat eight (8) inches from the ring and remove the mat and base to a depth of six (6) inches below finish grade. Rings shall then be removed, and the existing riser rings adjusted and pointed to provide the required subgrade for resetting the set rings, free of pressure points. Once the ring is reset to finish grade the collar eight (8) inch x six (6) inch void between the mat and the ring shall be filled with asphaltic concrete and compacted.



### 3.07 ADAMS COUNTY ASPHALT REQUIREMENTS

- A. Existing asphalt pavement shall be removed to straight edges made by full-depth vertical saw cuts. A "T" patch with additional width for the top course of asphalt will not be required since the County expects to modify or reconstruct the pavement with the future Tennyson Street Improvements project.
- B. The edges of pavement removal/patching must be located 1 foot or more outside of the top edges of the trench excavation, i.e., the patch width shall be 2 feet or more wider than the top width of trench.
- C. The sawcut edges of existing pavement must receive a tack coat of diluted emulsified asphalt before the patch material is placed.
- D. Patch material shall be Hot Mix Asphalt SX (75) (PG 64-22) placed and compacted in lifts with typical thickness of 2 inches and maximum thickness of 3 inches. A substitute asphalt mix may be submitted to Adams County for consideration.

### 3.08 TOLERANCES

- A. Section 01400 - Quality Requirements: Tolerances.
- B. Scheduled Compacted Thickness: Within ¼ -inch.
- C. Variation from Indicated Elevation: Within ½ -inch.
- D. Or as required by the City/County having jurisdiction.

### 3.09 POTHOLE REPAIR

- A. Exploratory potholing voids are to be backfilled and the core patched with a temporary patching material immediately after initial potholing is complete.
- B. All material disturbed and/or removed during the exploratory operation shall be replaced with an approved flow-fill mix.
- C. Squeegee shall not be allowed as backfill material except for use as pipe bedding with a twelve inch (12") maximum depth over the pipe.
- D. Within seven (7) days of initial drilling, or within a reasonable and practical amount of time after completion of the projected work, potholes will be permanently patched.
- E. Portions shall not be left on any trench patch at the end of the working day if the depth of the patch is lower than the existing street surface.
- F. Any exploratory pothole and/or patch that are deemed dangerous shall be repaired immediately.
- G. All permanent repairs shall be made to look symmetrical and/or uniform. No jagged, uneven patches will be allowed.
- H. All edges and patch areas shall be dried, cleaned and tacked. All newly placed asphalt shall be maximum one-half inch (1/2") mix (SX) and shall be compacted properly in two (2) inch lifts.

### 3.10 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Materials testing shall be performed by a qualified geotechnical engineer working under the direction of a Colorado Registered Professional Engineer. Testing will be performed and/or paid for by the Owner on City projects unless otherwise noted in the Special Conditions for the project.
- C. See the asphalt testing table in the Arvada Engineering Code of Standards and Specifications section 922.00 for additional requirements related to asphalt testing, reference standards, and minimum test frequencies.

END OF SECTION

## SECTION 02750

### RIGID PAVEMENT (CONCRETE)

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Concrete sidewalks.
  - 2. Concrete curbs, gutters, curb ramps, and crosspans.
  - 3. Miscellaneous concrete slabs.

##### 1.02 REFERENCES

- A. Arvada Engineering Code of Standards and Specifications, Section 800.
- B. Colorado Department of Transportation (CDOT), Standard Specifications for Road and Bridge Construction, current version.

##### 1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Product Data: Submit product information and mix design for each proposed mix to be used.
- C. Engineer may require a Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

##### 1.04 QUALITY ASSURANCE

- A. Obtain materials from same source throughout.

#### PART 2 PRODUCTS

##### 2.01 CONCRETE MATERIALS

- A. Aggregate Base Course: In accordance with Section 02721 Aggregate Base Course and City/County standards.
- B. Concrete materials shall meet the requirements specified in the appropriate subsections listed in CDOT Section 601 *Structural Concrete* and the appropriate City/County standards.
- C. Roadways, Crosspans, Curb Cuts, Curb Ramps, Driveways, Sidewalks, Curb, and Gutter:
  - 1. Class P Concrete, in accordance with CDOT Section 601 *Structural Concrete*.
  - 2. Minimum 28-day compressive strength: 4,500 psi.



## 2.02 REINFORCING STEEL

- A. Reinforcing Steel in accordance with CDOT Section 602 *Reinforcing Steel*.

## 2.03 FORM MATERIALS

- A. Forms shall be of wood, metal, or other suitable material, and shall extend from the full depth of the concrete.
- B. All forms shall be straight, free from warp, and of sufficient strength to resist the pressure of the concrete without springing.
- C. Bracing and staking of forms shall be such that the forms remain in both horizontal and vertical alignment until their removal.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify compacted subgrade is acceptable and ready to support paving and imposed loads.
- B. Verify gradients and elevations of base are correct.
- C. It is the responsibility of the Contractor to contact the Owner's Inspector a minimum of one (1) full working day (twenty-four [24] hours) in advance of the required inspections. Concrete shall not be placed until all forms and reinforcement have been observed by the Owner's Inspector. See Section 800 of the City of Arvada Engineering Code of Standards and Specifications for inspection requirements.

### 3.02 BASE COURSE

- A. Aggregate Base Course: Install as required by the City/County and as specified in Section 02721 Aggregate Base Course.

### 3.03 PREPARATION

- A. Moisten base to minimize absorption of water from fresh concrete.
- B. Coat surfaces of manhole and catch basin frames with oil to prevent bond with concrete pavement, as applicable.
- C. Notify Owner's Inspector and Project Engineer a minimum 24 hours prior to commencement of concreting operations.
- D. All edges of the existing flatwork to remain shall be saw cut. Flatwork repairs and replacement shall be as directed by the Owner's Inspector and at the Contractor's expense.

### 3.04 PLACING CONCRETE

- A. Place concrete in accordance with City/County standards and in accordance with CDOT Section 601.12 *Placing Concrete*.

- B. Concrete thickness shall match existing concrete thickness unless otherwise noted.
  - 1. Detached sidewalks along local residential streets shall be a minimum of four (4) inches thick and all other sidewalks shall be a minimum of six (6) inches thick. Areas of sidewalk or concrete trails crossed by driveways or in parks, open spaces or greenbelts shall be constructed with a minimum of six (6) inch thick concrete.
  - 2. Curb cuts in six (6) inch vertical curbs shall be constructed at all driveway locations.
- C. Curb ramps shall be installed at locations designated by the Project Engineer and as shown on the Drawings. Directional curb ramps, rather than diagonal or corner curb ramps, shall be installed unless site conditions or constraints prohibit their placement; or their placement creates an unsafe or undesirable condition for pedestrians or wheelchair travel along the sidewalk. The curb ramps shall be constructed with slopes, landings, and detectable warnings (truncated domes) as shown in the latest revision of the Colorado Department of Transportation M&S Standards. Truncated domes shall be from the CDOT approved products list, and the Contractor shall follow specific installation details per the manufacturer. Replaceable cast-in-place (wet set) truncated dome panels shall be easily removed and replaced, made of fiber reinforced fiberglass/composite material, and color shall contrast the surface applied to. Panels shall have a beveled edge for wheelchair egress. No truncated dome pavers shall be used within City right-of-way. Panel size shall have a depth of two (2) feet.
- D. Fresh concrete shall be adequately protected from weather damage and mechanical injury during curing periods. Should damage occur, the concrete shall be removed and replaced at no cost to the Owner. The selected curing process shall be started as soon as it can be performed without injury to the concrete surface. See Section 800 of the City of Arvada Engineering Code of Standards and Specifications for additional placing requirements.

### 3.05 TESTING

- A. A representative of the concrete testing agency shall inspect, sample, and test material and production of concrete as required by the Project Engineer. Minimum testing frequency shall be as specified in Section 825.00 of the Arvada Engineering Code of Standards and Specifications.
- B. Any test failures shall trigger testing for the next three (3) loads. The concrete testing agency shall report all test and inspection results to the Project Engineer and Contractor immediately after they are performed. All test reports shall include the exact location of the work at which the batch represented by a test was deposited. The report of the strength test shall include detailed information on storage and curing of specimen prior to testing, the project number, and the location of the concrete (curb, manhole, inlet, sidewalk, paving, etc.).
- C. The concrete testing agency or its representative is not authorized to revoke, alter, relax, expand or release any requirements of these Standards and Specifications, nor to approve or accept any portion of the work. When it appears that any material furnished or work performed by the Contractor fails to fulfill

specification requirements, the testing agency shall report such deficiencies to the Project Engineer and the Contractor.

3.06 FINISHING

- A. Sidewalks and Bikeways: Light broom and trowel joint edges.
- B. Curbs and Gutters: Light broom.
- C. Parking Area Pavement: Light broom.

3.07 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Construction Observation.

END OF SECTION



## SECTION 02951

### VIDEO INSPECTION OF PIPELINES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section Includes:
  - 1. Pipeline flushing and cleaning.
  - 2. Video inspection of sewer pipelines
    - a. All new gravity sewer lines
  - 3. Audio-video taping of pipeline interior.

##### 1.02 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.
- B. Submit completed USB drives, identified by project name, street name, and manhole numbers. USB drives become property of Owner.
- C. Submit cleaning and television inspection logs for each section of sewer line to be inspected.

##### 1.03 QUALIFICATIONS

- A. Video inspection of pipelines to be completed by a Company specializing in performing work of this section with minimum 5 years documented experience.
- B. Video inspections must be in NASSCO version 7, or latest edition.

#### PART 2 PRODUCTS

##### 2.01 MEDIA

- A. NASSCO Version 7 Compatible, or latest edition.
- B. Windows Real Player, Windows Media Player, or Flexireader formatted USB drives.
  - 1. Videos shall be delivered in Mpeg4 format.
- C. Audio track containing simultaneously recorded narrative commentary describing in detail condition of pipeline interior.

##### 2.02 CONTENTS OF VIDEO INSPECTION

- A. The following information, to the extent it can be reasonably determined, is to be recorded visually on the USB drives, and video logs. NASSCO Version 7, or latest edition, shall be followed.

- B. Date: The date on which the videotaping was performed at the beginning of each segment.
- C. Manhole to Manhole: The manhole identification number for both the upstream and downstream manholes at either end of the taped segment.
- D. Direction of Video: Relative to flow direction, indication whether the camera is facing upstream or downstream.
- E. Continuous Digital Counter: A digital counter to designate the distance from the "upstream" manhole.
- F. Street Name: The street name which contains the video segment and/or the nearest cross street.
- G. Service Identification: Identification of all taps by size, type, and pipe entrance location. A clock reference is also preferred.
- H. Cracks: Identification of all cracks (spiral, lateral, beam) by type, severity, location and footage.
- I. Broken Pipe: Identification of all broken pipe other than cracks by location, cause if known (i.e., improper installation of service, encroachment of other utility, etc.), severity, and footage.
- J. Sags: Identification of all sags greater than one inch (1") by beginning/start, best estimate of depth of sag (greatest point), and ending footage. If the segment has a number of sags or one long continuous sag, view the apparent length and depth of the sag. Once convinced as to the extent of the sag, suck the sag down by the use of the jet cleaning unit so the condition of the pipe wall can be viewed. Also identify any apparent high spots.
- K. Infiltration: Identification of all forms of infiltration (or exfiltration) by estimation of flow volume (GPM), possible source, visible calcium deposits, and footage.
- L. Vertical/Horizontal Offset Joints: Identification of all joints which appear to be offset from original alignment, severity, location, and footage.
- M. Wide Joints: Identification of all joints which appear to have a wider separation of bell and spigot than normal, by width and footage.
- N. Oval/Deformed Pipe: If PVC or other flexible pipe material exists which may deflect and not sustain noticeable failure, identification of shape of pipe (i.e., egg shaped, non-circular, etc.), footage, and location.
- O. Percent Deterioration: Identify severity of deterioration.
- P. Lens Height: Indication whether the camera has been lowered, and the reason. Otherwise, the camera should be set as close to the center of the pipe as possible.
- Q. Size and Type (Material): List inside pipe diameter and type of material for each pipe segment.

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify location of sewer pipelines to be inspected.

### 3.02 PREPARATION

- A. Flush and clean pipeline interiors to remove sludge, dirt, sand, stone, grease, and other materials from pipe to ensure clear view of interior conditions.
- B. Intercept flushed debris at next downstream manhole by use of weir or screening device, remove, and dispose of debris from system off site.

### 3.03 APPLICATION

- A. Closed-circuit TV Camera System:
  - 1. Utilize cameras specifically designed and constructed for closed-circuit sewer line inspection. Utilize camera equipment with pan and tilt capability to view each lateral connection at multiple angles.
  - 2. Utilize camera capable of moving both upstream and downstream; minimum 1,000 feet horizontal distance with one setup; direct reading cable position meter.

### 3.04 PROCEDURES

- A. Color Video: Since color provides better contrast and detail, no black and white video will be accepted.
- B. Video (Travel) Speed: To the extent practicable, the speed range at which all segments will be videotaped will be a maximum of 1 Ft/Sec, and a minimum of ½ Ft/Sec. Should variance from these parameters occur, it must be noted on the audio, and the reason for the variance. It is recognized that variance from the minimum speed according to the condition of the pipe is not a serious problem, but that exceeding the maximum velocity can reduce the viewability of the video and may be grounds for request of re-videotaping the specified segment.
- C. Counter Variance:
  - 1. Variance of counter/as-built distance shall not exceed the following:

As-Built Distance	Variance
0 - 100 feet	2%
101 - 200 feet	2%
201 - 300 feet	3%
301 - 400+ feet	3%

- 2. If the as-built distance and counter distance have a greater difference than specified by the variance, the Contractor shall either verify recorded as-built distance or re-video the entire segment.
- D. Lens Obstruction: If the lens is obstructed by a foreign object or by fog (e.g., water spray, mist, etc.), attempt to clear the lens of the obstruction. If attempts fail and



additional videotaping would produce the same results, continue to videotape the extent of the segment; otherwise, re-video all or the portion which had not been viewed.

- E. Lighting: Ensure that the illumination level inside the pipe is high enough to identify clearly the condition of the interior circumference. If segments are not already visible, a request will be made to re-video the segment. If there are outside contributing factors which make the pipe impossible to illuminate, identify such on video log.
- F. Skips in Video: If a portion of the video segment is not recorded on the CD USB drive (such as through malfunction of equipment), the segment must either be entirely re-videotaped from the beginning of the skip to the end, or the entire segment must be re-videotaped. Such corrective action will be at the Contractor's expense.
- G. Video Footage: Properly identify footage from "upstream" manhole (i.e., as-built footage is from center of manhole to center of manhole). State location of beginning of video segment and correlate counter to this footage (i.e., beginning of pipe segment would be 2 feet, center of manhole would be 0 feet).

### 3.05 FIELD QUALITY CONTROL

- A. Section 01400 - Quality Requirements: Construction Observation.

END OF SECTION

## SECTION 03300

### CONCRETE MIXTURES, HANDLING, PLACING, AND CONSTRUCTING

#### PART 1 - GENERAL

##### 1.01 SUMMARY

###### A. Section Includes:

1. Requirements for materials, proportioning, production, and delivery of concrete.
2. Production of cast-in-place structural concrete.
3. Methods and procedures for obtaining quality concrete through proper batching, handling, placing, and inspection.

##### 1.02 REFERENCES

###### A. American Concrete Institute (ACI):

1. ACI 117 Specification for Tolerances for Concrete Construction and Materials
2. ACI 301 Specifications for Structural Concrete
3. ACI 305 Guide to Hot Weather Concreting
4. ACI 306 Guide to Cold Weather Concreting
5. ACI 350 Code Requirements for Environmental Engineering Concrete Structures

###### B. ASTM International (ASTM) Standard Specification or Test Method:

1. ASTM C31 Making and Curing Concrete Test Specimens in the Field
2. ASTM C33 Concrete Aggregates
3. ASTM C39 Compressive Strength of Cylindrical Concrete Specimens
4. ASTM C40 Organic Impurities in Fine Aggregates for Concrete
5. ASTM C42 Obtaining and Testing Drilled Cores and Sawed Beams of Concrete
6. ASTM C87 Effect of Organic Impurities in Fine Aggregate on Strength of Mortar
7. ASTM C88 Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
8. ASTM C94 Ready-Mixed Concrete
9. ASTM C131 Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
10. ASTM C136 Sieve Analysis of Fine and Coarse Aggregates
11. ASTM C138 Density (Unity Weight), Yield, and Air Content (Gravimetric) of Concrete
12. ASTM C142 Clay Lumps and Friable Particles in Aggregates
13. ASTM C143 Slump of Hydraulic-Cement Concrete
14. ASTM C150 Portland Cement
15. ASTM C157 Length Change of Hardened Hydraulic-Cement Mortar and Concrete
16. ASTM C172 Sampling Freshly Mixed Concrete

17. ASTM C173 Air Content of Freshly Mixed Concrete by the Volumetric Method
  18. ASTM C192 Making and Curing Concrete Test Specimens in the Laboratory
  19. ASTM C231 Air Content of Freshly Mixed Concrete by the Pressure Method
  20. ASTM C260 Air-Entraining Admixtures for Concrete
  21. ASTM C494 Chemical Admixtures for Concrete
  22. ASTM C595 Blended Hydraulic Cements
  23. ASTM C618 Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete
  24. ASTM C827 Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures
  25. ASTM C869 Foaming Agents Used in Making Preformed Foam for Cellular Concrete
  26. ASTM C989 Slag Cement for Use in Concrete and Mortars
  27. ASTM C1064 Temperature of Freshly Mixed Hydraulic-Cement Concrete
  28. ASTM C1077 Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation
  29. ASTM C1240 Silica Fume used in Cementitious Mixtures.
  30. ASTM C1293 Determination of Length Change of Concrete Due to Alkali-Silica Reaction
  31. ASTM C1602 Mixing Water Used in the Production of Hydraulic Cement Concrete
  32. ASTM D2419 Sand Equivalent Value of Soils and Fine Aggregate
- C. American Association of State Highway and Transportation Officials (AASHTO):
1. T26 Standard Method of Test for Quality of Water to be Used in Concrete
- D. NSF/ANSI 61 – Drinking Water System Components – Health Effects

### 1.03 SUBMITTALS

- A. Submit in accordance with Section 01300 (01 33 00).
- B. Product Data:
1. Concrete mix product certification: Submit certified laboratory test results that the mix proportions and materials comply with these Specifications.
    - a. Mix design: identification number, proportions, and characteristics. Indicate concrete type each mix design is being submitted under along with the proposed location of use.
    - b. Mix test results: See Mix Test Requirements under CONCRETE MIX DESIGN for required pre-construction testing.
    - c. Cementitious materials: Types, manufacturing location, shipping locations, and certificates showing compliance with material requirements.
    - d. Coarse and fine aggregates: Types, pit or quarry locations, producers' names, gradations, specific gravities, and evidence not more than 90 days old demonstrating compliance with the material requirements.
    - e. Admixtures: Types, brand names, producers, manufacturer's technical data sheets, and certification data.



- f. Water: Source of supply and compliance with specified standards.
  - g. Description of conveying and placing equipment.
  - h. Ready-mix plant certification or ASTM C94 certification documentation.
  - i. NSF 61 certification of submitted mix design where concrete will be in contact with potable water.
- C. Shop Drawings and Plans:
- 1. Proposed method of measuring concrete temperatures.
  - 2. Proposed method for hot weather concrete placement.
  - 3. Proposed method for cold weather concrete placement.
  - 4. Proposed method for wet weather concrete placement.
  - 5. Proposed method for underwater concrete placement.
  - 6. After defects are identified and investigation, Contractor to submit design of repair plan specific for each noted defect in accordance with Section 03935 (03 93 50).
- D. Samples:
- 1. Sample panels for any concrete specified to receive a sandblasted, exposed aggregate, or other architectural finish.
  - 2. Submit any item of product data proposed for use and not fully assembled by a single manufacturer or described in this section.
- E. Quality Assurance/Control Submittals:
- 1. Test Agency Reports: Submit records of test and inspection. Submit report results. Provide a copy of the test reports to the Ready-mix plant for record purposes.
  - 2. Submit notification of concrete placement at least 24 hours prior to placement. When Engineer is scheduled to perform structural observation provide at least 48 hours' advance notification.

#### 1.04 QUALITY ASSURANCE

- A. Contractor Qualifications: 5 years of experience constructing similar building facilities OR 10 years of experience constructing similar environmental containment facilities.
- B. Construction Standard: Applicable quality requirements of the IBC, ACI 301, and ACI 350.
- C. Concrete Products and Materials Tests: Certified by independent commercial testing laboratories. Submit certification on cementitious products and aggregates performed within the past 6 months. Furnish any necessary labor to assist in obtaining and handling samples at the project site or at the source of materials.
- D. Concrete Mix Designs: By an independent commercial testing laboratory, complying with ASTM C1077 and favorably reviewed by the Engineer. Concrete mix design proportions shall be established on the basis of field experience and trial mixtures with the materials to be employed in accordance with ACI 301 Chapter 4 or ACI 350 Chapter 5.
- E. Concrete Mix Test Results, prior to construction:
- 1. Submit in accordance with Mix Test Requirements under CONCRETE MIX DESIGN.

- F. Preconstruction Meeting:
1. Attend meeting with Owner and Engineer, bringing representatives of concrete supply, pumping, placement, and finishing subcontractors plus testing laboratories.
  2. Review preliminary concrete placing plans for walls and slabs, prior to plan submittals.
  3. Meeting agenda includes:
    - a. Mix design.
    - b. Schedule of mix review.
    - c. NSF Certification Process and Schedule.
    - d. Formwork products (Section 03100 OR 03 10 00).
    - e. Miscellaneous products.
    - f. Construction joint layout (Section 03150 OR 03 15 00).
    - g. Concrete placement.
    - h. Finishes required (Section 03350 OR 03 35 00).
    - i. Curing and protection methods.
    - j. Field Testing (Section 03300 OR 03 30 00, paragraph 1.04.G).
    - k. Test result distribution and review schedule.
    - l. Testing of hydraulic structures (Section 03340 OR 03 34 00).
    - m. Other special inspection requirements.
    - n. Hot weather concrete requirements.
    - o. Cold weather concrete requirements.
    - p. Resolve any difficulties foreseen by any interested party.
    - q. Other Issues.
- G. Concrete Tests, as placed: Performed by the Owner's Testing Agency:
1. Testing agencies that perform testing services on concrete materials shall meet the requirements of ASTM C1077.
  2. Provide Owner's Representative with at least 48 hours' notice in advance of operations to allow for completion of quality tests and for assignment of personnel.
  3. Provide and maintain adequate facilities for safe storage and proper curing of concrete test specimens on the project site for initial curing as required by ASTM C31.
  4. Test frequency for strength:
    - a. Obtain at least one composite sample for each 100 yd<sup>3</sup>, or a fraction thereof, of each concrete mixture placed in any 1 day.
  5. Concrete samples: In accordance with ASTM C172. Provide all material required.
  6. Compressive strength: A set of six standard 6-inch by 12-inch concrete cylinders OR A set of nine standard 4-inch by 8-inch concrete cylinders shall be cast for each test set for concrete greater than 2,500 psi.
    - a. Making, storing, initial cure, and final cure of cylinders: ASTM C31. Provide site storage and initial cure, 16 hours minimum and 24 hours maximum.
    - b. Test of cylinders: ASTM C39. Testing laboratory will transport cylinders from site, cure, test, and provide report. Test two cylinders at age of 7 days, two at 28 days, and hold two for additional testing at 56 days, if required OR Test three cylinders at age of 7 days, three at 28 days, and hold three for additional testing at 56 days if 4-inch cylinders are used.

- c. Evaluation: Test results from standard molded and cured test cylinders shall be evaluated separately for each specified concrete mixture. For evaluation, each specified mixture shall be represented by at least five tests.
7. Slump: Test will be performed on each 50 cubic yards or fraction thereof. Test each sample used for strength tests.
  - a. Testing: ASTM C143.
  - b. Results outside the limits indicate possible cause for rejection of concrete at the sole discretion of the Engineer.
8. Air content: Test will be performed on concrete samples used for strength tests. Use calibrated equipment to perform the test.
  - a. Testing: ASTM C231 or ASTM C173.
  - b. Air content tests will be made on samples from the first three batches in the placement and until three consecutive batches have air contents within the range specified, at which time every fifth batch will be tested. This test frequency will be maintained until a batch is not within the range specified, at which time testing of each batch will be resumed until three consecutive batches have air contents within the range specified. Air content tests may be taken on composite samples or on samples from the batch at any time after discharge of  $\frac{1}{4}$  yd<sup>3</sup> of concrete.
9. Shrinkage: A set of three standard 4-inch by 4-inch by 11-inch test prisms will be cast for each 200 cubic yards. Test will be performed on concrete used for strength tests.
  - a. Testing: ASTM C157 as modified below.
  - b. Moist curing: Specimens shall be removed from molds at 23 ±1 hours after batching and shall be placed in water for at least 30 minutes and shall be measured within 30 minutes to determine original length. Specimens shall be submerged in saturated lime water until 7 days after batching.
  - c. Measurements: Measurements to determine shrinkage shall be made after 7, 14, 21, and 28 days of drying after 7 days of moist curing. Compare to the preliminary measurement made after 1-day and the basic measurement made after 7 days curing, which will be used for calculations.
  - d. Report all test results, with the 28-day of drying results governing acceptance. Field shrinkage results shall meet the requirements stated in Paragraph 2.05.B.
10. Unit Weight: Determine the fresh concrete density. Test will be performed on concrete samples used for strength tests. Use calibrated equipment to perform the test.
  - a. Testing: ASTM C138.
11. Temperature: Test to be performed at time of strength tests.
  - a. Testing: ASTM C1064.
12. Testing Agency Reports:
  - a. Include location in the work where the batch represented by test was deposited and the batch ticket number on strength test reports.
  - b. Include detailed information of storage and curing of specimens before testing on strength test reports.
  - c. Provide final reports within 7 days of test completion.



H. Additional Tests:

1. General: Strength tests shall be considered satisfactory if the requirements of ACI 350 Section 5.5.2.3 OR ACI 301 Section 1.6.6.1 are satisfied. Tests on hardened concrete will be performed when concrete test results as placed fail to satisfy the specification requirements. Testing will be performed by Owner's Testing Agency at Contractor's expense. If in the opinion of the Engineer, results of tests on concrete cylinders indicate the possibility of substandard concrete in the structure, cored samples will be required to be taken from the concrete.
2. Nondestructive tests: The use of the rebound hammer, pulse-velocity method, or other nondestructive tests are permitted in evaluating the uniformity or for selecting areas to be cored; however, only core tests will be permitted for verifying the concrete strength in place.
3. Core tests: Obtain cores in accordance with ASTM C42. Wipe cores surface-dry immediately after coring and allow to dry in air for a period not exceeding 1 hour after drilling. Seal cores in plastic bags or nonabsorbent containers until testing. At least three representative cores shall be taken from each member or area of concrete in place that is considered potentially deficient. Submit the location of cores for favorable review by Engineer before testing. Fill core holes with low-slump concrete or mortar of a strength equal to or greater than the original concrete. The Engineer will investigate low-strength test results in accordance with the requirements of ACI 350 Section 5.5.4 OR ACI 301 Section 1.6.6; however, the requirements of ACI 350 Section 5.5.4.4 OR ACI 301 1.6.6.2 are not applicable.
4. Repair: Repair rejected concrete by removing and replacing or other acceptable repair methods as required by Engineer. To bring rejected concrete into compliance, use repair methods that meet specification requirements for strength, function, durability, dimensional tolerances, and appearance. Submit for acceptance the proposed repair methods, materials, and modifications. The Contractor is responsible to bring concrete into compliance with the requirements of the Contract Documents.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Cementitious Materials: Store cementitious materials in dry, weather-tight buildings, bins, or silos that will exclude contaminants. If required to be stored at the site, store immediately after delivery in a dry, weather-tight, properly ventilated structure, with adequate provisions for prevention of moisture absorption and overheating of the cement.
- B. Aggregates: Store and handle aggregate in a manner that will avoid segregation and prevent contamination with other materials or other sizes of aggregates. Store aggregates to drain freely. Do not use aggregates that contain frozen lumps. If required at site, store in piles which afford good drainage and which are protected to prevent the inclusion of foreign material. Stockpile the various sizes or gradations of aggregates separately. Site stored aggregates shall be tested for moisture content on each day of batching operations.
- C. Admixtures: Protect stored admixtures against contamination, evaporation, or damage. Provide agitating equipment for admixtures used in the form of suspensions or unstable solutions to ensure thorough distribution of the

ingredients. Protect liquid admixtures from freezing and from temperature changes that would adversely affect their characteristics.

## 1.06 DEFINITIONS

- A. Hot Weather: Job-site conditions that accelerate the rate of moisture loss or rate of cement hydration of freshly mixed concrete. These conditions include ambient temperatures above 80°F or any combination of ambient temperature, concrete temperature, low humidity, and wind that combine to produce an evaporation rate that exceeds 0.2 lb/sq. ft./hr.
- B. Cold Weather: Cold weather is considered to exist when the temperature has fallen below, or is expected to fall below, 40°F during placement and curing.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Qualify proposed materials and establish mixture proportions.
- B. Obtain materials from an NCRMA certified manufacturer or supplier or one qualified through ASTM C94. Unless allowed otherwise, all materials shall be new.

### 2.02 CEMENTITIOUS MATERIALS

- A. General: Use cementitious materials that are of the same brand and type and from the same plant of manufacture as the cementitious materials used in the concrete represented by the submitted test records or used in the trial mixtures. The color shall not significantly alter the typical grey concrete color.
- B. Portland Cement: ASTM C150. Type II or V as indicated in the Concrete Type table below. Comply with the requirements for low alkali cement in ASTM C150 Table 2.
- C. Pozzolan: ASTM C618, Mineral Admixture Class N.
- D. Blended Cement: ASTM C595 Type 1P(MS).
- E. Fly Ash: ASTM C618, Class F, with the following restrictions:
  - 1. Loss on Ignition: 4% maximum
  - 2. SO<sub>3</sub> Content: 3% maximum
  - 3. Moisture Content: 1% maximum.
- F. Ground Granulated Blast-Furnace Slag: ASTM C989. Minimum Grade 100.
- G. Silica Fume: ASTM C1240.

### 2.03 CONCRETE AGGREGATES:

- A. General:
  - 1. ASTM C33:
    - a. Aggregates used in concrete shall be obtained from the same sources and have the same size ranges as the aggregates used in the concrete represented by submitted historical data or used in trial mixtures.
    - b. Provide test results confirming conformance with applicable specifications not more than 90 days old. Test results for aggregate

- soundness, abrasion, and reactivity may be older than 90 days, but not older than 1 year, provided test results for the other properties specified in ASTM C33 indicate that the aggregate quality has not changed.
- c. Provide free from organic materials, waste products, clay balls, shale, and mica and thoroughly washed before use.
2. Provide aggregate meeting the combined gradation requirements below as specified in Paragraph 2.05.B. For thin sections, such as slabs or walls 10 inches thick or less, or for sections that require special placement due to shape, form, or congestion of reinforcing, provide 1-inch maximum size.
  3. Nominal maximum size of coarse aggregate shall not exceed three-fourths of the minimum clear spacing between reinforcing bars, one-fifth of the narrowest dimension between sides of forms, and one-third of the thickness of slabs or toppings.
  4. Reactivity: Provide aggregates that are shown to be non-deleteriously reactive in accordance with ASTM C1293. Submit test report on aggregates.
  5. Grading: ASTM C136. Submit results of sieve analysis.
- B. Coarse Aggregates:
1. Provide clean, hard, durable gravel, crushed gravel, crushed rock, or combinations.
  2. Deleterious substances: Submit compliance with ASTM C33, Table 3 and as follows:
    - a. Clay lumps and friable particles: ASTM C142. Max friable/clay materials in coarse aggregate at 2% for exposed architectural concrete, 3% for liquid retaining concrete structures, and 5% for all other structural concrete.
    - b. Abrasion: ASTM C131. Not more than 45%.
    - c. Soundness: ASTM C88. Not more than 10%.
  3. Do not use aggregate containing more than 10% of inferior materials, including: flat or elongated particles, cracked or laminated rock, or rock that can be readily broken after immersion in water for 1 hour.
- C. Fine Aggregate:
1. Provide natural sand or a combination of natural and manufactured sand, of siliceous, granitic, or igneous origin, hard and durable.
  2. Deleterious substances: Submit compliance with ASTM C33 Table 1 and as follows:
    - a. Organic impurities: ASTM C40. Lighter than standard. ASTM C87. Not less than 95% relative strength.
    - b. Sand equivalent: ASTM D2419. For three tests not less than 70, with an average greater than 75.
- D. Combined Aggregates: Provide a mixture of fine aggregate and coarse aggregate uniformly graded between the screen sizes specified below.



Sieve Size	Percentage Passing	
	1-1/2-Inch Gradation	1-Inch Gradation
2-inch	100	--
1-1/2-inch	90-100	100
1-inch	50-96	90-100
3/4-inch	45-80	55-100
3/8-inch	38-55	45-75
No. 4	30-45	35-60
No. 8	23-38	27-45
No. 16	17-33	20-35
No. 30	10-22	12-25
No. 50	3-10	3-15
No. 100	0-3	0-5
No. 200	0-2	0-2

## 2.04 WATER

- A. Mixing water for concrete and water used to make ice shall be potable water unless alternative sources of water complying with ASTM C1602 or AASHTO T26 are available. Water for washing aggregates, for mixing concrete, for patching grout, and for curing shall be free from oil and contain no more than 1,000 parts per million (ppm) of chlorides as Cl, nor more than 1,300 ppm of sulfates as SO<sub>4</sub>. Do not allow impurities that will cause a change in the setting time of the Portland Cement of more than 25%, nor a reduction in the compressive strength of mortar at 14 days of more than 5%, when compared to the results obtained with distilled water.
- B. Do not allow impurities that cause discoloration of the concrete or produce etching of the surface.
- C. The Engineer may require tests of the water should there be a question of the quality. Costs of such tests would be borne by the Owner unless the quality does not meet the requirements in Paragraph A above.

## 2.05 ADMIXTURES

- A. Admixtures used in concrete shall be the same as those used in the concrete represented in the submitted test records or used in trial mixtures.
- B. Air Entraining: ASTM C260. MasterAir-AE 90 by Master Builders Solutions; Eucon AEA-92 or 92S by Euclid; Daravair 1000 by GCP Applied Technologies; or equal.
- C. Accelerating: ASTM C494, Type C or E. MasterSet AC 534 by Master Builders Solutions; Eucon Accelguard 80 by Euclid; Daraset 400 by GCP Applied Technologies; or equal.
- D. Retarding: ASTM C494, Type D. Daratard 17 by GCP Applied Technologies; Eucon Retarder 75 by Euclid; MasterSet R 100 by Master Builders Solutions; or equal.
- E. Water Reducing: ASTM C494, Type A. WRDA 64 by GCP Applied Technologies; MasterPozzolite 210 by Master Builders Solutions; Eucon WR-91 by Euclid or equal.

- F. High Range Water Reducing: ASTM C494, Types F or G, second or third generation type. Add at the batch plant, after all other ingredients have been mixed and initial slump has been verified. ADVA 190 by GCP Applied Technologies; MasterGlenium 3030 by Master Builders Solutions; Eucon 1037 by Euclid; or equal.
- G. Shrinkage Reducing: ASTM C494, Type S. MasterLife SRA 035 by Master Builders Solutions; Eucon SRA-XT by Euclid, Eclipse 4500 by GCP Applied Technologies; or equal.
- H. Corrosion Inhibition and Permeability Reduction (Silica Fume): ASTM C1240. Force 10,000D by GCP Applied Technologies, MasterLife SF 100 by Master Builders Solutions, Eucon MSA by Euclid, or equal.
- I. Controlled Low Strength Material (CLSM) Admixture: See Specification Section 02065 (31 23 24) OR ASTM C869. DaraFill by GCP Applied Technologies, MasterCell by Master Builders Solutions, or equal.
- J. When two or more admixtures are used, they must be added to the mix separately (through dispensers or manually) and must not be mixed with each other prior to adding to the concrete mix. Add admixtures to concrete mix ingredients in liquid form by a special dispensing unit, approved by the manufacturer of the admixture as suitable for accurately dispensing the admixture. Install an alarm or indicator, which will immediately inform the batch plant operator, if the dispensing unit malfunctions. Dispense admixtures uniformly into the mixing water as it is added to the concrete batch.
- K. When two or more admixtures are used, manufacturer shall certify that the admixtures are compatible with each other and will not detrimentally impact the performance of other admixtures.
- L. Admixtures containing calcium chloride or any chloride ions are prohibited.
- M. All admixtures shall be NSF 61 Certified.

## 2.06 CONCRETE MIX DESIGN

- A. General:
  1. Employ an independent commercial testing laboratory complying with ASTM C1077 and favorably reviewed by the Engineer to design all concrete mixes and carry out all necessary testing. Concrete mix design proportions shall be established on the basis of field experience and trial mixtures with the materials to be employed in accordance with ACI 350 5.3 OR ACI 301 Section 4.2.3.
  2. When the testing laboratory has mix designs meeting the specifications that are available from prior projects, submit material and mixture proportions with supporting test results and test record statistics to demonstrate compliance with the requirements of this Section and ACI 350 Section 5.3 OR ACI 301 Section 4.2.3. Include calculations for  $f'_{cr}$  based on source quality test records.
  3. If new mix designs are required, prepare a range of trial batches for each design, and submit the mixes that demonstrate satisfactory test results in accordance with ACI 350 Section 5.3 OR ACI 301 Section 4.2.3.

4. Allow for the variability of concrete strength from test to test by increasing the required average compressive strength over the specified strength as specified in ACI 350 Section 5.3 OR ACI 301 Section 4.2.3.
5. From results of these tests, plot a curve showing the relationship between w/cm and compressive strength. From the curve of w/cm versus compressive strength, select the w/cm corresponding to the required average compressive strength  $f'_{cr}$ . This is the maximum w/cm that shall be used to establish mixture proportions, unless a lower w/cm is specified in the mix proportions table below. Establish mixture proportions so that the maximum w/cm is not exceeded when slump is at the maximum specified.
6. Take sole responsibility for selection of laboratory, submittal of materials to laboratory in time for all tests, and overall timing of all aspects of testing program, including submittals.
7. Prepare mix designs for concrete placement by the batch process and/or by pumping, as required, and state the process on the design submittal.
8. Allow for the hot or cold weather and the time required to transport the concrete from the mixer to the site and to place within the forms. If accelerating or retarding admixtures will be required for only a proportion of the concrete placements, submit test results that include the full range of options.
9. Do not exceed the water-cementitious material ratios. Vary the water-reducing admixtures to accomplish an increase in slump or workability time.
10. Proportion cementitious materials, aggregates, and water by weight.
11. Check periodically the weight of moisture contained within the stockpiled aggregates. Compensate for this water when proportioning the concrete mix and adjust when change occurs. Frequency shall comply with ASTM C94.
12. Do not use chlorides in any concrete mix.
13. Submit any adjustments to mixture proportions or changes in materials, along with supporting documentation, made during the course of the work. If it is necessary to increase the cementitious materials content, submit a request for acceptance of the proposed revised mixture with higher cementitious materials content. Confirm the adequacy of modified proportions has been verified through the submittal of a set of new test data.
14. Resubmit mix design for review for each class of concrete when modification of the mix design is required by ACI 350 Section 5.3 OR ACI 301 Section 4.2.3. If a class of concrete requires modification based on low strength tests, Contractor shall discontinue use of mix design until corrective action can be taken, and a revised mix design is favorably reviewed.

**B. Mix Proportions:**

<b>Mix Design Requirements</b>	<b>Concrete Type</b>						
	<b>A*</b>	<b>B*</b>	<b>C</b>	<b>D</b>	<b>E</b>	<b>F</b>	<b>G</b>
Specified 28-Day Compressive Strength $f'_c$ (psi)	4,500	5000	4,000	4,500	2,500	3,000	5,000
Combined Aggregate Gradation (in)	1-1/2 OR 1	1-1/2 OR 1	1	1	1	1	1
Air Content at Point of Placement (%)	5-1/2 OR 6	5-1/2 OR 6	1 OR 4-1/2	6	1 OR 4-1/2	1 OR 4-1/2	4-1/2 OR 6



Mix Design Requirements	Concrete Type						
	A*	B*	C	D	E	F	G
Maximum Water-Cementitious Material Ratio	0.42	0.40	0.50	0.45	0.55	0.55	0.45
Minimum Cementitious Material Content (lb/yd <sup>3</sup> )	570	590	520	540	520	520	540
Maximum 28-Day Drying Shrinkage (%) – Mix Test	0.05	0.05	--	--	--	--	-
Maximum 28-Day Drying Shrinkage (%) – Field Test	0.065	0.065	--	--	--	--	-
Cement Type	V OR II	V OR II	II	II	II	II	V OR II
Unit Weight (lb/ft <sup>3</sup> )	--	--	--	--	--	110 OR 115	--
NSF 61 Certification Required	Y	Y	N	N	N	N	Y OR N

\*See Paragraph 2.05.E for additional requirements for Mix Type A OR B when 1-1/2-inch aggregate is specified.

- C. Cementitious Material: Either Portland Cement, cement with fly ash, cement with natural Pozzolan, blended cement, or cement with slag.
- D. Pozzolan, Slag, Fly Ash, or Silica Fume: Optional. If used, not less than 15%, nor more than 25% of the weight of the cementitious materials. Do not use pozzolan or fly ash as an admixture in concrete made with Portland-Pozzolan cement. Silica fume shall not be more than 10% of the weight of the cementitious materials.
- E. Modified Mix Design: Provide a modified mix design of the concrete type indicated in the table above for horizontal concrete joints, as specified in Section 03150 (03 15 00), for environmental structures consisting of the designated concrete mix with one-half of the coarse aggregate removed. The remaining constituents shall be adjusted proportionally in the modified mix design to complete the cubic yard. Modified Mix shall meet all other requirements noted for the base mix in Paragraph 2.05.B.
- F. Mix Test Requirements:
  1. Testing agencies that perform testing services on concrete materials shall meet the requirements of ASTM C1077.
  2. Compression: ASTM C192 for cylinder preparation. ASTM C39 for cylinder tests. Submit 7-day and 28-day curing test results in accordance with Paragraph A above.
  3. Slump: ASTM C143. Slump range is 3 to 4 inches at point of delivery. Slump tolerances in accordance with ACI 117. When utilizing a Type I or II plasticizing admixture or a Type F or G high-range water-reducing admixture, proportion to a maximum slump of 8 inches at the point of delivery after the admixture is added.
  4. Air Content: ASTM C231 or ASTM C173. Air content tolerance is  $\pm 1\frac{1}{2}\%$ .
  5. NSF 61 Certification, submit samples to NSF and receive certification for all mixes indicated in chart. Contractor shall provide all necessary samples and pay for certification costs, and shall contact NSF.
  6. Unit Weight: ASTM C138.

7. Shrinkage: The mix tests requirements shall be in accordance with ASTM C157, except as described below. NOTE: the following requirements differ from ASTM C157 and must be strictly followed in order to obtain favorable review for a concrete mix design. One set of three test specimens shall be prepared.
  - a. Moist curing: Specimens shall be removed from molds at  $23 \pm 1$  hours after batching and shall be placed in water for at least 30 minutes and shall be measured within 30 minutes to determine original length. Specimens shall be submerged in saturated lime water until 7 days after batching.
  - b. Measurements: Measurements to determine shrinkage shall be made after 7, 14, 21, and 28 days of drying after 7 days of moist curing. Compare to the preliminary measurement made after 1-day and the basic measurement made after 7 days, which will be used for calculations.
  - c. Test prism size: 4 by 4 by 11 inches.
  - d. Report all test results, with the 28-day tests results governing acceptance. Plot the results at other time intervals as a test of validity of the readings.
8. After favorable review of the mix design, no variations of the constituents are permitted during the project without prior submittal and favorable review.
9. Provide and pay for additional testing and inspection required because of changes in materials or mixture proportions.

## 2.07 READY-MIX CONCRETE

- A. Supply concrete for the project using one of the following methods:
  1. Supply concrete using truck mixers and a ready-mix plant certified by the National Ready-Mix Concrete Association.
  2. Qualify the supplier according to ASTM C94 Sections 8 through 11, inclusive.

## 2.08 CEMENT REPAIR MORTAR

- A. See Section 03935 (03 93 50).

## 2.09 SOURCE QUALITY CONTROL

- A. Concrete:
  1. Maintain records verifying materials used are of the specified and accepted types and sizes and are in conformance with the material requirements.
  2. Provide ready-mix batch plant delivery tickets contain all product information necessary for acceptance of the concrete delivered to site.
  3. Document and record that the mixing and trucking equipment have adequate capacity to deliver the concrete batches to site on time, thoroughly mixed and discharge without segregation.
  4. Submit new data from new trial mixtures for acceptance before use in concrete when brand, type, size, or source of cementitious materials, aggregates, water, ice, or admixtures are proposed to be changed.

## PART 3 - EXECUTION

### 3.01 PROPORTIONING CONCRETE MATERIALS

- A. Do not place concrete prior to favorable review of submittals for reinforcing steel, materials specified in this Section and the mix proposed. Unfavorable results of actual placements may require a redesign of mixes in addition to corrective work related to any defects.
- B. Do not make substitutions to the constituents tested in the design of concrete mixes without favorable review of the revised mix and the new test results.

### 3.02 MEASURING, BATCHING, AND MIXING CONCRETE MATERIALS

- A. General:
  - 1. Measure, batch, mix, transport and deliver concrete materials and concrete in conformance with ASTM C94. If packaged dry-combined materials are used, they shall conform to the requirements of ASTM C387.
  - 2. Deliver completely mixed to the project site.
  - 3. When concrete arrives at the point of delivery with a slump below that which will result in the specified slump at the point of placement and is unsuitable for placing, the slump may be adjusted to the required value by adding water up to the amount allowed in the favorably reviewed mixture proportions. Addition of water shall be in accordance with ASTM C94. Do not exceed the specified water-cementitious material ratio (w/cm) or slump. Do not add water to concrete delivered in equipment not acceptable for mixing. After plasticizing or high-range water-reducing admixtures are added to the concrete at the site to achieve flowable concrete, do not add water to the concrete. Measure slump and air content of air-entrained concrete after slump adjustment to verify compliance with specified requirements. Do not add water unless approved by the Engineer. Do not add mixing water during hauling. Add water after delivery and only from the "hold-out" volume indicated on the mix ticket. Should water be added, revolve the mixing drum not less than 30 revolutions at mixing speed after adding and before commencing discharge.
  - 4. Deliver each load at the job site accompanied by a ticket showing mix design number, volume of concrete, the weight of cement in pounds and the total weight of each ingredient in pounds. Also show the time at which the materials were batched and the reading of the revolution counter at the time the truck mixer was charged.
  - 5. No retempering of partially hardened material is permitted. Do not use partially hardened concrete in the work.
- B. Batching in Adverse Weather:
  - 1. Cold Weather: In accordance with ACI 306 OR Section 03306 (03 30 60).
  - 2. Hot Weather: In accordance with ACI 305 OR Section 03305 (03 30 50).

### 3.03 FORMWORK AND FORMWORK ACCESSORIES

- A. See Section 03100 (03 10 00).



### 3.04 PLACING CONCRETE AND GROUT

#### A. Preliminary Work:

1. Remove hardened concrete and foreign materials from the inner surface of the mixing and conveying equipment. Remove all debris from the space to be occupied by the concrete.
2. Remove water from the space to be occupied by the concrete before concrete is deposited. Divert any flow of water into an excavation through proper site drainage to a sump, or by other methods. If required by the Engineer, grout up any water vent pipes and drains after the concrete has thoroughly hardened.
3. Remove snow, ice, frost, and other foreign materials from surfaces, including reinforcement and embedded items, against which concrete will be placed.
4. Provide satisfactory redundancy in the delivery system so that work can continue in the event of a breakdown.
5. Rapidly convey concrete from mixer to final deposition by methods that prevent segregation or loss of constituents and ensure the required concrete quality.
6. Do not use aluminum materials in pumping lines, transfer hoppers, or chutes. Provide conveyor belts instead of chutes when the distance is longer than 50 feet. Use a storage hopper at the start of the line.
7. For pumped concrete, provide a hose with an angle-change, to create a back-pressure at the outlet.
8. Provide illumination if necessary inside the forms, so that the placed concrete will be visible from the deck at top of formwork.
9. Before placing a concrete slab-on-grade, clean foreign materials from the subgrade and provide subgrade soils satisfying the following requirements:
  - a. Well drained and of uniform loadbearing nature.
  - b. Uniform in-place density throughout the area and at least the minimum required in Contract Documents.
  - c. Free from frost or ice.
  - d. Moist with no free water and no muddy or soft spots.

#### B. Embedded Items:

1. Place equipment, bolts, anchors, sleeves, inserts, structural steel members, angles, and similar items which require embedment in the concrete.
2. Position and secure in place expansion joint materials, anchors, waterstops, and other embedded items.
3. Hot-dip galvanize ferrous metal sleeves, inserts, anchors, and other embedded ferrous items unless shown otherwise. Set anchor bolts for equipment in templates, carefully plumbed and checked for location and elevation with an instrument, and held in position rigidly by double-nutting to the template to prevent displacement while concrete is being placed.
4. Ensure that aluminum items inserted in the concrete are isolated by a bituminous or asphaltic coating in accordance with Division 5 specifications.
5. Notify engineer where modifications are necessary to avoid interference with reinforcing steel or embedded items.
6. Inspect the installation of embedded items and reinforcing.
7. Unless noted otherwise on the Drawings do not embed conduit or pipe in concrete.

- C. Placing:
1. Place reinforcement in accordance with the requirements of Section 03200 (03 20 00).
  2. Do not begin to place concrete while rain, sleet, or snow is falling unless adequate protection is provided and acceptance of protection is obtained. Do not allow rain water to increase mixing water or to damage the surface of the concrete.
  3. Use metal or metal-lined chutes having rounded bottoms, and sloped between one vertical section to two horizontal sections and one vertical to three horizontal sections of chute. Chutes longer than 20 feet and chutes not meeting slope requirements may be used provided the discharge is into a hopper before distributing into the forms.
  4. Use pumping equipment that has sufficient capacity so that:
    - a. Initial setting of previously placed concrete does not occur before subsequent placement.
    - b. Discharge of pumped concrete does not result in segregation.
    - c. Modification of accepted concrete mixture is not required.
  5. Place concrete without separation or loss of ingredients and without displacement of the reinforcement.
  6. Do not place concrete that contains foreign material.
  7. Do not deposit partially hardened concrete in the work.
  8. Do not subject concrete to procedures that will cause segregation.
  9. Deposit concrete continuously and as near as practicable to the final position.
  10. Do not deposit fresh concrete on concrete that has hardened sufficiently to cause formation of cold joints. Maintain, until the completion of the placement, a plastic concrete surface, approximately horizontal.
  11. Do not place concrete over columns or walls until concrete in columns and walls has reached final set. Place concrete for beams, girders, brackets, column capitals, haunches, and drop panels at the same time as the concrete for adjacent slabs.
  12. Maximum height of free fall for concrete during placement:
    - a. Concrete with maximum 4-inch slump: 4 feet.
    - b. Concrete with high-range water reducing admixture and minimum 6-inch, maximum 9-inch slump: 8 feet.
  13. Provide a dense, impervious, homogeneous concrete, free from voids or pockets. If honeycomb, air, or rock pockets occur, repair the structure in accordance with Section 03935 (03 93 50), and modify the placing method or mix design, to prevent recurrence of deficient concrete. Provide such repairs and modifications at no additional cost. Honeycomb or large defects may be cause for rejection of the work.
  14. When underwater placement is required, place concrete by an acceptable method. Deposit fresh concrete so that concrete enters the mass of previously placed concrete from within, displacing water with minimum disturbance of the concrete surface.
- D. Time Limit: Place all concrete in its final position in slab or forms within 1-1/2 hours of batching or before the drum has revolved 300 revolutions, whichever comes first in accordance with ASTM C94. Alternatively, as part of the mix design, provide admixtures that delay the initial set and state the proposed length of time in the submittal.

- E. Temperature Limits: Place all concrete in its final position in slab or forms at:
1. Less than 80°F, measured in the mix.
  2. When the average of the highest and lowest ambient air temperature during the period from midnight to midnight is expected to drop below 40°F for more than 3 successive days, deliver concrete to meet the following minimum temperatures immediately after placement:
    - a. 55°F for sections less than 12 inches in the least dimension
    - b. 50°F for sections 12 to 36 inches in the least dimension
    - c. 45°F for sections 36 to 72 inches in the least dimension
    - d. 40°F for sections greater than 72 inches in the least dimension.
  3. The temperature of concrete as placed shall not exceed these values by more than 20°F. These minimum requirements may be terminated when temperatures above 50°F occur during more than half of any 24-hour duration.
  4. Temperature measurements above refer to on-site measurements. Refer to the vibration, concrete joints and curing sections for other requirements.
  5. When the temperatures are outside these ranges or when placing concrete in hot or cold weather, place concrete in accordance with ACI 305 and ACI 306 OR Sections 03305 (03 30 50) and 03306 (03 30 60).
- F. Precast Items:
1. Supply and design vaults and manholes in accordance with the Division 2 sections for these items. Comply with additional requirements below.
  2. Items may be cast on or off the site.
  3. Apply all applicable portions of Sections 03300 (03 30 00), 03100 (03 10 00), 03150 (03 15 00), 03330 (03 33 00), 03350 (03 35 00), and 03935 (03 93 50), including materials, forms, placement, finish, and curing.
  4. Take particular care when handling and placing the precast items. Lift or move after a minimum of 90% of the specified compressive strength has been attained using the average compressive strength of at least two test cylinders.

### 3.05 CONSOLIDATING

- A. Consolidate concrete by vibration. Consolidate concrete around reinforcement and embedded items into corners of forms to eliminate honeycombing or planes of weakness due to air voids and stone pockets.
- B. Use internal vibrators to consolidate the concrete. Workers shall be experienced in the use of vibrators. Do not use vibrators to move concrete within the forms. Spacing of immersion vibrator insertions shall not exceed 1-1/2 times the vibrator's radius of action in the concrete being consolidated.
- C. Furnish sufficient vibrators to complete the compaction as specified without causing delay in the depositing of concrete. Provide a minimum of two vibrators, and at least one unit in addition to those planned for active use.
- D. Operate vibrators with vibratory element submerged in the concrete, with frequency between 8,000 and 12,000 impulses per minute when submerged.
- E. Compact the concrete with high frequency, internal mechanical vibrating equipment, and when required, supplement by hand spading and tamping. Consolidate slabs 6 inches or less in depth by hand tampers, spreading and settling with a heavy leveling straightedge.



- F. Vibrate by direct action in the concrete for approximately 10 seconds at approximately 12-inch intervals, not against forms or reinforcements. Vibrate the concrete around the reinforcement, and around embedded fixtures and into the corners of the forms. Penetrate 6 to 12 inches into previously placed layers as new layers are placed, provided the running vibrator penetrates by its own weight. To secure even and dense surfaces, free from aggregate pockets, honeycomb, or air pockets, supplement vibration when required by forking or spading by hand or hammering the forms lightly opposite the freshly placed concrete. Revibrate the final layer. Stop vibrating when concrete is thoroughly compacted and has ceased to decrease in volume and give off air bubbles.
- G. When placing concrete with 8-inch or more slumps, reduce the time of vibration to 5 seconds and follow the admixture manufacturer's recommendations for technique.
- H. Use immersion-type vibrators with nonmetallic heads when consolidating concrete around epoxy-coated reinforcement.

### 3.06 FIELD QUALITY CONTROL

- A. Site Tests:
  - 1. Testing agencies that perform testing services on concrete materials shall meet the requirements of ASTM C1077.
  - 2. Testing Agency Reports:
    - a. Include location in the work where the batch represented by test was deposited and the batch ticket number on strength test reports.
    - b. Include detailed information of storage and curing of specimens before testing on strength test reports.
    - c. Provide final reports within 7 days of test completion.
  - 3. Furnish any necessary labor to assist in obtaining and handling samples at the project site or at the source of materials.
- B. Inspection:
  - 1. Inspect concrete batching, mixing, and delivery operations.
  - 2. Inspect forms; foundation preparation; reinforcement; embedded items; reinforcement placing; and concrete placing, finishing, and curing operations.
  - 3. Concrete not within the specified limits of air entrainment, slump, and temperature shall be brought to the attention of the Contractor, Owner or Owner's Representative, and Engineer as soon as possible. Do not place material that is not within specified requirements.

### 3.07 PROTECTION OF IN-PLACE CONCRETE

- A. Loading and support of concrete: Do not allow construction loads to exceed the superimposed load that the structural member, with necessary supplemental support, is capable of carrying safely and without damage.
- B. Protection from mechanical injury: During the curing period, protect concrete from damaging mechanical disturbances including load stresses, shock, and harmful vibration. Protect concrete surfaces from damage by construction traffic, equipment, materials, rain or running water, and other adverse weather conditions.

END OF SECTION

## SECTION 03305

### CAST-IN-PLACE CONCRETE FOR PIPELINES

#### PART 1 GENERAL

##### 1.01 SUMMARY

- A. Section includes cast-in-place concrete for manhole bases and benches, pipeline encasements, kickblocks, and Flow Fill or Flowable Concrete Backfill.
- B. Related Sections:
  - 1. Division 1 - General Requirements
  - 2. Section 02300 - Earthwork

##### 1.02 REFERENCES

- A. American Concrete Institute:
  - 1. ACI 301 - Specifications for Structural Concrete.
  - 2. ACI 305 - Hot Weather Concreting.
  - 3. ACI 306.1 - Standard Specification for Cold Weather Concreting.
  - 4. ACI 318 - Building Code Requirements for Structural Concrete.
- B. American Society for Testing and Materials:
  - 1. ASTM A185 - Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement
  - 2. ASTM A615 - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
  - 3. ASTM C31 - Standard Practice for Making and Curing Concrete Test Specimens in the Field.
  - 4. ASTM C33 - Standard Specification for Concrete Aggregates.
  - 5. ASTM C39 - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
  - 6. ASTM C42 - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
  - 7. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
  - 8. ASTM C143 - Standard Test Method for Slump of Hydraulic Cement Concrete.
  - 9. ASTM C150 - Standard Specification for Portland Cement.
  - 10. ASTM C260 - Standard Specification for Air-Entraining Admixtures for Concrete.
  - 11. ASTM C295 - Standard Guide for Petrographic Examination of Aggregates for Concrete.
  - 12. ASTM C494 - Standard Specification for Chemical Admixtures for Concrete.
  - 13. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
  - 14. ASTM D4832 - Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.

##### 1.03 SUBMITTALS

- A. Section 01300 - Submittals: Requirements for submittals.

- B. Product Data: Submit data on concrete mix design in accordance with ACI 301 a minimum of 10 days prior to starting concrete work.
- C. Product Data: Submit data on CLSM mix design a minimum of 10 days prior to starting concrete work.

#### 1.04 QUALITY ASSURANCE

- A. Perform Work in accordance with ACI 301.
- B. Acquire cement and aggregate from one source for Work.
- C. Conform to ACI 305 when concreting during hot weather.
- D. Conform to ACI 306.1 when concreting during cold weather.

### PART 2 PRODUCTS

#### 2.01 CONCRETE MATERIALS

- A. Cement
  - 1. All Cement used shall be Type II Portland cement conforming to the requirements of ASTM C150.
- B. Aggregates
  - 1. Fine Aggregates: Fine aggregates shall consist of natural sand or a blend of natural sand and crushed sand provided the quantity of crushed sand is not more than 50% of the total sand by dry weight.
  - 2. Coarse Aggregates: Coarse aggregates shall consist of gravel or crushed stone and shall conform to the grading and quality requirements of ASTM C33 for Size No. 467, No. 57, or No. 67. Nominal maximum size of coarse aggregate shall comply with ACI 318.
  - 3. If the aggregates used are known to be reactive with high alkali cement, as determined by ASTM C295, or if the reactivity of the aggregate is not known, the use of low alkali cement is required to assure adequate protection from alkali aggregate reaction.
- C. Water
  - 1. The batch mixing water and mixer washout water shall conform to the requirements of ASTM C94.

#### 2.02 ADMIXTURES

- A. Air Entrainment
  - 1. An air-entraining agent shall be used in all concrete. The agent used shall be in accordance with ASTM C260 and shall be added to the batch in accordance with ASTM C94.
- B. Chemical
  - 1. Chemical admixtures that do not contain calcium chloride and that conform to ASTM C494 for concrete may be used. All chemical admixtures shall be compatible with the cement and all other admixtures in the batch.



C. Fly Ash

1. Fly ash may be used in the concrete mixes. Additions to the mix will be on a cement substitution basis. The fly ash shall conform to ASTM C618. Fly Ash content shall not exceed 20% by weight.

2.03 CONCRETE PROPORTIONS

A. Class A Concrete (4,000 psi)

1. Class A concrete shall be molded and cured in compliance with ASTM C31.
2. Class A concrete shall be used for structural concrete for pipeline encasements and manhole benches.
3. Class A concrete shall conform to the following requirements:

<u>Unit</u>	<u>Measurement</u>
Compressive Strength (28 day)	4,000 psi
Water/Cement Ratio	0.50 by weight (maximum)
Air Entrained	4 to 7 percent
Slump -	2 inches (minimum) 4 inches (maximum)

B. Class B Concrete (2,500 psi)

1. Class B concrete shall be molded and cured in compliance with ASTM C31.
2. Class B concrete shall be used exclusively for kickblocks.
3. Class B concrete shall conform to the following requirements:

<u>Unit</u>	<u>Measurement</u>
Compressive Strength (28 day)	2,500 psi
Water/Cement Ratio	0.63 by weight (maximum)
Air Entrained	4 to 7 percent
Slump -	2 inches (minimum) 4 inches (maximum)

C. Flow Fill

1. Flow Fill or Flowable Concrete Backfill, shall be molded and cured in compliance with ASTM D4832.
2. Flow Fill shall be designed in accordance with section 02300 Earthwork and used as bedding or backfill as depicted in that section.

D. Concrete Reinforcement

1. All deformed reinforcing bars shall conform to ASTM A615, Grade 40 or 60.
2. All welded steel wire fabric shall conform to ASTM A185 except that the weld shear strength requirement shall be extended to include a wire size differential up to and including six gages.

PART 3 EXECUTION

3.01 PREPARATION

- A. All equipment used in mixing and transporting concrete shall be clean. All debris, water or ice shall be removed from places to be occupied by the concrete.

### 3.02 FORMWORK

#### A. Concrete Structures

1. Forms shall produce shapes, lines and dimensions of the concrete structures as shown on the Drawings.
2. Forms shall be made of wood, metal or other acceptable material. The forms shall produce a smooth concrete finish to the tolerances described in ACI 301.
3. Forms shall be mortar tight and braced or tied to maintain its proper position and shape during and after concrete placement. Embedded metal ties with snap-off ends shall be used for internal form ties. Ordinary wire ties will not be allowed.
4. The Owner's Inspector, prior to pouring concrete, shall review forms.
5. Forms shall be removed in a manner that will insure the integrity of the structure and its surfaces.

### 3.03 PLACING CONCRETE

- A. Place concrete in accordance with ACI 301.
- B. Notify Owner's Inspector minimum 24 hours prior to commencement of concrete operations.
- C. Ensure reinforcement, inserts, embedded parts and formed joints are not disturbed during concrete placement.
- D. Maintain records of concrete placement. Record date, location, quantity, air temperature, and samples taken.

### 3.04 CONCRETE FINISHING

- A. Concrete surface finishing for manhole benches shall be a brushed non-skid surface in accordance with ACI 301.

### 3.05 CURING AND PROTECTION

- A. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.

END OF SECTION

## SECTION 03600

(03 60 00)

### GROUTS

#### *Introduction*

*This specification is not a standalone specification. It is intended to be used with other division 3 specifications. This specification also requires close coordination with the drawings. This Guide Specification is intended for use by specifiers who are knowledgeable in the discipline or construction craft covered herein for use in preparing project Contract Documents. It is a tool to help such users do a better job in less time. This document is a starting point only. Careful consideration of project specific requirements and editing are critical for developing a successful project specification.*

*Where choices are given, review the project specific requirements and discuss or clarify your selection with the project designated QC reviewer. The track changes mode in this document is "on". Leave it on as you modify the text so that the reviewer can easily see the changes that have been made.*

#### PART 1 - GENERAL

##### 1.01 SUMMARY

###### A. Section Includes:

1. Non-shrink cementitious grout (non-shrink grout).
2. Non-shrink epoxy grout.
3. Cement grout.
4. Concrete grout. (Masonry grout is covered in Section 04050 (04 05 00).)
5. Swept-in grout.

##### 1.02 REFERENCES

###### A. ASTM International (ASTM):

1. C531 Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical Resistant Mortars, Grouts and Monolithic Surfacing and Polymer Concretes.
2. C827 Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens from Cementitious Mixtures.
3. 1107 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
4. D695 Standard Test Method for Compressive Properties of Rigid Plastics.

###### B. U.S. Army Corps of Engineers Standard (CRD):

1. CRD C-621 Corps of Engineers Specification for Non-shrink Grout.



### 1.03 SUBMITTALS

- A. Submit in accordance with Section 01300 (01 33 00).
- B. Product Data: Submit product data for all grout products specified in Part 2 of this Section. Product data shall include:
  - a. Catalog information,
  - b. Technical data,
  - c. Storage requirements,
  - d. Product life,
  - e. Working time after mixing,
  - f. Temperature considerations,
  - g. Conformity to required ASTM Standards and Material Safety Data Sheet (MSDS),
  - h. Type and brand of the cement,
  - i. Gradation of the fine aggregate, and
  - j. Proposed admixtures and the proposed mix of the grout for non-packaged mixes.
  - k. Concrete grout: The submittal shall include data as required for concrete as delineated in Section 03300 (03 30 00) and for fiber reinforcement as delineated in Section 03200 (03 20 00). This includes the mix design, constituent quantities per cubic yard and the water/cement ratio.
  - l. Swept-in grout: The submittal shall include data as required for concrete as delineated in Section 03300 (03 30 00) and for fiber reinforcement as delineated in Section 03200 (03 20 00). This includes the mix design, constituent quantities per cubic yard and the water/cement ratio.
- C. Samples:
  - 1. Field samples for color control, if a color match is required.
- D. Quality Control:
  - 1. Laboratory Test Reports:
    - a. Submit laboratory test data as required under Section 03300 (03 30 00) for concrete to be used as concrete grout.
  - 2. *Certifications:*
    - a. *Certify that commercially manufactured grout products and concrete grout admixtures are suitable for use in contact with potable water per NSF 61 after 30 days curing.*
  - 3. Qualifications:
    - a. Submit documentation that grout manufacturer has at least 3 years experience in the production and use of the proposed grouts which they will supply

### 1.04 QUALITY CONTROL

- A. Qualifications:
  - 1. Grout manufacturer shall have a minimum of 3 years experience in the production and use of the type of grout proposed for the work.

### 1.05 QUALITY ASSURANCE

- A. Special Inspection shall be completed by the Owner's Representative.

## 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the jobsite in original, unopened packages, clearly labeled with the manufacturer's name, product identification, batch numbers and printed instructions.
- B. Store materials in full compliance with the manufacturer's recommendations. Total storage time from date of manufacture to date of installation shall be limited to 12 months or the manufacturer's recommended storage time, whichever is less.
- C. Material which becomes damp or otherwise unacceptable shall be immediately removed from the site and replaced with acceptable material at no additional cost to the Owner.
- D. Non-shrink cement-based grouts shall be delivered as preblended, prepackaged mixes requiring only the addition of water.
- E. Non-shrink epoxy grouts shall be delivered as premeasured, prepackaged, three component systems requiring only blending as directed by the manufacturer.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Non-shrink Cementitious Grout (Non-shrink Grout):
  - 1. Non-shrink cementitious grouts shall meet or exceed the requirements of ASTM C1107, Grades B or C and CRD C-621. Grouts shall be portland cement based, contain a pre-proportioned blend of selected aggregates and shrinkage compensating agents and shall require only the addition of water. Non-shrink cementitious grouts shall not contain expansive cement or metallic particles. The grouts shall exhibit no shrinkage when tested in conformity with ASTM C827.
    - a. General purpose non-shrink cementitious grout shall conform to the standards stated above and shall be SikaGrout 212 by Sika Corp.; Euco NS by The Euclid Chemical Co.; Five Star Grout by Five Star Products, Inc.; or approved equal.
    - b. Flowable (Precision) non-shrink cementitious grout shall conform to the standards stated above and shall be Hi-Flow Grout by the Euclid Chemical Co.; SikaGrout 212 by Sika Corp.; Five Star Grout by Five Star Products Inc.; or approved equal.
- B. Non-shrink Epoxy Grout:
  - 1. Non-shrink epoxy-based grout shall be a pre-proportioned, three-component, 100% solids system consisting of epoxy resin, hardener, and blended aggregate. It shall have a compressive strength of 14,000 psi in 7 days when tested in conformity with ASTM D695 and have a maximum thermal expansion of  $30 \times 10^{-6}$  inch per inch per degree F when tested in conformity with ASTM C531. The grout shall be Five Star HP Epoxy Grout by Five Star Products.; Sikadur 42 Grout-Pak by Sika Corp.; E3-G Epoxy Grout by the Euclid Chemical Co.; or approved equal.
- C. Cement Grout:
  - 1. Cement grouts shall be a mixture of one part Portland Cement conforming to ASTM C150, Types I, II, or III and 1 to 2 parts sand conforming to ASTM C33 with sufficient water to place the grout. The water content shall be sufficient to

impart workability to the grout but not to the degree that it will allow the grout to flow.

D. Concrete Grout:

1. Concrete grout shall conform to the requirements of Section 03300 (03 30 00) except as specified herein. Proportion with Type II Portland Cement, pozzolan, coarse and fine aggregates, water, water reducer and air entraining agent to produce a mix having an average strength of 3500 psi at 28 days (2500 psi nominal strength). Coarse aggregate size shall be 3/8-inch maximum. Slump shall not exceed 5 inches. Minimum cement content shall be 540 lbs per cubic yard and maximum water-to-cement ratio shall be 0.45.
2. Add synthetic reinforcing fibers as specified in Section 03200 (03 20 00) to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Add fibers from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

*Note to Specifier*

*Swept-In-Grout is typically specified for circular clarifiers as a final lift on the clarifier floor.*

E. Swept-in Grout:

1. Swept-in grout shall be a mixture of 1 part portland cement conforming to ASTM C150, Type II OR Type V and 3 parts sand conforming to ASTM C33 with clean water. Provide enough water to provide reasonable slump for ease of distribution of the grout by the equipment during screeding. Sand Gradation: 100% passing a 20-mesh sieve and not more than 30% retained on a 30-mesh sieve.
2. Add synthetic reinforcing fibers as specified in Section 03200 (03 20 00) to the concrete grout mix at the rate of 1.5 lbs of fibers per cubic yard of grout. Add fibers from the manufacturer's premeasured bags and according to the manufacturer's recommendations in a manner which will ensure complete dispersion of the fiber bundles as single monofilaments within the concrete grout.

F. Water:

1. Potable water, free from injurious amounts of oil, acid, alkali, organic matter, or other deleterious substances.

G. Grout for Grouting of Masonry:

1. See Specification Section 04050 (04 05 00) OR 04221 (04 22 01).

- H. Like materials in areas of common viewing shall be the products of one manufacturer or supplier in order to provide standardization of appearance. Baseplate grout thicknesses are typically shown on the Drawings; confirm that the selected grout product is recommended for the grout thicknesses shown.

## PART 3 - EXECUTION

### 3.01 PREPARATION

- A. Place grout over cured concrete that has attained its full design strength unless otherwise approved by the Owner's Representative.



- B. Concrete surfaces to receive grout shall be clean and sound; free of ice, frost, dirt, grease, oil, curing compounds, laitance and paints and free of all loose material or foreign matter which may affect the bond or performance of the grout.
- C. Roughen concrete surfaces by chipping, sandblasting, or other mechanical means to ensure bond of the grout to the concrete. Remove loose or broken concrete. Irregular voids or projecting coarse aggregate need not be removed if they are sound, free of laitance and firmly embedded into the parent concrete.
  - 1. Air compressors used to clean surfaces in contact with grout shall be the oilless type or equipped with an oil trap in the airline to prevent oil from being blown onto the surface.
- D. Remove all loose rust, oil or other deleterious substances from metal embedments or bottom of baseplates prior to the installation of the grout.
- E. Concrete surfaces shall be washed clean and then kept moist for at least 24 hours prior to the placement of cementitious or cement grout. Saturation may be achieved by covering the concrete with saturated burlap bags, use of a soaker hose, flooding the surface, or other method acceptable to the City Representative. Upon completion of the 24-hour period, visible water shall be removed from the surface prior to grouting. The use of an adhesive bonding agent in lieu of surface saturation shall only be used when approved by the City Representative for each specific location of grout installation.
- F. Epoxy-based grouts do not require the saturation of the concrete substrate. Surfaces in contact with epoxy grout shall be completely dry before grouting.
- G. Construct grout forms or other leakproof containment as required. Forms shall be lined or coated with release agents recommended by the grout manufacturer. Forms shall be of adequate strength, securely anchored in place and shored to resist the forces imposed by the grout and its placement.
  - 1. Forms for epoxy grout shall be designed to allow the formation of a hydraulic head and shall have chamfer strips built into forms.
- H. Level and align the structural or equipment bearing plates in accordance with the structural requirements and the recommendations of the equipment manufacturer.
- I. Equipment shall be supported during alignment and installation of grout by shims, wedges, blocks or other approved means. The shims, wedges and blocking devices shall be prevented from bonding to the grout by appropriate bond breaking coatings and removed after grouting unless otherwise approved by the Owner's Representative.

### 3.02 INSTALLATION – GENERAL

- A. Mix, apply and cure products in strict compliance with the manufacturer's recommendations and this Section.
- B. Have sufficient manpower and equipment available for rapid and continuous mixing and placing. Keep all necessary tools and materials ready and close at hand.
- C. Maintain temperatures of the foundation plate, supporting concrete, and grout between 40° and 90° F during grouting and for at least 24 hours thereafter or as recommended by the grout manufacturer, whichever is longer. Take precautions to minimize differential heating or cooling of baseplates and grout during the curing period.

- D. Take special precautions for hot weather or cold weather grouting as recommended by the manufacturer when ambient temperatures and/or the temperature of the materials in contact with grout are outside of the 60° and 90° F range.
- E. Install grout in a manner which will preserve the isolation between the elements on either side of the joint where grout is placed in the vicinity of an expansion or control joint.
- F. Continue all existing underlying expansion, control and construction joints through the grout.

### 3.03 INSTALLATION – CEMENT GROUTS AND NON-SHRINK CEMENTITIOUS GROUTS

- A. Mix in accordance with manufacturer's recommendations. Do not add cement, sand, pea gravel or admixtures without prior approval by the Owner's Representative.
- B. Avoid mixing by hand. Mixing in a mortar mixer (with moving blades) is required if recommended by the manufacturer. Pre-wet the mixer and empty excess water. Add premeasured amount of water for mixing, followed by the grout. Begin with the minimum amount of water recommended by the manufacturer and then add the minimum additional water required to obtain workability. Do not exceed the manufacturer's maximum recommended water content.
- C. Placements greater than 3-inch in depth shall include the addition of clean, washed pea gravel to the grout mix when approved by the manufacturer. Comply with the manufacturer's recommendations for the size and amount of aggregate to be added.
- D. Place grout into the designated areas in a manner which will avoid segregation or entrapment of air. Do not vibrate grout to release air or to consolidate the material. Placement shall proceed in a manner which will ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- E. Place grout rapidly and continuously to avoid cold joints. Do not place cement grouts in layers. Do not add additional water to the mix (retemper) after initial stiffening.
- F. Just before the grout reaches its final set, cut back the grout to the substrate at a 45-degree angle from the lower edge of bearing plate unless otherwise approved by the City Representative. Finish this surface with a wood float (brush) finish.
- G. Begin curing immediately after form removal, cutback, and finishing. Keep grout moist and within its recommended placement temperature range for at least 24 hours after placement or longer if recommended by the manufacturer. Saturate the grout surface by use of wet burlap, soaker hoses, ponding or other approved means. Provide sunshades as necessary. If drying winds inhibit the ability of a given curing method to keep grout moist, erect wind breaks until wind is no longer a problem or curing is finished.

### 3.04 INSTALLATION – NON-SHRINK EPOXY GROUTS

- A. Mix in accordance with the procedures recommended by the manufacturer. Do not vary the ratio of components or add solvent to change the consistency of the grout

mix. Do not overmix. Mix full batches only to maintain proper proportions of resin, hardener and aggregate.

- B. Monitor ambient weather conditions and contact the grout manufacturer for special placement procedures to be used for temperatures below 60° or above 90° F.
- C. Place grout into the designated areas in a manner which will avoid trapping air. Placement methods shall ensure the filling of all spaces and provide full contact between the grout and adjoining surfaces. Provide grout holes as necessary.
- D. Minimize "shoulder" length (extension of grout horizontally beyond base plate). In no case shall the shoulder length of the grout be greater than the grout thickness.
- E. Finish grout by puddling to cover all aggregate and provide a smooth finish. Break bubbles and smooth the top surface of the grout in conformity with the manufacturer's recommendations.
- F. Epoxy grouts are self curing and do not require the application of water. Maintain the formed grout within its recommended placement temperature range for at least 24 hours after placing, or longer if recommended by the manufacturer.

### 3.05 INSTALLATION - CONCRETE GROUT

- A. Inspect slabs finished under Section 03350 (03 35 00) and scheduled to receive concrete grout. Protect and keep the surface clean until placement of concrete grout.
- B. Clean and Roughen surface in accordance with preparation instructions above. Do not flush debris into structure drain piping.
- C. Saturate the concrete surface in accordance with instructions above. . Place cement slurry immediately ahead of the concrete grout so that the slurry is moist when the grout is placed. Work the slurry over the surface with a broom until it is coated with approximately 1/16 to 1/8-inch thick cement paste. A bonding grout composed of 1-part portland cement, 1.5 parts fine sand, an approved bonding admixture and water, mixed to achieve the consistency of thick paint, may be substituted for the cement slurry.
- D. Place concrete grout to final grade using the scraper mechanism as a guide for surface elevation and to eliminate high and low spots. Unless specifically approved by the equipment manufacturer, mechanical scraper mechanisms shall not be used as a finishing machine or screed.
- E. Provide grout control joints as indicated on the Drawings.
- F. Steel trowel finish as specified in Section 03350 (03 35 00). Cure the concrete grout as specified for cast-in-place concrete in Section 03300 (03 30 00).

### 3.06 INSTALLATION – SWEPT-IN GROUT

- A. Inspect slabs finished under Section 03350 (03 35 00) and scheduled to receive swept-in grout. Protect and keep the surface clean until placement of concrete grout.
- B. Clean and Roughen surface in accordance with preparation instructions above. Do not flush debris into structure drain piping.
- C. Provide for tanks and clarifiers, where shown on the Drawings. After construction of the concrete slab, and after all scraping equipment has been installed and



leveled, and before painting has commenced, sweep a 2-inch thickness of cement mortar grout over the slab, screeded by the equipment.

D. Suggested Method:

1. Install metal edged and lined wood 2 x 10 screeds on two arms of the mechanism, 180° apart. Set the metal edge location on the bottom of screed at the average level of the squeegees or scrapers to be installed after the completion of the grouting operation. Extend the metal lining of wood screeds at least 2 inches up both sides from the bottom edge and cover the bottom edge.
2. Moisten the surface, then broom a neat cement and water paste into the roughened concrete immediately ahead of placing the grout. Then place and screed grout specified in Part 2.
3. Attach saturated burlap strips to the trailing side of screed to serve as a float.
4. Ballast the screed arms, as required, and adjust the ballast, if necessary, to compensate for temperature changes.
5. Set equipment speed to assure a reasonable screeding and finishing period. Provide wet cure similar for slabs. The completed grout floor shall be sprayed with a suitable curing compound that has NSF 60 Certification as soon as it is hard enough to permit access.
6. Provide a method approved by the equipment manufacturer.

### 3.07 SCHEDULE

- A. The following list indicates where the particular types of grout are to be used:
1. General purpose non-shrink cementitious grout: Use at all locations where non shrink grout is called for on the plans except for base plates greater in area than 3-foot wide by 3-foot long and except for the setting of anchor rods, anchor bolts or reinforcing steel in concrete.
  2. Flowable non-shrink cementitious grout: Use under all base plates greater in area than 3-foot by 3-foot. Use at all locations indicated to receive flowable non-shrink grout by the Drawings. The Contractor, at his/her option and convenience, may also substitute flowable non-shrink grout for general purpose non-shrink cementitious grout.
  3. Non-shrink epoxy grout: *Use for the setting of anchor rods, anchor bolts and reinforcing steel in concrete and for all locations specifically indicated to receive epoxy grout.*
  4. Cement grout: *Cement grout may be used for grouting of incidental base plates for structural and miscellaneous steel such as post base plates for platforms, base plates for beams, micropiles, etc. It shall not be used when non-shrink grout is specifically called for on the Drawings or for grouting of primary structural steel members such as columns and girders.*
  5. Concrete grout: Use at all locations indicated on the Drawings to receive concrete grout.

### 3.08 FIELD QUALITY CONTROL

A. *Field Testing:*

1. *Field testing and inspection services other than Special Inspection required shall be provided by the Contractor. The Contractor shall complete the sampling of materials and shall provide any ladders, platforms, etc., for access to the work. The methods of testing shall comply in detail with the applicable ASTM Standards.*

2. *The field testing of concrete grout shall be as specified for concrete in Section 03300 (03 30 00).*

END OF SECTION

## SECTION 05100

### STRUCTURAL METAL FRAMING

#### PART 1 - GENERAL

##### 1.01 SUMMARY

###### A. Section Includes:

1. Structural steel, stainless steel or aluminum, such as beams, channels, angles, tees, bars, pipe, tubing and plates (connection and base plates).
2. Fabricated metal items, such as pipe supports, brackets, hangers, equipment supports, and lift hooks.
3. All anchors, eye bolts, turnbuckles, cable clamps, bolts, nuts, washers, inserts, and other metal items not specified elsewhere.
4. Fabricated tanks, hoppers, and similar structures, if not specified elsewhere.
5. All structural metal framing.

##### 1.02 REFERENCES

###### A. Aluminum Association:

1. AA Manual-Aluminum Design Manual

###### B. American Institute of Steel Construction Specifications:

1. ANSI/AISC 360-05 Specification for Structural Steel Buildings
2. ANSI/AISC 341-05 Seismic Provisions for Structural Steel Buildings Including Supplement No.1
3. ANSI/AISC 358-05 Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications
4. AISC 303-05 Code of Standard Practice for Steel Buildings and Bridges

###### C. Research Council on Structural Connections:

1. RCSC Specification for Structural Joints Using ASTM A325 or A490 Bolts, 2004

###### D. American Iron and Steel Institute (AISI).

###### E. American National Standards Institute:

1. ANSI H35-1 Alloy and Temper Designation Systems for Aluminum

###### F. ASTM International (ASTM) Standard Specifications:

1. ASTM A36 Structural Steel
2. ASTM A53 Pipe, Steel, Black and Hot-dipped, Zinc-coated Welded and Seamless
3. ASTM A108 Specification for Steel Bars, Carbon, Cold-Finished, Standard Quality
4. ASTM A123 Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products
5. ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware
6. ASTM A276 Stainless Steel Bars and Shapes
7. ASTM A370 Test Methods and Definitions for Mechanical Testing of Steel Products



8. ASTM A500 Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
  9. ASTM A653 Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
  10. ASTM A992 Specification for Steel for Structural Shapes for Use in Building Framing
  11. ASTM B633 Electrodeposited Coatings of Zinc on Iron and Steel
  12. ASTM C827 Test Method for Early Volume Change of Cementitious Mixtures
  13. ASTM C1107 Packaged Dry, Hydraulic-Cement Grout (Non-shrink)
  14. ASTM E8 Test Methods for Tension Testing of Metallic Materials
  15. ASTM E165 Practice for Liquid Penetrant Inspection
  16. ASTM E709 Practice for Magnetic Particle Examination
  17. ASTM F2329 Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
- G. American Welding Society:
1. AWS D1.1 Structural Welding Code - Steel
  2. AWS D1.2 Structural Welding Code - Aluminum
  3. AWS D10.4 Recommended Practices for Welding Austenitic Chromium-Nickel Stainless Steel Piping and Tubing
  4. AWS A4.3-93R Standard Methods for Determination of the Diffusible Hydrogen Content of Martensitic, Bainitic, and Ferritic Steel Weld Metal Produced by Arc Welding
  5. AWS A5.1 Mild Steel Covered Arc Welding Electrodes
  6. AWS A5.3 Aluminum and Aluminum Alloy Electrodes for Shielded Metal Arc Welding
  7. AWS A5.4 Covered Corrosion-Resisting Chromium-Nickel Steel Welding Electrodes
  8. AWS A5.5 Low Alloy Steel Covered Arc Welding Electrodes
  9. AWS A5.9 Corrosion-Resisting Chromium-Nickel Steel Base and Composite Metal Cored and Stranded Welding Electrodes and Welding Rods
  10. AWS A5.10 Aluminum and Aluminum Alloy Bare Welding Rods and Electrodes
  11. ANSI/AWS B4.0-98 Standard Methods for Mechanical Testing of Welds – U.S. Customary
  12. AWS B5.1-2003 Standard for the Qualification of Welding Inspectors
  13. AWS C4.1 Oxygen Cutting Surface Roughness Gauge and Wall Chart for Criteria Describing Oxygen-Cut Surfaces
- H. American Society for Nondestructive Testing (ASNT):
1. ASNT SNT TC-1a-2001 Recommended Practice for the Training and Testing of Nondestructive Testing Personnel
  2. ANSI/ASNT CP-189-2001 Standard for the Qualification and Certification of Nondestructive Testing Personnel
- I. Federal Emergency Management Agency (FEMA):
1. FEMA 350 Recommended Seismic Design Criteria for New Steel Moment-Frame Buildings, July 2000
- J. International Code Council (ICC)

- K. International Building Code (IBC) 2009 Edition and California Building Code (CBC) 2010 Edition OR with Amendments adopted by the Washington State Building Code Council OR with Amendments adopted in the State of Oregon 2010 Structural Specialty Code.

### 1.03 SUBMITTALS

- A. Submit in Accordance with Section 01300 (01 33 00).
- B. Product Data:
  - 1. Hangers, pipe and equipment supports (shelf items).
  - 2. Stainless steel and aluminum items (not fabricated).
  - 3. Certified mill test results on structural metals.
  - 4. Electrode manufacturer's data and product data, including electrodes to be used for dissimilar metals.
  - 5. Insulation between dissimilar metals.
  - 6. Manufacturer's product data sheets or catalog data for SMAW, FCAW and GMAW composite (cored) filler metals to be used.
  - 7. Manufacturer's certifications that the filler metal meets the supplemental Charpy V-Notch (CVN) toughness requirements for demand critical welds.
  - 8. Non-shrink grout.
- C. Samples: Manufacturer's latest standard product. Specify special or unique products.
- D. Shop and Erection Drawings:
  - 1. Structural framing.
  - 2. Designation of the members and connections that are part of the seismic load resisting system (SLRS).
  - 3. Connection material specifications.
  - 4. Locations of demand critical shop welds.
  - 5. Locations and dimensions of protected zones.
  - 6. Gusset and base plates drawn to scale.
  - 7. Welding requirements as specified in AWS D1.1 Appendix W, Sections W2.2 and W2.3.
  - 8. Locations of pretensioned bolts.
  - 9. Field assembly or erection sequence.
- E. Quality Assurance:
  - 1. Welder performance qualification test records "welder's certification".
  - 2. Written Welding Procedure Specifications (WPSs) in accordance with AWS D1.1 requirements for each different welded joint proposed for use whether prequalified or qualified by testing.
  - 3. Procedure Qualification Record (PQR) in accordance with AWS 1.1 for all procedures qualified by testing.
  - 4. Fabricator's and Erector's AISC Certifications.

### 1.04 QUALITY ASSURANCE

- A. General:
  - 1. Furnish materials and fabricated items from an established and reputable manufacturer or supplier. Fabricator and Erector shall both be AISC certified for the work that they are performing.
  - 2. Supply all new materials and fabricated items made from first class ingredients and construction and guaranteed to perform the service required.

3. The Contractor is responsible for preparing and submitting written WPSs. WPSs for each joint type shall indicate proper AWS qualification and be available where welding is performed. WPSs shall be included with any shop drawings referencing welds. WPSs shall include the manufacturer and specific electrode.
  4. Quality control and quality assurance shall be provided in accordance with AISC 341 Appendix Q.
- B. Codes and Standards:
1. Metalwork:
    - a. Steel: AISC Specification.
    - b. Aluminum: AA Manual.
  2. Welding:
    - a. Steel: AWS D1.1.
    - b. Aluminum: AWS D1.2.
    - c. Stainless Steel: AWS D10.4.
  3. Welders:
    - a. Qualify welders in accordance with AWS D1.1 for each process, position, and joint configuration.
    - b. All welding operators are subject to examination for requalification at any time during the progress of the work.
- C. Tests:
1. General: The Owner will provide Special Inspection, defined by IBC OR CBC Section 1704, for welding and high-strength bolting. Visual welding inspection and nondestructive testing (NDT) shall be conducted in accordance with a written practice by personnel qualified in accordance with AISC 341 Appendix W.
  2. Weld Tests: By a testing laboratory, selected by Engineer and paid by Owner.
    - a. Visual inspection:
      - 1) Check fit-up of joint materials. Verify satisfactory alignment of material. Verify gaps and bevels of penetration welds.
      - 2) Check during welding. Verify satisfactory technique is used.
      - 3) Check after welding completed and cleaned by wire brush or chipping hammer.
      - 4) Inspect with magnification when necessary and under strong, adequate light.
      - 5) Inspect for the following defects:
        - a) Surface cracking.
        - b) Porosity.
        - c) Excessive roughness.
        - d) Unfilled craters.
        - e) Gas pockets.
        - f) Undercuts.
        - g) Overlaps.
        - h) Size.
        - i) Insufficient throat and concavity.
    - b. Nondestructive testing: Ultrasonic testing, except where not feasible due to the type or location of the weld. Magnetic particle, liquid penetrant or radiograph tests when ultrasonic testing is not feasible.
      - 1) Ultrasonic inspection technique and standards: AWS D1.1 Part C.
      - 2) Particle inspection method: ASTM E709.



- 3) Penetrant inspection method: ASTM E165.
  - 4) Radiography tests: AWS D1.1, Part B.
  - 5) Charpy V-Notch (CVN).
    - a) When they are used as members in the Seismic Resisting Force System, ASTM A6, Group 3 shapes with flanges 1½ inches thick and thicker, ASTM A6 Groups 4 and 5 shapes, and plates that are 1½-inch thick or thicker in built-up cross sections shall have a minimum CVN toughness of 20 ft-lbs. at 70°F.
    - b) All complete joint penetration groove welds used in the Seismic Force Resisting System shall be made with a filler metal that has a minimum CVN toughness of 20 ft-lbs at minus 20°F, as determined by AWS classification or manufacturer certification Ultrasonic inspection technique and standards: AWS D1.1 Part C.
- c. Extent of testing:
- 1) Visual inspection of all welds.
  - 2) Measurement of weld profiles for 25% of all welds at random.
  - 3) Magnetic particle examination or liquid penetrant examination performed on root pass and on finished welds for 25% of all shear plate, stiffener plate, column base plate, gusset plate, and miscellaneous fillet welds.
  - 4) Ultrasonic contact examination on all complete joint penetration (CJP) welds. See Drawings for CJP welded beam or girder to column moment connections. Defective welds shall be repaired and costs of retesting defective welds shall be borne by the Contractor.
- D. Additional Tests: Provide and pay for all necessary additional tests made on welds or bolts required to repair or replace faulty work performed during the original fabrication.

#### 1.05 DELIVERY, STORAGE AND HANDLING

- A. Handle, ship and store material in a manner that will prevent distortion, rust, damage to the shop coat or any other damage.
- B. Store material in a clean, properly drained location out of contact with the ground.
- C. Ensure that dissimilar metals are not in contact with each other.
- D. Replace or repair all damaged material in an approved manner.

### PART 2 - PRODUCTS

#### 2.01 STRUCTURAL STEEL MEMBERS

- A. W-Shapes and WT-Shapes: ASTM A992,  $f_y = 50$  ksi,  $f_u = 65$  ksi.
- B. M-, S-, and HP-Shapes and Channels, Angles, Structural Tees, Plates and Similar Items: ASTM A36,  $f_y = 36$  ksi,  $f_u = 58$  ksi. Except plates for W-Shapes and WT-Shapes ASTM A572, Grade 50.

- C. Hollow Structural Sections (HSS): Rectangular and square, ASTM A500, Grade B,  $f_y = 46$  ksi,  $f_u = 58$  ksi. Round, ASTM A500, Grade B,  $f_y = 42$  ksi,  $f_u = 58$  ksi.
- D. Steel Pipe: ASTM A53 Type E or S, Grade B,  $f_y = 35$  ksi,  $f_u = 60$  ksi.

## 2.02 STAINLESS STEEL ARTICLES

- A. Material: AISI Type 304, unless Type 316 is specifically specified.
- B. Channels, Angles and Structural Tees: ASTM A276.

## 2.03 FABRICATED ALUMINUM ITEMS

- A. Material: ANSI H35-1 Alloy and Temper 6061-T6 with an anodized finish.
- B. Surfaces in Contact With Concrete or Masonry: Shop prime with a bituminous mastic or zinc chromate coating.
- C. Bolted Connections: Provide stainless steel fasteners.

## 2.04 METAL FASTENINGS

- A. See Section 05090 (05 05 23).

## 2.05 WELDING ELECTRODES, FILLER METALS

- A. Steel:
  - 1. AWS A5.1 or A5.5, E70XX category.
  - 2. AWS A5.20, A5.29, E7XTX-X except -2, -3, -10, -GS for FCAW.
  - 3. AWS A5.17 or A5.23, F7XX-EXXX for SAW.
- B. Stainless Steel: AWS A5.4 or A5.9.
- C. Aluminum: AWS A5.3 or A5.10.
- D. For welding dissimilar metals, submit the appropriate electrodes for Product Review.

## 2.06 GALVANIZING

- A. Hot-dip galvanize all exterior and exposed steel items, except when specified otherwise.
  - 1. Sheet steel, plain or shaped: ASTM A653, coating designation G 90, commercial grade, 115 or heavier, check availability.
  - 2. Products fabricated from rolled, pressed and forged steel shapes, plates, bars and strip 1/8-inch-thick or heavier: ASTM A123.
  - 3. Structural tubing and pipe: ASTM A53
  - 4. Grind smooth fabricated items at welded joints, edges, and corners, and galvanize after fabrication.
  - 5. Items that are specified to receive paint or a coating after galvanizing shall receive no post treatment baths and shall not be stacked or stored in a wet environment until coated.
- B. Repair Materials: Gal-Viz by Thermacote Welco, Pasadena, CA; ReGalv by Rotometals, Inc., San Francisco, CA; or equal.

## 2.07 NON-SHRINK GROUT

- A. See Section 03300 (03 30 00) OR ASTM C1107 with no shrinkage as measured by ASTM C827. Furnish a pre-mixed product consisting of properly proportioned amounts of non-metallic dimensionally stable material to which water is added.

## 2.08 MISCELLANEOUS ITEMS

- A. Furnish all items required to complete the project, but not specified herein, not specified in Section 05500 (05 50 00) OR \_\_\_\_\_.

## 2.09 FABRICATION

- A. Structural Steel Work: Comply with the applicable provisions of the AISC Specification, the AISC Standard Practice and AWS D1.1. Weld only in accordance with favorably reviewed WPSs, which are to be available to welders and inspectors during the production process. Provide workmanship equal to standard commercial practice in modern structural shops.
  - 1. Fabricate and assemble in the shop to the greatest extent possible, and deliver to the project as a unit ready for installation. Coordinate the work, making all provisions necessary for the passage of all applicable work into, and attachment to, the structures. Make joints carefully and neatly, with corners mitered and spliced, bolted, screwed, or welded together.
  - 2. Make proper allowance for the expansion and contraction of the metals, and of the materials to which they are fastened.
  - 3. Make completely watertight joints on exterior work.
  - 4. Shape all members correctly, with no kinks, twists, dents, or other blemishes prior to erection. Evenly spring all curved work.
  - 5. Make exposed edges free of burrs, sharp edges or corners. Make corners rounded or chamfered. Grind exposed welds smooth when specified.
  - 6. Include supplementary parts necessary to complete each item, even though such work may not be definitely specified. Provide all such miscellaneous metalwork required by the project in accordance with good accepted standard practice.
  - 7. Review monorail supports and splices with the hoist manufacturer.
  - 8. Shop prime all items that are not galvanized or epoxy coated, including connection angles, using a material compatible with the finish coat, as specified in Section 09900 (09 91 00) OR Section 09960 (09 96 00). Provide finish paint coats as specified in Section 09900 (09 91 00) OR Section 09960 (09 96 00).
- B. Stainless Steel Work:
  - 1. Use the proper type of stainless steel electrodes or welding rods complying with AWS D10.4. Grind all welded joints smooth and polished, using wheels never used on carbon steel. Provide welds that eliminate injury to stainless steel parts in appearance, strength and resistance to corrosion.
  - 2. Remove by grinding and polishing, all scratches, marks, pits and other blemishes on exposed surfaces incurred during fabrication of the material, until the entire surface possesses the same finish as the adjacent work.
- C. Aluminum Work:
  - 1. Comply with the applicable provisions of the AA Manual and AWS D1.2.
  - 2. Back painting: When aluminum is in contact, such as with concrete, mortar, masonry, or adsorptive materials subject to wetting, including condensation,



- give the contact surfaces a brush coat of cut-back asphaltic, or coal tar paint. Submit paint for favorable review.
3. Aluminum shall have an anodized finish.
- D. Base and Bearing Plates: Furnish under all columns, pipe supports, including rack type, supports for tanks, equipment frames and cabinets, and similar items. Provide rounded or chamfered corners.
  - E. Dissimilar Metals: Insulate the faying surfaces with a brush coat of cut-back asphaltic or coal tar paint or by gasketing. Submit for favorable review.
  - F. Metals in contact with cementitious or other material: Provide finish coating prior to erection.

## 2.10 SOURCE QUALITY CONTROL

- A. Material Tests: Not required for materials identified with valid mill test records.
  1. Unidentified materials: Test samples from each 20 tons of each material, or fraction thereof. Perform tension and bend tests, conforming to ASTM A370 for steel. Perform tension tests conforming to ASTM E8 for aluminum.
  2. Do not provide unidentified stainless steel.
- B. Welding:
  1. Qualify welders in accordance with AWS D1.1 for each process, position, and joint configuration.
  2. Weld only in accordance with favorably reviewed WPSs, which are to be available to welders and inspectors during the production process.
- C. Tolerances: AISC Standard Practice.
- D. Fabrication Tests: Standard and extent: See paragraph 1.04.

## PART 3 - EXECUTION

### 3.01 ERECTION

- A. Structural Steel Work:
  1. Erect members in accordance with the AISC Specification, and the AISC Standard Practice except as modified.
  2. Incorrect fabrication or damaged members:
    - a. When a condition exists whereby parts cannot be assembled or fitted properly as a result of errors in fabrication, or of deformation due to handling or transportation, report the condition immediately. The method of correction must be approved before any corrective work is done. Make the corrective work in the presence of the Engineer.
    - b. Straighten plates and angles or other shapes using approved methods.
    - c. Do not heat already heat-treated parts for straightening.
  3. Connections:
    - a. Provide anchor bolts and other connections between structural steel and foundations. See Specification Section 05090 (05 05 23) for additional connection requirements.
    - b. Set all anchor bolts by template, with provisions to hold bolts rigid and in correct position with respect to plan and elevation.
    - c. Detail any undesigned connections in accordance with the AISC Specification

- d. Do not increase any hole diameter or slot length without the Engineer's approval.
  4. Install work anchored in sleeves set in concrete with non-metallic non-shrink grout. Allow a ¼-inch minimum clearance between items anchored and the sleeve.
  5. Where metal is fastened to concrete, make the connections by anchor bolts, or by fastenings embedded in concrete, such as adhesive, or expansion anchors, installed in accordance with Specification Section 05090 (05 05 23). Contractor shall not substitute post-installed fasteners for cast-in-place bolts without prior written permission from the Engineer.
  6. Provide a 4-inch band of coal-tar epoxy applied, half in concrete and half in air, to galvanized or painted steel, partially embedded in concrete and subject to weathering.
  7. Provide grout pads below base and bearing plates of non-shrink non-metallic grout having a minimum thickness of ¾-inch unless otherwise noted. Do not bear directly on concrete slabs or equipment bases.
  8. Provide leveling nuts on anchor bolts, below base plates, and adjust prior to grouting.
  9. Complete the work square, plumb, straight and true, accurately fitted, and with tight joints and intersections.
- B. Welding:
1. Weld only in accordance with favorably reviewed WPSs, which are to be available to welders and inspectors during the production process. Perform all welding by the shielded electric arc method in accordance with AWS D1.1.
  2. Repair and make additional inspections, at the Contractor's expense, of the weld areas which have been rejected as a result of inspection. Follow this procedure until the welds are acceptable to the Engineer.
  3. Qualify welders in accordance with AWS D1.1 for each process, position, and joint configuration.
  4. All tack welds shall be of the same quality as the final welds. This includes preheat requirements. All tack welds not incorporated in the final welds shall be removed.
- C. Repair of Galvanized Coating:
1. Repair surfaces damaged by cutting or welding by the heated repair method. Repair handrails or other surfaces that will not be painted and that are field welded or damaged by the heated galvanize repair method.
  2. Heat substrate to 600°F, or apply hot process touch-up material right after welding before metal has cooled below 600°F.
  3. Rub bar of specified galvanize repair material over surface of hot substrate to apply a uniform coating of zinc. Wire brush hot coating with a clean wire brush to smooth out and bond zinc coating to substrate to apply a uniform coating of zinc.

### 3.02 FIELD QUALITY CONTROL

- A. Welding:
1. Qualify welders in accordance with AWS D1.1 for each process, position, and joint configuration.
  2. The Owner's testing agency will inspect shop or field welding for conformance with AWS D1.1 requirements and will verify that welds are made in accordance with favorably reviewed WPSs.

- B. Erection Sequence: Verify each stage is completed before proceeding to the next.
- C. Tolerances: AISC Standard Practice.
- D. Erection Tests: Standard and extent: See paragraph 1.04.

END OF SECTION



SECTION 08307  
ACCESS HATCHES

PART 1 - GENERAL

1.01 SUMMARY

- A. Section Includes:
1. Floor access hatches.
  2. Sidewalk access hatches.
  3. Vault access hatches.
  4. Wet well access hatches.

1.02 REFERENCES

- A. California Building Standards Commission
1. California Building Code (CBC), current adopted edition.  
(California Code of Regulations, Title 24)
  2. California Energy Code (CEC), current adopted edition
- B. International Code Council (ICC):
1. International Building Code (IBC), current adopted edition.
  2. Oregon Structural Specialty Code (OSSC), current adopted edition.
  3. Oregon Energy Efficiency Specialty Code, current adopted edition.
  4. Washington State Building Code Council (SBCC)
    - a. Washington State Building Code, current adopted edition.
    - b. 2012 Washington State Energy Code, current adopted edition.
  5. Hawaii State Building Code Council (HSBCC)
    - a. International Building Code, current adopted edition.
- C. Trade and Technical Association Standards:
1. "Aluminum Design Manual 2015" published by The Aluminum Association.
  2. "AWS D1.2, Structural Welding Code – Aluminum" published by American Welding Society (AWS).

1.03 SUBMITTALS

- A. Submit in accordance with Section 01300 (01 33 00).
- B. Product Data: Fully describe all items proposed for use. Include sufficient data to show that products conform to specification requirements as indicated herein and in Related Sections.
- C. Shop Drawings: Show dimensions, attachments, inserts and relationship of work to adjoining construction.
- D. Warranty.
- E. Special Guarantee.

1.04 QUALITY ASSURANCE

- A. Regulatory Requirements:
1. Applicable State of Insert State Occupational Safety and Health (OSHA) Regulations.

2. International Building Code, Insert year edition.

## PART 2 - PRODUCTS

### 2.01 ACCESS HATCHES

- A. Minimum clear opening dimensions of each hatch shall be as shown under "Special Requirements" in the Access Hatch Schedule of Paragraph 2.02. Coordinate with the favorably reviewed pump or equipment manufacturer if larger in size. Provide single leaf or double leaf hatches as indicated in the Access Hatch Schedule, or as recommended by the manufacturer for the overall hatch dimensions.
  1. Single Leaf: Bilco "J-AL" series; equivalent by L.W. Products Co.; equivalent by EJ; equivalent by Babcock-Davis; equivalent by U.S.F. Fabrication; or equal.
  2. Double Leaf: Bilco "JD-AL" series; equivalent by L.W. Products Co.; equivalent by EJ; equivalent by Babcock-Davis; equivalent by U.S.F. Fabrication; or equal.
- B. Live load: Provide hatches to withstand the loads indicated in the Access Hatch Schedule.
- C. Door Leaves: 1/4-inch thick aluminum, diamond pattern, reinforced as required to withstand the specified loads.
- D. Frame: Minimum 1/4-inch thick aluminum channel with anchor flange around perimeter for embedment into concrete. Provide channel to collect rain water and provide 1-1/2-inch drainage coupling for connection to drain lines except for water tight and indoor or non-weather tight hatches as noted in the Access Hatch Schedule. Contractor shall provide and route drain lines as shown on the Drawings OR as follows. Drain lines shall be freely draining by gravity.
- E. Doors: Doors shall open to minimum 90 degrees and shall include an automatic hold-open arm with a positive automatic latch that will secure the door in the open position until the release handle is activated. Provide stainless steel hold-open pin through holes in hold-open arms to ensure against accidental hatch closure. Attach pin to hatch with a short stainless steel chain to prevent loss. Submit details of latch for review. Door hinges shall be recessed or flush.
- F. Lock: Provide a slam-lock with removable handle OR a recessed keyed cylinder lock with a removable OR recessed or drop-down flush lifting handle(s) OR a hinged covered recess with a door to frame padlock hasp and a removable OR recessed or drop-down flush lifting handle(s).
- G. Lift-Assist Mechanism: Provide stainless steel compression spring(s) or pneumatic spring(s) enclosed in sealed telescoping tube(s).
- H. Safety Chain: For double leaf doors, provide a stainless steel safety chain between doors at the opposite end from the latch to form a barrier when the doors are locked in the open position.
- I. Safety Grate: Where indicated in the Access Hatch Schedule, provide a secondary fall protection safety grate located beneath the solid hatch cover, which lifts independently from the cover and is equipped with a latch to hold it in the open position. The grate shall be manufactured from aluminum flat bars, load-rated for 300 pounds per square foot, and safety orange in color. The grate shall have a

padlock hasp for locking in the closed position. The grate shall comply with OSHA Standard 1910.28 for fall protection.

- J. All non-aluminum metals and hardware: Type 316 stainless steel.
- K. Finish: Mill finish aluminum. All surfaces of aluminum in contact with concrete shall be coated for isolation in accordance with Section 05500 (05 50 00).
- L. Weather-Tightness: All hatches shall be rated "weather tight" unless noted otherwise in the Access Hatch Schedule. Provide an EPDM or neoprene rubber rim gasket to prevent infiltration of rainwater. Include gaskets and o-rings for accessory penetrations as applicable.
- M. Water-Tightness: Where indicated in the Access Hatch Schedule, provide bolt-down or tightly latched gasketed water-tight covers capable of withstanding a 10-foot column of water without leaking. Hatch and frame shall be the concrete embedment type, with the top surface flush with the adjacent concrete surface.
- N. Odor-Tightness: Where indicated in the Access Hatch Schedule, provide EPDM or neoprene rubber gaskets to limit the transmission of odors when the hatch doors are closed. Air leakage shall not be greater than 1 cfm per liner foot of gasket at a 1-inch water column (WC) pressure differential.
- O. Warning Sign:
  - 1. Provide a sign or decal permanently attached to the underside of hatch doors reading: "Warning: Permit Confined Space Entry."
  - 2. Provide a sign or decal permanently attached to the underside of hatch doors reading: "Danger: Make Sure Hold-Open Latch is Positively Engaged Before Using. Insert Pin in Holes in Hold-Open Arms to Hold Door Open."

2.02 ACCESS HATCH SCHEDULE

Hatch Location	No. of Leaves	Live Load	Safety Grate	Special Requirements
Describe location of hatch, or tag number	Single OR Double	300 pounds per square foot OR H-20 vehicular	Yes OR No	N/A  OR 1. Indoor rated (non-weather tight) 2. Odor tight 3. Water tight 4. Describe special lock or handle requirements if different from that specified in Paragraph 2.01(F). 5. Provide Warning Sign 1, OR 2, [ _ ] 6. etc.
Describe location of hatch, or tag number	Single OR Double	300 pounds per square foot OR H-20 vehicular	Yes OR No	N/A  OR 1. Indoor rated (non-weather tight) 2. Odor tight 3. Water tight 4. Describe special lock or handle requirements. 5. Provide Warning Sign 1, OR 2, [ _ ] 6. etc.
(Add rows as necessary)				



## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Deliver hatches to job site in time for installation in the concrete pour.
- B. Coat all aluminum surfaces, which will be in contact with concrete, in accordance with Section 05500 (05 50 00).
- C. Make connection of drainage coupling to plumbing drain line prior to the concrete pour.
- D. Install in conformance with the manufacturer's installation instructions. Set frame level and true to plane at all four corners, and flush with adjacent finished surfaces. Doors, when closed, shall be flush with frames and flush with each other.
- E. Install specified warning sign(s).

END OF SECTION

## SECTION 16010

### GENERAL ELECTRICAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

###### A. Work Included:

1. Provide all required labor, project equipment and materials, tools, construction equipment, safety equipment, transportation, and test equipment, and satisfactorily complete all electrical work shown on the Drawings, included in these Specifications, or required for a complete and fully operating facility. In addition, provide wiring for the equipment that will be provided under other Divisions of these Specifications.
2. Provide conduit, wire and field connections for all motors, motor controllers, control devices, control panels and electrical equipment furnished under other Divisions. Coordinate with the supplier of electrical equipment specified under other Divisions.
3. Provide all conduit, wiring and terminations for all field-mounted instruments furnished and mounted under other Divisions, including process instrumentation primary elements, transmitters, local indicators and control panels. This also includes lightning and surge protection equipment wiring at process instrumentation transmitters if required. Contractor shall install vendor furnished cables specified under other Divisions.
4. Provide a complete raceway system for the specialty cable systems. Install the specialty cable systems in accordance with the system manufacturer's installation instructions. Review of the raceway layout, prior to installation, with the system supplier and cable manufacturer to ensure raceway compatibility with the system and materials being furnished. Where redundant cables are furnished, install them in separate raceways.
5. Provide raceway and power wiring for all heating, ventilation and air conditioning equipment furnished under other related Divisions. Refer to HVAC drawings and related specifications for power requirements. .
6. Auxiliary Devices: Provide conduit and wire for power and control for all auxiliary devices such as solenoid valves, pressure switches, and instruments that are included as part of a manufacturer's packaged system (i.e., all systems specified in Divisions 11 (40) through 15 (48)). Contractor shall be responsible for conduit and wire to these auxiliary devices even if not specifically shown on the Drawings or specified herein.
7. Provide concrete, excavation, backfill and steel reinforcement required for encasement, installation or construction of the WORK of the various Sections of Division 16 (26) as a part of the WORK under the respective Sections, including duct banks, manholes, handholes, equipment housekeeping pads and light pole bases.

###### B. Work to be Done by Utilities:

1. Providing and connecting power company meters and instrument transformers.

###### C. Safety: Conduct operations in accordance with NFPA 70E, Standard for Electrical Safety Requirements for Employee Workspaces.

## 1.02 CODE COMPLIANCE AND REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC) and with the latest edition of the following codes and standards:
  - 1. National Electrical Safety Code (NESC)
  - 2. Occupational Safety and Health Administration (OSHA)
  - 3. National Fire Protection Association (NFPA)
  - 4. National Electrical Manufacturers Association (NEMA)
  - 5. American National Standards Institute (ANSI)
  - 6. Insulated Cable Engineers Association (ICEA)
  - 7. Instrument Society of America (ISA)
  - 8. Underwriters Laboratories (UL)
  - 9. Factory Mutual (FM)
  - 10. Institute of Electrical and Electronics Engineers
  - 11. American Society of Testing Materials (ASTM)
  - 12. Local Telephone Company requirements
  - 13. Local Utility Company requirements
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.
- C. All materials and equipment for which a UL standard exists, shall bear a UL label. No such material or equipment shall be brought onsite without a UL label affixed.
- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Owner/Engineer.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times.

## 1.03 SUBMITTALS

- A. Shop Drawings shall be custom prepared for this project and submitted as listed in each of the Electrical Specification Sections. Shop drawings shall include the following:
  - 1. Complete materials list stating manufacturer, brand name and catalog number of each item or class of material.
  - 2. For equipment, panels, boxes, control devices, wiring devices, and other uniquely-tagged items as indicated on the Drawings, include the respective tag(s) on each applicable shop drawing and cut sheet.
  - 3. Shop drawings for grounding work not specifically indicated on the drawings but required under the NEC.
  - 4. Front, side and rear elevations along with top views with required dimensional data.
  - 5. Location of conduit entrances and access plates.
  - 6. Catalog cuts defining component data.



7. Connection diagrams, terminal numbers, internal wiring diagrams, conductor size and cable numbers.
  8. Method of anchoring, seismic requirements and weight.
  9. Types of materials and finish.
  10. Nameplates.
  11. Temperature limitations, as applicable.
  12. Voltage requirements, phase and current, as applicable.
  13. Front and rear access requirements.
  14. Test reports.
- B. O&M Manuals and other documentation, shall be submitted in accordance with these contract documents. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists, etc. to instruct operating and maintenance personnel unfamiliar with such equipment. All manuals and other documentation shall be submitted as listed in each of the Electrical Specification Sections and include the following:
1. A comprehensive index.
  2. A complete "As-built" set of approved shop drawings.
  3. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
  4. A table listing of the "as left" settings for all timing relays and alarm and trip set points.
  5. System schematic drawings "As-Built", illustrating all components, piping and electrical connections of the system supplied under this Section.
  6. Detailed service, maintenance and operation instructions for each item supplied.
  7. Special maintenance requirements particular to this system shall be clearly defined, along with special calibration and test procedures.
  8. The operating instructions shall also incorporate a functional description of the entire system, with references to the systems schematic drawings and instructions.
  9. Complete parts list with stock numbers, including spare parts.
- C. Record Drawings shall be promptly furnished when the equipment installation is complete. Payment may be withheld until Record Drawings have been furnished and approved.
- D. At the time of delivery of the equipment, the Contractor shall have an approved shop drawing in his possession for the Owner's Inspector and/or Owner's Engineer for verification.
- E. As-Built Drawings: As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called "As-Built Drawings". The As-Built Drawings and specifications shall be kept up to date throughout the project. As-Built Drawings shall accurately show the installed condition of the following items at a minimum:
1. One-line Diagram(s).
  2. Raceways and pullboxes.
  3. Conductor sizes and conduit fills.
  4. Panelboard Schedule(s).
  5. Control Wiring Diagram(s).
  6. Luminaire Schedule(s)
  7. Luminaire, receptacle and switch outlet locations.

8. Underground raceway and duct bank routing including manhole/handhole locations.
9. Plan view, sizes and locations of switchgear, switchboards, distribution transformers, motor control centers and panelboards.

#### 1.04 TESTS

- A. The Contractor shall be responsible for factory and field tests indicated in Division 16, as required by the Engineer and as required by other authorities having jurisdiction.
- B. Furnish necessary testing equipment
- C. Pay the costs of the tests, including replacement parts and labor due to damage resulting from damaged equipment or from testing and correction of a faulty installation.
- D. Reporting
  1. Where test reporting is indicated, submit proof-of-design test reports for mass-produced equipment with the Shop Drawings.
  2. Submit factory performance test reports for custom-manufactured equipment for approval prior to shipment.
  3. Submit field test reports for review prior to Substantial Completion.
- E. Remove and replace equipment or material that fails a test, or, if the Engineer approves, repair and retest for compliance.
- F. Connections to equipment or materials with a factory warranty shall be as recommended by the manufacturer and shall be performed in a manner that does not void the warranty.

#### 1.05 PERMITS AND INSPECTIONS

- A. Obtain permits and pay all fees required for permits inspections.
- B. Pay inspection, connection and turn-on service charges required by the utility company.
- C. Favorable review of the equipment at the factory only allows the manufacturer to ship the equipment to the project site. The Contractor shall be responsible for the proper installation and satisfactory startup operation of the equipment to the satisfaction of the manufacturer and the Engineer.

#### 1.06 DEMOLITION AND RELATED WORK

- A. General
  1. Perform electrical demolition work as indicated.
  2. The Contractor is cautioned that demolition work may also be indicated on non-electrical Drawings.
  3. Coordinate with all trades regarding electrical de-energization, disconnection and removal, and the overall sequence of construction.
- B. Electrical Requirements for Removed Equipment
  1. Remove dedicated wiring and exposed conduits back to the source.
  2. Where control wiring to be demolished shares a conduit with other wiring to remain, the control wiring shall be abandoned in place. Where power wiring to be demolished shares a conduit with other wiring to remain, the power wiring shall be removed.

3. Remove power wiring from the power source to the first pullbox or manhole remote from the panel and abandon in place the remaining wiring.
4. Abandon in place wiring routed through encased conduits and cut encased conduits flush to the floor and grout flush with the floor.
5. Remove remote mounted starters, disconnect switches, circuit breakers, sensors and transmitters

#### 1.07 COORDINATION

- A. Coordinate the electrical work with the other trades, code authorities, utilities, and the Owner.
- B. Where connections must be made to existing installations, properly schedule all the required work with the Owner, including the power shutdown periods. Schedule and carry out shutdowns so as to cause the least disruption to operation of the plant and privately owned facilities.
- C. Submit a written sequencing request indicating the sequence and duration of activities to be performed during the plant shutdown.
- D. Switching, safety tagging and other project related tasks required for shutdown or to isolate existing equipment, shall be performed by the Contractor.
- E. In no case shall the Contractor begin any work in, on or adjacent to existing equipment without written authorization from the Engineer.
- F. Existing Utilities
  1. Exercise extreme caution when digging trenches to not damage existing underground utilities.
  2. The cost of repairs of damages caused during construction shall be included as a part of the Work.
- G. Field Verifications
  1. Visit the site before submitting a Bid to become better acquainted with the Work of this Contract.
  2. The lack of knowledge will not be accepted as justification for extra compensation to perform the Work.
  3. The cost for the above field verifications shall be included as part of the Work.
- H. Installation of Temporary Power
  1. To facilitate the continuous operation of existing equipment, provide temporary equipment as indicated.
  2. Submit installation and connection details for favorable review and acceptance by the Engineer.
  3. Costs associated with these temporary installations shall be included as part of the Work.
  4. Temporary wiring and equipment shall remain the property of the Contractor unless indicated otherwise.

#### 1.08 ELECTRICAL SERVICES

- A. Contact the serving utility and verify compliance with requirements before construction.
- B. Coordinate schedules and payments for Work by utilities.



- C. Where conduits and conductors in the Work are indicated to be larger, heavier schedule, or have greater protective coating than utility requirements, provide the larger size, heavier schedule or greater protection.
- D. Provide electrical service as indicated and as required by the serving utility.
- E. Verify and provide service conduits, fittings, transformer pad, grounding devices and service wires not provided by the serving utility.
- F. Verify with the utility the exact location of each service point and type of service, and pay charges levied by the serving utilities as part of the Work.

#### 1.09 LOCATIONS

- A. General: Use equipment, materials and wiring methods suitable for the types of locations in which they are located, as defined in Paragraph B. herein.
- B. Definitions of Types of Locations:
  - 1. Dry Locations: All those indoor areas which do not fall within the definitions below for Wet, Damp, Hazardous, or Corrosive Locations and which are not otherwise designated on the Drawings.
  - 2. Wet Locations: All locations exposed to the weather, whether under a roof or not, unless otherwise designated on the Drawings.
  - 3. Damp Locations: All spaces wholly or partially underground, or having a wall or ceiling forming part of a channel or tank, unless otherwise designated on the Drawings.
  - 4. Hazardous Locations: All areas in which fire or explosion hazards may exist, normally or accidentally, due to flammable gases or vapors, flammable liquids, combustible dust, or ignitable fibers or flyings. These areas are shown on the Drawings, together with the Class and Division designations as defined in the NEC, determining the enclosure types and wiring methods required.
- C. Unless otherwise specified herein or shown on the Drawings, electrical enclosures and associated installations shall have the following ratings:
  - 1. NEMA 1 gasketed for dry, non-process indoor above grade locations
  - 2. NEMA 3R for outdoor installations identified not to be hazardous or corrosive.
  - 3. NEMA 4X enclosures of Type 304 or 316 stainless steel in corrosive areas except in chlorine and HFS areas where non-metallic enclosures shall be provided.
  - 4. NEMA 6 or 6P enclosures for submersible, indoor or outdoor use. Enclosures for temporary submersion shall be rated NEMA 6 and prolonged submersion shall be rated 6P at limited depth.
  - 5. NEMA 7 enclosures (and listed for use in the area classifications shown) for "Class 1 Div. 1 Group D" and "Class 1 Div. 2 Group D" hazardous locations shown on the Drawings or as defined in NFPA 820 or other codes.
  - 6. NEMA 9 enclosures (and listed for use in the area classifications shown) for "Class 1 Div. 1 Group E, F and G" and "Class 1 Div. 2 Group E, F and G" hazardous locations shown on the Drawings or as defined in NFPA 820 or other codes.
- D. Equipment, materials and installation in areas designated as hazardous on the Drawings shall comply with NEC Articles 500, 501, 502 and 503.
- E. Equipment and materials installed in areas designated as hazardous on the Drawings shall be UL Listed for the appropriate hazardous area classification.

## 1.10 PHASE BALANCING

- A. The Drawings do not attempt to balance the electrical loads across the phases. Circuits on motor control centers and panelboards shall be field connected to result in evenly distributed loads across all three phases.
- B. Field balancing of circuits shall not alter the conductor color coding requirements defined in Section 16120.

## 1.11 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which equipment must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure the tilting does not impair the functional integrity of the equipment.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Products that are specified by manufacturer, trade name or catalog number establish a standard of quality and do not prohibit the use of equal products of other manufacturers provided they are favorably reviewed by the Engineer prior to installation.
- B. It is the intent of these Specifications and Drawings to secure high quality in all materials and equipment in order to facilitate operation and maintenance of the facility. All equipment and materials shall be new and the products of reputable suppliers having adequate experience in the manufacture of these particular items. For uniformity, only one manufacturer will be accepted for each type of product. All equipment shall be designed for the service intended and shall be of rugged construction, of ample strength for all stresses, which may occur during fabrication, transportation, erection, and continuous or intermittent operation. All equipment shall be adequately stayed, braced and anchored and shall be installed in a neat and workmanlike manner. Appearance and safety, as well as utility, shall be given consideration in the design of details.
- C. All components and devices installed shall be standard items of industrial grade, unless otherwise noted, and shall be of sturdy and durable construction suitable for long, trouble-free service. Light-duty, fragile and competitive grade devices of doubtful durability shall not be used.
- D. Where a NEMA enclosure type is indicated in a non-hazardous location, use that type of enclosure despite the fact that certain modifications such as cutouts for control devices may negate the NEMA rating.
- E. Temperature Ratings of Equipment Terminations and lugs shall be rated for use with 75-degree C conductors. Wire sizes in the Contract Documents are based on NEC ampacity tables using the 75-degree C ratings.

## 2.02 MOUNTING HARDWARE

- A. Miscellaneous Hardware
  - 1. Provide nuts, bolts and washers constructed of stainless steel.
  - 2. Provide threaded rods for trapeze supports constructed from continuous threaded galvanized steel, 3/8-inch diameter minimum.
  - 3. Slotted channel
    - a. Construct struts for mounting of conduits and equipment of aluminum slotted channel.
    - b. Where contact with concrete or dissimilar metals may cause galvanic corrosion, use suitable non-metallic insulators in order to prevent such corrosion.
    - c. Slotted channel manufacturer shall be Unistrut, B-Line or approved equal.
  - 4. Provide plastic protective end caps for all exposed slotted channel ends. End caps shall be manufactured by Unistrut P2860-33 or approved equal
  - 5. Provide stainless steel expansion anchors for attaching equipment to concrete walls, floors and ceilings. Expansion anchors shall be manufactured by Power Fasteners, Inc and be the "Power-Bolt" or "Power-Stud" series or approved equal.

## 2.03 NAMEPLATES

- A. For each piece of electrical equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings and the model designation.
- B. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using fasteners constructed of brass, cadmium plated steel or stainless steel and screwed into inserts or tapped holes as required. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the Contractor.
- C. Provide engraved characters of the block style, with no characters smaller than 1/8 inch top to bottom.

## 2.04 PROTECTIVE MATTING

- A. Provide full-length, high-voltage switchboard matting in front of indoor switchgear, service equipment and motor control centers.
- B. For equipment rated at 600-volt, provide matting that is 1/4-inch thick and 42" wide.
- C. Protective matting shall be as manufactured by Rhino or approved equal

## 2.05 PAINTING

- A. Equipment: Refer to each electrical equipment section of these Specifications for painting requirements of equipment enclosures. Repair any final paint finish, which has been damaged or is otherwise unsatisfactory, to the satisfaction of the Engineer.
- B. Wiring System: Paint all exposed conduits, boxes and fittings to match the color of the surface to which they are affixed. Paint finishes shall include proper surface preparation, prime coat and a final finish coat, and shall conform to Section 09960.



## PART 3 - EXECUTION

### 3.01 REQUIREMENTS

- A. All electrical installations shall conform to the codes and standards outlined in this Section.

### 3.02 WORKMANSHIP

- A. Assign a qualified representative who shall supervise the electrical construction work from beginning to completion and final acceptance.
- B. Perform all labor using qualified craftsmen, who have had experience on similar projects. Provide first-class workmanship for all installations.
- C. Ensure that all equipment and materials fit properly in their installations.
- D. Perform any required work to correct improperly fit installations at no additional expense to the Owner.
- E. Provide materials and incidentals required for a complete and operable system, even if not required explicitly by the Contract Documents.
- F. Typical incidentals are terminal lugs not furnished with vendor-supplied equipment, compression connectors for cables, splices, junction and terminal boxes, and control wiring required by vendor-furnished equipment to connect with other equipment indicated in the Contract Documents.

### 3.03 EXCAVATION AND BACKFILL

- A. Provide the excavations for electrical equipment foundations and trenches for conduits as shown on the Drawings.
- B. Exercise caution during all excavation work and avoid damage to existing underground pipes. Exercise extreme caution when working near existing electrical conduits and facilities. Field verify the location of all electrical facilities before proceeding with any nearby work.
- C. Refer to Division 2, Earthwork, of these Specifications for all excavation and backfilling work.

### 3.04 CONCRETE

- A. Where shown on the Drawings or specified, provide the required concrete installations for conduit encasement and equipment foundations.
- B. Refer to Division 3, Concrete, of these Specifications for all concrete work.

### 3.05 CONDUCTOR IDENTIFICATION

- A. Identify all wires and cables in conformance with the requirements of Sections 16120, 16122, and 16124. This requirement applies to all equipment provided under this contract, regardless of Division, as well as to all conductors provided or worked on during this contract.

### 3.06 CUTTING, DRILLING, AND WELDING

- A. Provide any cutting, drilling, and welding that is required for the electrical construction work.

- B. Structural members shall not be cut or drilled, except when favorably reviewed by the Engineer. Use a core drill wherever it is necessary to drill through concrete or masonry.
- C. Provide the required welding for equipment supports. Conduits and fittings shall not be welded to structural steel.
- D. Perform patch work with the same materials as the surrounding area and finish to match, as specified in Division 3 of these Specifications.

### 3.07 METAL PANELS

- A. Mount all metal panels which are mounted on or abutting concrete walls in damp locations or any outside walls 1/4 inch from the wall, and paint the back sides of the panels with a high build epoxy primer. Film thickness shall be 10 mils minimum.

### 3.08 PROTECTIVE DEVICE COORDINATION

- A. Perform power system studies and provide protective device coordination in accordance with Section 16961.

### 3.09 TESTING

- A. Perform acceptance testing in accordance with Section 16950.
- B. Perform additional testing as indicated within specific equipment sections.

### 3.10 EQUIPMENT STORAGE AND PROTECTION

- A. During construction, provide adequate storage for all equipment and materials that will become part of the completed facility so that it is protected from weather, dust, water, and other environmental impacts, or damage from construction operations.
- B. Store and protect products in accordance with manufacturer's instructions. Seals and labels shall be intact and legible.
- C. Store moisture sensitive products including electrical equipment, instruments and controls in weathertight, humidity and temperature-controlled enclosures to avoid condensation and dust buildup.
- D. Arrange storage of products to permit access for inspection. Periodically inspect to assure products are undamaged and are maintained under specified conditions.
- E. Exercise care at all times after installation of equipment, motor control centers, etc., to keep out foreign matter, dust, dirt, debris, or moisture. Use protective sheet-metal covers, canvas, heat lamps, etc., as needed to ensure equipment protection.

### 3.11 CLEANING EQUIPMENT

- A. Before final acceptance, thoroughly clean the electrical Work of cement, plaster and other materials.
- B. Clean out and vacuum all construction debris from the bottom of all equipment.
- C. Provide and touch-up to original condition any factory painting that has been marred or scratched during shipment or installation, using paint furnished by the equipment manufacturer.

- D. Remove temporary tags, markers, stickers and the like.
- E. Remove all oil and grease spots with a non-flammable cleaning solvent by carefully wiping and scraping cracks and corners.
- F. Clean luminaires inside and out.
- G. Dispose of cleaning debris and refuse off-site.

END OF SECTION



## SECTION 16110

### ELECTRICAL RACEWAY SYSTEMS

#### PART 1 - GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish and install complete raceway systems as shown on the drawings and as specified herein.
- B. Raceways and conductors that are listed on the conduit and cable schedules are generally not shown on the Drawings, except where they are required to pass through a restricted or designated space and the Contractor would benefit from additional information. Conduit block diagrams indicate exposed conduits as solid lines and shall be run near the ceilings or along walls of the areas through which they pass and shall be routed to avoid interferences with HVAC ducts, cranes and hoists, lighting fixtures, doors and hatches, etc. Conduit block diagrams indicate concealed or buried conduits as dashed lines and shall be run in underground duct banks, center of concrete floor slabs, in partitions, or above hung ceilings as required.
- C. In the event that individual equipment loads provided are larger than indicated in the Contract Documents, revise raceways, conductors, starters, overload elements, and branch circuit protectors as necessary in order to control and protect the increased connected load in conformance to NEC requirements as part of the WORK.

##### 1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) Publications:
  - 1. C80.1 Specification for Zinc Coated Rigid Steel Conduit
  - 2. C80.5 Specifications for Rigid Aluminum Conduit
- B. Federal Specifications (FS):
  - 1. FS W C 1094 W C 1094A Conduit and Conduit Fittings, Plastic, Rigid
  - 2. FS WW C 540 WW C 540A Conduit, Metal, Rigid, (Electrical, Aluminum)
  - 3. WW C 540C Conduit, Metal, Rigid & Coupling, Elbow & Nipple, Electrical Conduit, Aluminum
  - 4. FS WW C 566 WW C 566C Flexible Metal Conduit
- C. National Electrical Manufacturers Association (NEMA) Publications:
  - 1. RN 1 Polyvinyl Chloride Externally Coated Galvanized Rigid Steel Conduit and Electrical Metallic Tubing
  - 2. TC2 Electrical Polyvinyl Chloride (PVC) Conduit
  - 3. TC 6 PVC and ABS Plastic Utilities Duct for Underground Installation
  - 4. TC14 Reinforced Thermosetting Resin Conduit (RTRC) and Fittings
- D. Underwriters Laboratories (UL) Standards:
  - 1. 6 Rigid Metal Electrical Conduit
  - 2. 6A Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless Steel
  - 3. 360 Liquid-Tight Flexible Metal Conduit
  - 4. 651 Electrical Rigid Nonmetallic Conduit and Fittings

5. 651A Type EB and A Rigid PVC Conduit and HDPE Conduit
6. 2515 Aboveground Reinforced Thermosetting Resin Conduit

### 1.03 SUBMITTALS

- A. Submit complete catalog cuts of raceways, fittings, boxes, supports, and mounting hardware, marked where applicable to show proposed materials and finishes.
- B. Prepare as-built drawings of encased concealed and exposed raceways, ducts, raceways, junction boxes, pull boxes, and electrical and instrumentation equipment.

### 1.04 LOCATIONS

- A. Refer to Section 16010 for definitions of types of locations.

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Pull and junction boxes, fittings and other indicated enclosures that are dedicated to the raceway system shall comply with the requirements of this Section.
- B. Provide exposed conduit of 3/4-inch minimum trade size and encased conduit of 1-inch minimum trade size.
- C. The use of short sections of 1/2-inch flexible conduit for final termination of field control devices and instrumentation is permitted. They may not be longer than 36 inches in length, and may only transition to the smaller size junction boxes or condulets at the field device.

### 2.02 CONDUIT RACEWAYS

- A. Galvanized Rigid Steel Conduit (GRS) shall be manufactured from mild steel, hot-dip galvanized inside and out, conforming to ANSI C80.1 and UL 6. Couplings shall be threaded type. Manufacturers shall be Allied Tube and Conduit, Wheatland Tube or approved equal.
- B. PVC coated rigid steel conduit (PGRS) shall meet the requirements of GRS above. A PVC coating shall be bonded to the outer surface with a thickness not less than 40 mils. The inside surfaces and threads of the conduit shall be provided with a 2-mil urethane coating. PGRS shall be manufactured in accordance with UL-6, ANSO C80.1 and NEMA RN1. Manufacturers shall be Robroy Industries Perma-Cote or Plasti-Bond series, Thomas & Betts Ocal Blue or approved equal.
- C. Liquidtight Flexible Conduit shall be constructed of a flexible galvanized metal core with a sunlight-resistant thermoplastic outer jacket. Conduit shall be manufactured in accordance with UL 360. Flexible conduit in hazardous areas shall be rated for the Class, Division and Group in which its installed. Manufacturers shall be Anaconda Sealtite, Electriflex Liquatite or approved equal.
- D. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be PVC Schedule 40 (PVC 40) or PVC Schedule 80 (PVC 80) and sunlight resistant. Conduit shall be approved for underground use and for use with 90°C wires, and shall conform to

NEMA TC-2 and UL 651. Manufacturers shall be Carlon, Cantex or approved equal.

## 2.03 CONDUIT SUPPORTS

- A. For indoor, dry locations, supports for individual conduits shall be galvanized malleable iron one-hole type with conduit back spacer. All other locations shall be Type 316 stainless steel.
- B. For indoor, dry locations, supports for multiple conduits shall be hot-dip galvanized Unistrut or Superstrut channels, or equal. All associated hardware shall be hot-dip galvanized. All other locations shall be Type 316 stainless steel.

## 2.04 FITTINGS

- A. General
  - 1. For use with metallic conduit, provide cast and malleable iron fittings of the threaded type with 5 full threads.
  - 2. Fittings
    - a. Provide fittings with neoprene gaskets and non-magnetic stainless steel screws.
    - b. Attach covers by means of holes tapped into the body of the fittings.
    - c. Covers for fittings attached by means of clips or clamps will not be accepted.
  - 3. Terminations
    - a. In outdoor areas, terminate conduit in rain-tight hubs as manufactured by Myers, O.Z. Gedney, Appleton or approved equal.
    - b. In other than outdoor areas, provide sealed locknuts and bushings.
- B. Fittings for use with rigid steel shall be hot dipped galvanized steel or galvanized cast ferrous metal; access fittings shall have gasketed cast covers and be Crouse-Hinds Condulets, Appleton Unilets, or equal. Provide threaded-type couplings and connectors; set-screw type and compression-type are not acceptable.
- C. Fittings for use with PVC-coated GRS conduit shall be PVC-coated that are the products of the same manufacturer as the conduit. Both male and female threads and internal surfaces shall contain a 2-mil urethane coating.
- D. Fittings for use with rigid nonmetallic conduit shall be PVC and have solvent-weld-type conduit connections. Boxes shall be manufactured of PVC or fiberglass reinforced polyester (FRP). Manufacturers shall be Carlon, Crouse-Hinds, Hoffman or approved equal. If such are not available, then the Specification for PVC coated galvanized rigid steel fittings shall apply.
- E. Fittings for flexible conduit shall be Appleton Type ST, O.Z. Gedney Series 4Q, or approved equal.
- F. Combination expansion-deflection fittings with internal grounding shall be installed where conduit movement is expected in more than one dimension, and where conduits transition out of structures in locations where differential settlement may occur. Combination expansion/deflection fittings shall be manufactured by Crouse-Hinds Type XJGD or approved equal.
- G. Expansion fittings with internal grounding shall be installed wherever exposed raceway cross building expansion joints. Expansion fittings shall be Crouse Hinds Type XLGSA or approved equal.



- H. Union couplings for conduits shall be the Erickson type and shall be Appleton Type EC, O.Z. Gedney 3-piece Series 4, or approved equal. Threadless couplings shall not be used.
- I. Bushings:
  - 1. Bushings shall be the insulated type.
  - 2. Bushings for rigid steel conduit shall be hot dip galvanized insulated grounding type, O.Z. Gedney Type HBLG, Appleton Type GIB, or approved equal.
- J. Conduit seals in hazardous areas shall have zinc electroplate and shall be Crouse-Hinds Type EYS or EZS; Appleton Type EYS, ESU, or EY series; or approved equal.

## 2.05 BOXES

- A. Boxes specified herein are for use with raceway systems only. Boxes used for housing electrical and instrumentation equipment shall be as described elsewhere in these Specifications.
- B. NEMA 1 Areas: NEMA 1 terminal boxes, junction boxes, pull boxes, etc. shall be either sheet or cast malleable iron or aluminum depending on raceway material. Boxes shall be suitable for wall mounting or have feet where self-standing. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. All boxes shall have hinged gasketed doors with quarter turn latches or 3-point latch (single operator) system on enclosures larger than 36 inches wide or 32 inches tall. Terminal boxes shall be furnished with terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20A, 600V. Boxes shall be Concept Series as manufactured by Hoffman Engineering Co. or approved equal.
- C. NEMA 4X Areas: NEMA 4X terminal boxes, junction boxes, pull boxes, etc. shall be Type 316 stainless steel. Boxes shall be suitable for wall mounting or have feet where self-standing. Boxes shall have continuously welded seams and welds shall be ground smooth. Box bodies shall be flanged and shall not have holes or knockouts. Box bodies shall not be less than 14 gauge metal and covers shall not be less than 12 gauge metal. All boxes shall have hinged gasketed doors with quarter turn latches or 3-point latch (single operator) system on enclosures larger than 36 inches wide or 32 inches tall. Terminal boxes shall be furnished with terminal mounting straps and brackets. Terminal blocks shall be NEMA type, not less than 20A, 600V. Boxes shall be Concept Series as manufactured by Hoffman Engineering Co. or approved equal.
- D. NEMA 7 Areas: Explosion-proof boxes shall be designed for the Class, Division and Group with which it is to be installed. Boxes shall have O-ring seals to meet NEM 4 requirements. Boxes shall be aluminum, with stainless steel hinged covers and stainless steel bolts. Boxes shall be as manufactured by Crouse Hinds Type EJB-N4, Appleton Electric, Adalet PLM or approved equal.

## 2.06 CONDUIT SEALANTS

- A. Moisture Barrier Types: Sealant shall be a non-toxic, non-shrink, non-hardening, putty type hand applied material providing an effective barrier under submerged conditions.
- B. Fire Retardant Types: Fire stop material shall be a reusable, non-toxic, asbestos-free, expanding, putty type material with a 3 hour rating in accordance with UL 1479. Provide products indicated by the manufacturer to be suitable for the type and size of penetration.

## PART 3 - EXECUTION

### 3.01 CONDUIT, RACEWAY AND FITTING INSTALLATION

- A. No wire shall be pulled until the raceway system is complete in all details; in the case of concealed work, until all rough plastering or masonry has been completed; in the case of exposed work, until the raceway system has been completed in every detail.
- B. From pull point to pull point, the sum of the angles of all of the bends and offsets shall not exceed 270 degrees.
- C. Coat threads with a conductive lubricant before assembly.
- D. Provide joints that are tight, thoroughly grounded, secure and free of obstructions by use of a mandrel. Adequately ream the conduit in order to prevent damage to the wires and cables inside. Use strap wrenches and vises to install the conduit in order to prevent wrench marks on the conduit. Any conduit with wrench marks shall be replaced.
- E. The ends of all conduits shall be tightly plugged to exclude dust and moisture during construction. Duxseal, or 3M seal spray shall be used in all applications. Plugging with tape is prohibited, even for short periods of time.
- F. For power, control and signal circuits, provide conduit per Conduit Use Tables below, unless specifically indicated otherwise on the Drawings:
  - 1. Exception: For raceways leaving a building above grade and then going below grade, provide PVC-coated GRS from a point 3 feet above grade to a point 5 feet from the building wall.
- G. Unless boxes have cast, threaded hubs, provide insulated type metallic grounding bushings for metallic conduits at all boxes. Bond together all conduits to provide continuity of the equipment grounding system. Size bonding conductor per NEC.
- H. Provide flexible conduit in lengths of not more than 36 inches at connections to motors, valves and any equipment subject to vibration or relative movement. All flexible conduits, regardless of length or manufacturer rating, shall have a dedicated ground bonding conductor pulled through, whether it is included in the conduit fill schedules or not.
- I. Damage to PVC coating of coated conduits or fittings shall be repaired with factory-approved PVC patching material to the original factory condition.

- J. Install fiberglass conduit in accordance with the manufacturer's instructions. Connections between sections of conduit may be either glued or threaded, at the Contractor's option.
- K. Underground Raceways: Slope all underground raceways to provide drainage; for example, slope conduit from equipment located inside a building to the handhole located outside the building. For additional requirements see Section 16402.
- L. Conduit Supports: Properly support all conduits as required by the NEC. Run all conduits exposed except where the Drawings indicate that they are to be embedded in the floor slab, walls, or ceiling, or to be installed underground.
  - 1. Exposed Conduits:
    - a. Support exposed conduits within 1 foot of any outlet and at intervals not exceeding NEC requirements; wherever possible, group conduits together and support on common supports. Support exposed conduits fastened to the surface of the concrete structure by one-hole clamps, or with channels. Use conduit spacers with one-hole clamps. Coordinate conduit locations with piping, equipment, fixtures, and with structural and architectural elements. Conduits attached to walls or columns shall be as unobtrusive as possible and shall avoid windows. Run all exposed conduits parallel to building lines. No diagonal runs will be accepted. Bends in parallel runs shall be concentric and shall be run straight and true.
    - b. Group together exposed conduits in horizontal runs located away from walls and support on trapeze hangers. Arrange such conduits uniformly and neatly. Trapeze hangers shall consist of channels of adequate size, suspended by means of minimum 3/8" diameter rods or other suitable means from the ceiling or from pipe hangers. Install such runs so as not to interfere with the operation of valves or any other equipment, and keep at least 6 inches clear of any pipe which may operate at more than 100°F. Treat cut surfaces or damaged ends with corrosion-resistant coatings such as "Devcon Z", prepared by Subox Coatings; "Galvanox Type I", prepared by Pedley-Knowles; or approved equal. Application shall follow manufacturer's recommendation.
- M. All penetrations through walls into or out of corrosive locations, as defined in Section 16010 shall be made gas-tight. In concrete walls, pour concrete after the conduit is in place, if possible. If not, core drill concrete or CMU walls, install conduit and caulk around it with non-shrink grout. Install conduit seal in each conduit near the penetration.
- N. All conduit penetrations through interior walls and floors shall be sealed with fire retardant type conduit sealant.
- O. Conduit Identification: In each handhole, pullbox, cabinet, motor control center or other equipment enclosure, identify each conduit using the conduit number shown on the Drawings by means of a stamped brass tag affixed with stainless steel wire; where affixing a tag is not feasible, identify conduits by affixing a brass tag with epoxy or other approved method of stenciling to the wall or structure adjacent to the conduit terminus.
- P. Conduit Seals:
  - 1. Moisture Seals: Provide in accordance with NEC Paragraph 300.5(g).
  - 2. Gas Seals: Provide in accordance with NEC Paragraph 501.5.



- Q. Aluminum conduit shall not be installed underground or encased in concrete. If necessary to run through concrete, install in a non-metallic conduit sleeve or use PVC coated conduit.
- R. Rigid PVC conduit shall be stored on a flat surface and shielded from the sun.

**CONDUIT USE TABLE 1**

	Inside	
	Exposed	
Circuit Type	Standard	Hazardous
Power & 120 Vac Control	GRS	PVC Coated GRS
Signal	GRS	PVC Coated GRS

**CONDUIT USE TABLE 2**

Circuit Type	Outside			Transition
	Exposed	Buried In Soil	Duct Bank Encased In Concrete	Within 5 Feet of Building
Power & 120 Vac Control	PVC Coated GRS	PVC Coated GRS	PVC-40	PVC Coated GRS
Signal	PVC Coated GRS	PVC Coated GRS	GRS	PVC Coated GRS

\* Provide ground wire sized per NEC requirements for all circuits.

Notes:

1. Generally, the Conduit Use Tables apply.
2. Signal circuits are those subject to RF interference or induced current. MSPs, TSPs, telephone cable, coaxial cable, and manufacturer's cables specially designed for low level signals are all presumed to be part of signal circuits.

END OF SECTION

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## SECTION 16120

### LOW VOLTAGE WIRE AND CABLE

#### PART 1 - GENERAL

##### 1.01 SCOPE OF WORK

- A. Furnish labor, materials, equipment and incidentals necessary to install wire and cable specified under this Section. Electrical work shall be in accordance with Specification 16010 – General Electrical Requirements.
- B. Work shall include building wire, cable, wiring connections and terminations and modular wiring systems.

##### 1.02 REFERENCE STANDARDS

- A. American Society for Testing and Materials (ASTM):
  - 1. B3-74 Specification for Soft or Annealed Copper Wire
  - 2. B8-77 Specification for Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard, or Soft
  - 3. B173-71 Specification for Rope Lay Stranded Copper Conductors Having Concentric Stranded Members
- B. Insulated Cable Engineers Association (ICEA):
  - 1. S-66-524 Cross-Linked Thermosetting Polyethylene Insulated Wire and Cable
- C. International Electrical Testing Association (NETA);
  - 1. ATS Acceptance Testing Specifications
- D. National Electrical Manufacturers Association
  - 1. WC-3 Rubber Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
  - 2. WC-5 Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
- E. Underwriters Laboratories (UL) Standards:
  - 1. 62 Flexible Cords and Fixture Wire
  - 2. 510 Insulating Tape
  - 3. 1063 Stranded Conductors for Machine Tool Wire

##### 1.03 SUBMITTALS

- A. Submit the following material or equipment data:
  - 1. Each type of cable and wire to be used.
  - 2. Cable and wire splices
  - 3. Wire markers

##### 1.04 DELIVERY, STORAGE AND HANDLING

- A. The Contractor shall protect all cable and wire from being damaged at all times.
- B. Cable ends shall be protected from water entry in accordance with the manufacturer's recommended procedures. Cable ends shall not be left open in



manholes or other locations subject to submergence. If the cable ends become submerged prior to splicing or termination, the cables shall be replaced in their entirety.

- C. Cables shall be pulled into raceways in accordance with the manufacturer's requirements. Under no circumstances shall cable pulling tensions exceed the manufacturer's written instructions.
- D. Pulling tensions on raceway cables shall be within the limits recommended by the cable manufacturer. Wire pulling lubricant, where needed, shall be UL approved.

## PART 2 - PRODUCTS

### 2.01 CONDUCTORS

- A. General: Conductors, include grounding conductors, shall be stranded copper. Aluminum conductor and/or solid conductor wire and cable will not be permitted. Insulation shall bear the UL label, the manufacturer's trademark, and identify the type, voltage, and conductor size. Conductors except flexible cords and cables, fixture wires, and conductors that form an integral part of equipment such as motors and controllers shall conform to the requirements of Article 310 of the National Electric Code, latest edition, for current carrying capacity. Flexible cords and cables shall conform to Article 400, and fixture wires shall conform to Article 402. Wiring shall have wire markers at each end.
- B. Power and Control Conductors, 600 Volts and Below:
  - 1. Solid copper wires shall be 600 volt Type XHHW, sizes #12 and #10 AWG for use with lighting and receptacle circuits only.
  - 2. Stranded copper wire for power circuits shall be 600 volt Type XHHW or RHW, Class B stranding, sizes #12 AWG and larger.
  - 3. Stranded copper wire for control circuits shall be 600 volt Type XHHW or RHW, Class B stranding, size #14 AWG.
  - 4. Control wires inside panels and cabinets shall be machine tool grade type MTW, UL approved, rated for 90 degrees C at dry locations.
  - 5. Fixture wire shall be 600 volt, silicone rubber insulated, 200°C, UL Type SF 2, with stranded copper conductors.
  - 6. Cords shall be 600 volt, 2 conductor plus ground, Type SO, hard service, of adequate length and with grounding type plug attached, rated in amperes as shown on the Drawings.
  - 7. Conductors for feeders as defined in Article 100 of the NEC shall be sized to prevent a voltage drop exceeding 3 percent at the farthest outlet of power, heating, and lighting loads, or combinations of such loads, and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.
  - 8. Conductors for branch circuits as defined in Article 100 of the NEC shall be sized to prevent voltage drop exceeding 3 percent at the farthest connected load or combinations of such loads and where the maximum total voltage drop on both feeders and branch circuits to the farthest connected load does not exceed 5 percent.

## 2.02 SPLICES AND TERMINATIONS OF CONDUCTORS

## A. Splices:

## 1. Wire and Cable Splicing Materials and Applications:

- a. For Lighting Systems and Power Outlets: Wire nuts shall be twist-on type insulated connectors utilizing an outer insulating cover and a means for connecting and holding the conductors firmly. They shall be UL listed and suitable for connecting two to four solid copper conductors of #14 or #12 AWG size or two or three #10 AWG solid copper conductors.
- b. All Equipment: Crimp type connectors shall be insulated type with nylon jacket, suitable for the size and material of the wires and the number of wires to be spliced and for use with either solid or stranded conductors. They shall be UL listed.
- c. Division 16 Equipment and Power Conductors: Bolted pressure connectors shall be suitable for the size and material of the conductors to be spliced. They shall be UL listed and of the split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor.
- d. All Equipment: Epoxy splice kits shall include epoxy resin, hardener, and mold, and shall be suitable for use in wet locations and hazardous locations.

## B. Terminations:

## 1. Low Voltage Terminations:

- a. Crimp type terminals shall be UL listed, self-insulating sleeve type, with ring or rectangular type tongue, suitable for the size and material of the wire to be terminated, and for use with either solid or stranded conductors.
- b. Terminal lugs shall be UL listed and of the split bolt or bolted split sleeve type in which the bolt or set screw does not bear directly on the conductor. Tongues shall have NEMA standard drilling.
- c. Crimp with manufacturer recommended ratchet-type tool with calibrated dies. Hand crimping tools are not acceptable.

## C. Tape used for splices and terminations shall be compatible with the insulation and jacket of the cable and shall be of plastic material. Tape shall conform with UL 510. Varnished cambric, rubber and thermoplastic tape shall be used for all split-bolt terminations.

## D. Wire markers shall be heat shrink type (Raychem; T&amp;B; or equal). Wire identification numbers shall be permanently imprinted on the markers. In locations which are not practical for heat shrink type labels, such as conduit bodies and small pull boxes, machine-printed, adhesive backed wire markers shall be used. Markers shall be custom-printed with the full identification string. Individual character markers and clip-on wire markers are not acceptable.

## PART 3 - EXECUTION

### 3.01 CONDUCTOR INSTALLATION

- A. The Contractor shall provide, terminate and test all power, control, and instrumentation conductors.
- B. The Contractor shall, as a minimum, provide the number of control wires listed in the conduit schedule or on the Contract Drawings. Excess wires shall be treated as spares for future use.
- C. Conductors shall not be pulled into any raceway until raceway has been cleared of moisture and debris.
- D. Wire in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be neatly fanned out to terminals.
- E. Provide the following types and sizes of conductors for the uses indicated for 600 volts or less:
1. Solid Copper, Sizes #12 and #10 AWG: As shown on the Drawings for circuits for receptacles, switches and light fixtures with screw-type terminals.
  2. Stranded Copper, Size #14 AWG and Larger, Individual Conductors or CC: As shown on the Drawings for the control of motors or other equipment. Size #14 shall not be used for power supplies to any equipment.
  3. Stranded Copper, Sizes #12 AWG and Larger: As shown on the drawings for motors and other power circuits.
  4. Stranded Copper, #6 AWG and Larger.
  5. Fixture Wire: For connections to all fixtures in which the temperature may exceed the rating of branch circuit conductors.
- F. Color Coding: All wire shall be coded with specific colors infused in the conductor insulation at the time of manufacture. If a conductor is specified in a gauge not available with integrally colored insulation, it shall be marked by the Contractor at the time of installation using colored electrical coding tape or an approved marking paint. Where tape or paint is used as the conductor identification system, it shall clearly distinguish the conductor over its entire exposed length in all junction boxes, manholes, conduit bodies, or other accessible intermediate locations, and at every termination. All wiring shall conform to the following wiring color code:

SYSTEM	CONDUCTOR	COLOR
120/240 Volt AC, 1-Phase, 3 Wire	Neutral Line 1 Line 2	White Black Red
120/208 Volt AC, 3-Phase, 4 Wire;	Neutral Phase A Phase B Phase C	White Black Red Blue
277/480 Volt AC, 3-Phase 4 Wire	Neutral Phase A Phase B Phase C	Grey Brown Orange Yellow

SYSTEM	CONDUCTOR	COLOR
All Systems	Earth, System, or Equipment Ground	Green Insulation, Green w/ Yellow Tracer, or Bare Conductor
120 Volt AC Control Power Circuits (In field or in Control Cabinets)	Neutral Line 1 Line 2	White Black Red
120 Volt AC UPS-derived Control Power (secondary side)	Neutral Line	White w/ Red Tracer Red w/ White Tracer
24 VAC Control Power Circuits (In field or in Cabinets)	Neutral Line	White or Grey, with Yellow Tracer Brown
12 or 24 Volt DC Control Wiring (PLC Discrete I/O, etc.)	DC Negative DC Positive DC Switched (DI/DO)	Yellow Orange Blue
120 Volt AC Control Wiring inside or outside cabinets to/from PLC Discrete I/O	Common or Neutral 120 VAC discrete inputs 120 VAC relay or discrete outputs	White or Grey, w/ Blue Tracer Blue Red
Instrumentation Twisted-shielded Cabling (PLC Analog I/O @ 4-20mA, or 1-5 Volt DC, etc.) Process Signals to/from Transmitters, Analyzers, etc.	Negative Polarity Positive Polarity (1st Conductor) Positive Polarity (2nd Conductor) Shield Drain Wire	Black White (or clear)  Red  Bare Conductor, or covered w/ heat-shrink tubing of a unique color
Instrumentation wiring in cabinets (PLC Analog I/O from field terminations of shielded cables).	PLC Analog Input Connections PLC Analog Output Connections	Grey  Brown

- G. Exercise care in pulling wires and cables into conduit or wireways so as to avoid kinking, putting undue stress on the cables or otherwise abrading them. No grease will be permitted in pulling cables. Only soapstone, talc, or UL listed pulling compound will be permitted. The raceway construction shall be complete and protected from the weather before cable is pulled into it. Swab conduits before installing cables and exercise care in pulling, to avoid damage to conductors.
- H. Wrap all cables in manholes with fireproofing tape. Extend tape 1-inch into ducts.
- I. Cable bending radius shall be per applicable code. Install feeder cables in one continuous length unless splices are favorably reviewed.
- J. Provide an equipment grounding conductor, whether or not it is shown on the Drawings, in any flexible conduit or any raceway in which all or any portion of a run consists of non-metallic duct or conduit. For flexible conduit, an external bonding jumper is an acceptable alternative.



- K. In panels, bundle incoming wire and cables, No. 6 AWG and smaller, lace at intervals not greater than 6 inches, neatly spread into trees and connect to their respective terminals. Allow sufficient slack in cables for alterations in terminal connections. Perform lacing with plastic cable ties or linen lacing twine. Where plastic panel wiring duct is provided for cable runs, lacing is not necessary when the cable is properly installed in the duct.
- L. For cables crossing hinges, utilize extra flexible stranded wire, make up into groups not exceeding 12, and arrange so that they will be protected from chafing and excess flexing when the hinged member is moved.

### 3.02 CONDUCTOR SPLICES AND TERMINATIONS

- A. Splices: Install all conductors without splices unless necessary for installation, as determined by the Engineer. Splices, when permitted, and terminations shall be in accordance with the splice or termination kit manufacturer's instructions. Splice or terminate wire and cable as follows:
  - 1. Watertight Splices: Splices in concrete pullboxes, for any type of cable or wire, shall be watertight and rated for continuous submergence. Make splices in low voltage cables using epoxy resin splicing kits rated for application up to 600 volts.
- B. Terminations:
  - 1. Terminate stranded #14 wire using crimp type terminals where not terminated in a box lug type terminal. Terminals must be coordinated with type of terminal board where provided.
  - 2. Excess control wire shall be long enough to terminate at any terminal block in the enclosure, be properly taped, be identified with origin and be neatly coiled.

### 3.03 CONDUCTOR IDENTIFICATION

- A. Except for interior lighting and receptacle circuits, identify each wire or cable at each termination and in each pullbox, junction box, handhole, and manhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer.
- B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

### 3.04 FIELD TESTS

- A. Refer to Specification 16950 – Electrical Tests for all cable testing requirements.

END OF SECTION

## SECTION 16124

### SIGNAL CABLE

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Related Work Described Elsewhere:
  - 1. Division 17: Instrumentation and Controls

##### 1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA):
  - 1. 568-C.2 Balanced Twisted-Pair Telecommunications Cabling and Components Standards
- B. American Society for Testing and Materials (ASTM):
  - 1. B8-11 Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- C. Institute of Electrical and Electronic Engineers (IEEE):
  - 1. 1143 Shielding Practice for Low Voltage Cables, Guide on
- D. Insulated Cable Engineers Association (ICEA)
  - 1. S-73-532 Standard for Control, Thermocouple, Extension, and Instrumentation Cable
- E. National Fire Protection Association (NFPA):
  - 1. 262 Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces
- F. Underwriters Laboratories Incorporated (UL):
  - 1. 13 Standard for Power-Limited Circuit Cables
  - 2. 83 Thermoplastic-Insulated Wires and Cables
  - 3. 444 Communications Cables
  - 4. 1666 Standard for Test for Flame Propagation Height of Electrical and Optical-Fiber Cables Installed Vertically in Shafts

##### 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Information category of the General Conditions and the submittal requirements of Section 16010.

#### PART 2 - PRODUCTS

##### 2.01 INSTRUMENTATION CABLE

- A. Provide UL listed, twisted pair instrumentation Tray Cable (TC) conforming to ICEA S-73-532, and suitable for transmission of 4-20mA analog, low voltage signals.

- B. The cable shall be two-conductor (2/C), three-conductor (3/C), four-conductor (4/C), or more as indicated on the Drawings.
- C. Each conductor in the cable shall be #16 AWG 7x24 stranded bare copper, or as indicated on the Drawings.
- D. Conductor insulation: Polyvinyl Chloride/Nylon
- E. Shield: Aluminum Foil, 100 percent coverage
- F. Drain wire: #18 AWG, stranded, tinned copper
- G. Jacket material: Polyvinyl Chloride, minimum thickness 0.047 inches.
- H. Insulation shall be rated at 600 volts.
- I. Temperature rating: UL dry, 90 degrees C; UL web, 75 degrees C
- J. Instrumentation cable installed in underground conduits shall be rated as suitable for the application.
- K. Instrumentation cable shall be Belden 3090A, 3091A, or approved equal.

## 2.02 ETHERNET (TCP/IP) CABLE

- A. Industrial use, unshielded:
  1. Provide UL listed, Category 6 unshielded twisted pair (UTP) Ethernet cable conforming to ANSI/TIA-568-C.2 and suitable for use in harsh environments.
  2. Conductors: 4 pairs of #23 AWG solid bare copper
  3. Conductor insulation: Fluorinated Ethylene Propylene, minimum thickness 0.01 inches
  4. Jacket material: Fluorinated Ethylene Propylene, factory marked at regular intervals indicating verifying organization and performance level. Minimum thickness 0.03 inches.
  5. Insulation shall be 600 volt class.
  6. Insulation temperature range: -55 to +150 degrees C
  7. Electrical Characteristics: Cable shall have a maximum attenuation of 20 dB per 100 meters at 100 MHz and 33 dB per 100 meters at 250 MHz
  8. Terminations/Connectors: Cables shall terminate in Category 6 RJ-45 crimp connectors with strain-relief boots, or at Category 6 punch down blocks at both ends.
  9. Cable shall be plenum-rated for flammability in accordance with NFPA 262, and suitable for use as riser cable.
  10. Ethernet cable installed in underground conduits shall be rated as suitable for the application.
  11. Industrial, unshielded Ethernet cable shall be Belden 7931A or approved equal.

## 2.03 ANTENNA FEEDER CABLE

- A. Antenna feeder cable shall be coaxial type suitable for use with a 450 MHz radio system.
- B. Use only coaxial cable recommended for specific applications such as radio antenna systems as required by the radio manufacturer or system supplier. Due to wide differences in electrical ratings and physical characteristics between cable

types, any deviations from manufacturers recommended types, cable is not acceptable.

## PART 3 - EXECUTION

### 3.01 CABLE INSTALLATION

- A. Signal cable shall be installed by personnel who have a minimum of 3 years' experience in terminating and splicing shielded twisted pair cables and coaxial cables.
- B. Adequate care shall be exercised by the installers to prevent cable damage or sheath distortion. Bending radius shall not be less than 10 times the cable outside diameter.
- C. Raceways shall be swabbed before installation of cable to remove moisture and debris.
- D. Cables shall be continuous from initiation to termination without splices except where specifically indicated.
- E. Cable shielding shall be grounded at one end only of the cable. Bonding shall be to a single ground point only. Bonding from cable to cable in multiple run installations shall not be permitted.
- F. Heat shrinkable sleeving shall be installed on all cables to insulate shielding at the ungrounded cable terminations.
- G. Signal cable shall not be run in the same raceway with power and control wiring except where specifically indicated.
- H. Where installed in control consoles containing power circuits, cables shall be routed a minimum of 2 inches distant. Color coding shall be strictly observed throughout the installation.
- I. Cable in panels, cabinets, and wireways shall be neatly grouped using nylon tie straps, and shall be fanned out to terminals.
- J. Manufacturer's cable pulling tension shall not be exceeded.
- K. Pulling lubricant shall be UL approved.

### 3.02 CONDUCTOR SPLICES AND TERMINATIONS

- A. Splices: Install all conductors without splices unless necessary for installation, as determined by the Engineer. Splices, where approved, and terminations shall be in accordance with the splice or termination kit manufacturer's instructions.
- B. Terminations:
  - 1. Crimp-type terminals shall be UL listed, self-insulating, sleeve type with ring or rectangular tongue, suitable for size and material of the wire to be terminated and for use with either stranded or solid wire. Spade type lugs are acceptable with telephone cable systems only.
  - 2. Crimp with manufacturer's recommended ratchet-type tool with calibrated dyes. Hand crimping tools are not acceptable.
  - 3. Coaxial cable and connectors shall be terminated in accordance with the manufacturer's instructions.



### 3.03 CONDUCTOR IDENTIFICATION

- A. Identify each wire or cable at each termination, in each pullbox, and in each handhole using numbered and lettered wire markers. All electrically common conductors shall have the same number. Each electrically different conductor shall be uniquely numbered. Identify panelboard circuits using the panelboard identification and circuit number. Identify motor control circuits using the equipment identification number assigned to the control unit by the motor control center manufacturer and the motor control unit terminal number. Identify other circuits as shown in the circuit schedule or as favorably reviewed by the Engineer. Conductor numbering shall be coordinated with the Interconnection Diagrams specified in Division 17.
- B. Conductors between terminals of different numbers shall have both terminal numbers shown at each conductor end. The terminal number closest to the end of the wire shall be the same as the terminal number.

### 3.04 FIELD TESTS

- A. Perform testing in accordance with Section 16950 – Electrical Tests.

END OF SECTION

## SECTION 16140

### WIRING DEVICES

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included:
  - 1. Installation, connection and furnishing all single, duplex, GFI and special purpose receptacles complete with wall plates and/or covers as shown on the Drawings.
  - 2. Installation, connection and furnishing of all single pole, three-way, pilot light and momentary position toggle switches complete with wall plates and or handle operators as shown on the Drawings.

##### 1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) Publication:
  - 1. C73 Plugs and Receptacles
  - 2. C73a Plugs and Receptacles
  - 3. 568 Communication Cables
- B. Federal Specifications (FS):
  - 1. W-C-596 D & E General Specifications for Cable Outlet Electrical Connector
  - 2. W-S-896 D & E General Specifications for Flush Mounted Toggle and Lock Switches
- C. National Electrical Manufacturers Association (NEMA) Publications:
  - 1. WD 1 General Color Requirements for Wiring Devices
  - 2. WD 6 Wiring Devices - Dimensional Specifications
- D. Underwriters Laboratories (UL) Standards:
  - 1. 20 General-Use Snap Switches
  - 2. 498 Standard for Attachment Plugs and Receptacles
  - 3. 514 Electrical Outlet Boxes
  - 4. 943 Ground-Fault Circuit-Interruptioners

##### 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Information category of the General Requirements and the submittal requirements of Section 16010.
- B. Submit complete catalog cuts of switches, receptacles, enclosures, covers and appurtenances, marked to clearly identify the proposed materials.
- C. Submit documentation showing that the proposed materials comply with the requirements of the NEC and UL.

## 1.04 LOCATIONS

- A. Refer to Section 16010, General Electrical Requirements, for definitions of types of locations.

## PART 2 - PRODUCTS

### 2.01 RECEPTACLES

- A. General: Receptacles shall be heavy duty, high abuse, grounding type conforming to NEMA configurations, NEMA WD1 and UL 514 Standards.
- B. Single and Duplex Receptacles:
  - 1. Receptacles shall be of back and side wire design utilizing screw type terminals. Receptacles shall be rated 20 ampere, two-pole, 3-wire, 120-volt, NEMA 5-20 configuration, self-grounding. Color shall be brown in industrial areas and ivory or white in office and laboratory areas. Power contacts shall be a T-type design and shall be brass. Ground contacts shall be brass.
  - 2. Devices shall have a nylon composition face with a nylon or melamine body. Units shall comply with Federal Specification W-C-596E and meet UL 498 test requirements. Receptacles shall be Hubbell HBL Series; Daniel Woodhead; or equal.
- C. GFI Receptacles:
  - 1. Device shall be rated 20 ampere, 2 pole, 3 wire, 120 volt, conforming to NEMA WD-1 configuration. Face shall be nylon composition meeting UL 498 test standards. Unit shall have test and reset push buttons. Reset push button shall have a visible indicator band to indicated tripped condition.
  - 2. GFCI component shall meet UL 498 Class A standards with a tripping time of 1/40 second at 5 milliamperes current unbalance. Operating range shall extend from 31°F to 158°F. Unit shall have transient voltage protection and shall be ceramic encapsulated for protection against moisture.
  - 3. Provide Hubbell 5362SG, Daniel Woodhead, or equal.
- D. Explosion Proof Receptacles: Devices shall be UL listed for use in Class 1, Division 1 or Division 2, or for Class 2, Division 1 areas as indicated on the Drawings. Units shall be factory sealed types where available and shall contain disconnecting mechanisms which must function prior to plug withdrawal or after insertion.
  - 1. All 20 amp, 125 and 250 volt, 2 pole, 3 wire receptacles shall be NEMA 5-20R and NEMA 6-20R. Receptacles shall be UL classified as interchangeable with male plugs of other manufacturers. Provide Killark KRS series; Crouse-Hinds; or equal.
  - 2. For corrosive areas, devices shall be Killark KP Series non-metallic plugs and switched receptacles suitable for Class 1, Division II Groups A, B, C, D; Class 2, Division I and II E, F, G; and Class 3, NEMA 3, 3R, 3S, 7, Division II and NEMA 9; Crouse-Hinds; or equal.

### 2.02 SWITCHES

- A. Line Voltage Types: Switches shall be rated 20 amperes at 120 or 277 Volts ac only. Units shall be flush mounted, self-grounding, quiet operating toggle devices. Handle color shall be brown in industrial areas and white or ivory in office and laboratory areas. Units shall conform to Federal Specifications W-S-896 D and E,

UL 20, and NEMA WD1 standards. Hubbell PRO Series; Daniel Woodhead; or equal.

- B. Explosion Proof Types: Units shall conform to the standards listed in Item A above, but in addition shall have UL listings for use in hazardous areas classified as Class 1, Division I or II, and Class 2, Division I. Units shall be factory sealed devices. Material shall be copper-free aluminum for metallic types. Provide Crouse Hinds EDS Series; Killark; or equal. Provide fiberglass or polyamide for non-metallic types.

## 2.03 PLATES

- A. General: Plates shall be of the style and color to match the wiring devices, and of the required number of gangs. Plates shall conform with NEMA WD1, UL 514, and ANSI C73. Plates on finished walls shall be non-metallic or stainless steel. Plates on unfinished walls and on fittings shall be of zinc plated steel or cast metal having rounded corners and beveled edges.
- B. Galvanized: Plates shall be galvanized sheet steel raised 1/2 inch, with rounded corners.
- C. Cast Metal: Plates shall be cast or malleable iron covers with gaskets so as to be moisture resistant or weatherproof.
- D. Damp or Wet and Corrosive Locations: Plates shall be provided with a hinged non-metallic cover/enclosure marked with "Suitable for Wet Locations when in use" and "UL Listed." Provide a gasket between the enclosure and the mounting surface, and between the hinged cover and mounting plate/base. The cover shall be TayMac Specification Grade; or equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION OF WIRING DEVICES

- A. Rigidly attach wiring devices in accordance with the NEC and as indicated, avoiding interference with other equipment.
- B. Damp or Wet Exterior Locations: Install only wiring devices approved for outdoor service in these locations.
- C. Mounting Heights: Locations of wall outlets shall be measured from the finished floor to the center of the outlet box. Boxes shall be adjusted so that the front edge of the box shall not be further back from the finished wall plane than 1/4 inch. Boxes shall be adjusted so that they do not project beyond the finished wall. Height above finished floor shall be as follows:

	<u>Inches From Floor</u>
Receptacles - Industrial Areas	46
Toggle Switches	46

- D. Damp or Wet Interior Locations: Install only wiring devices approved for outdoor service. Adjust boxes so that front edge will be 1/4 inch beyond the rear edge of the finished wall. Use metal tubing sleeves to bring device mounting straps flush with the front edge of the finished wall.
- E. Receptacles:



1. Receptacles shall be grounded by a grounding conductor, not by a yoke or screw contact.
2. Receptacles shall be oriented so that the grounding slot is located at the top of the outlet.
3. Receptacles shall be installed with connections pigtailed (spliced) to the branch circuit wiring so that removal of the receptacle will not lose neutral continuity and branch circuit power will not be lost to other receptacles on the same circuit.

### 3.02 INSTALLATION OF WALL PLATES

- A. General: Plates shall match the style of the device and shall be plumb within 1/16-inch of the vertical or horizontal.
- B. Exterior and/or Wet Locations: Install plates with gaskets on wiring devices in such a manner as to provide a raintight weatherproof installation. Cover type shall match box type.

### 3.03 GROUNDING

- A. Devices including switches and receptacles, shall be grounded in accordance with NEC, Article 250 and Specification 16450.
- B. Switches and associated metal plates shall be grounded through the switch mounting yoke, outlet box, and raceway system.

### 3.04 TESTS

- A. See Specification 16950 for Testing Requirements.

END OF SECTION

## SECTION 16160

### PANELBOARDS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provide panelboards complete and operable, in accordance with the Contract Documents.
- B. Single Manufacturer: Like products shall be the end product of one manufacturer in order to achieve standardization of appearance, operation, maintenance, spare parts, and manufacturer's services.

##### 1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI):
  - 1. Z55.1 Gray Finishes for Industrial Apparatus and Equipment
- B. National Electrical Manufacturers Association (NEMA):
  - 1. PB1 Panelboards
  - 2. 250 Enclosures for Electrical Equipment (1,000 Volts Maximum)
- C. Federal Specifications (FS):
  - 1. W-P-115 Panel, Power Distribution
  - 2. W-C-375 Circuit Breakers, Molded Case, Branch Circuit, and Service
- D. Underwriters Laboratories (UL):
  - 1. 50 Enclosures for Electrical Equipment, Non-Environmental Considerations
  - 2. 67 Standard for Panelboards
  - 3. 869A Reference Standard for Service Equipment
  - 4. 1699 Standard for Arc-Fault Circuit-Interrupters
- E. National Fire Protection Association (NFPA):
  - 1. 70 National Electrical Code (NEC)

##### 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.
- B. Shop Drawings: For each panelboard, submit manufacturer's name and data as required:
  - 1. Bill of materials.
  - 2. Panelboard enclosure type.
  - 3. Main bus and terminal connection sizes.
  - 4. Main bus configuration
  - 5. Bus materials
  - 6. Location of line connections.
  - 7. Scaled and dimensioned cabinet drawings showing conduit entrance and exit locations.
  - 8. Gutter space.

9. Gauge of boxes and fronts
  10. Finish data.
  11. Voltage rating.
  12. Continuous current rating.
  13. Short circuit rating.
  14. Breaker types, trip ratings, and interrupting ratings.
  15. Mounting method.
  16. Circuit breaker layout drawing with dimensions and nameplate designations matching the Drawings.
- C. Submit catalog cuts for panelboard, circuit breakers, protective devices, metering, and any other included accessories.
- D. Submit time current curves for each circuit breaker type included.
- E. Submit field acceptance test results.

#### 1.04 LOCATIONS

- A. Refer to Section 16010 for definitions of types of locations.

### PART 2 - PRODUCTS

#### 2.01 GENERAL

- A. Panelboards shall be factory assembled, dead-front units conforming to NEMA PB 1, UL 50, and UL 67. All panelboards shall be UL labeled.
- B. Unless otherwise indicated, provide enclosure types to match the ratings required for the location in which the panelboard is installed, in accordance with Section 16010.
- C. Provide service entrance rated panelboards where used as a service entrance. Service entrance rated panelboards shall conform to UL 869A and be labeled as such.
- D. Each panelboard shall have a manufacturer's nameplate showing the voltage, bus rating, phase, frequency and number of wires.
- E. Panelboards, circuit breakers, and all major components installed within shall be the product of a single manufacturer.
- F. The number and arrangement of circuits, spares and blank spaces for future circuit breakers shall be as shown on the Drawings.
- G. Circuit breaker ampere trip ratings shall be as required by the equipment.
- H. Ratings:
1. Voltage: As shown on the Drawings
  2. Continuous current: As shown on the Drawings
  3. Main circuit breaker: As shown on the Drawings
  4. Short circuit:
    - a. Service entrance panelboards rated 240 VAC or less shall have short circuit ratings not less than 22,000 amperes RMS symmetrical or as indicated by the Short Circuit Study, whichever is greater.

- b. Panelboards shall be labeled with a UL short circuit rating. Series ratings are not acceptable.

## 2.02 PANELBOARDS

- A. Panelboards shall meet the requirements of Federal Specification W-P-115 for Type I, Class 1 panelboards with circuit breakers.
- B. Construction:
  - 1. Busbars shall be tinned copper.
  - 2. All circuit breakers shall be bolt-on type, with 1, 2 or 3 poles, as shown on the Drawings. Breakers shall be quick-make, quick-break, inverse time trip characteristics, to trip free on overload or short circuit. Each breaker shall have a single operating handle which indicates the trip condition of the breaker by its position. Circuit breakers shall meet the requirements of Federal Specification W-C-375.
  - 3. Where GFCI circuit breakers are shown on the Drawings or required by NEC, a unit shall be provided that contains a conventional thermal-magnetic trip and a ground-fault sensor, rated to trip the circuit breaker in approximately 0.025 second for a 5-milliampere ground fault, UL Class A sensitivity. The ground-fault sensor shall have the same rating as the circuit breaker and shall have a push-to-test button.
  - 4. Panelboards shall have hinged doors with combination catch and latch and common keying for locks. The front panels shall be arranged such that when the plates are removed, the gutters, terminals and wiring will be exposed and accessible. The doors shall have inner doors within the plates to have only the breaker operating mechanism exposed when they are opened. Live conductors and terminals shall be concealed behind the plates.
  - 5. Unless dictated otherwise by the enclosure type, panelboards shall be constructed of hot dipped zinc galvanized steel with stainless steel screws. Enclosures shall have a factory-applied finish in ANSI 61 grey, in accordance with ANSI Z55.1.
- C. Provide surge protective devices (SPDs) as shown on the Drawings and in accordance with Section 16280.
- D. Manufacturers:
  - 1. 240V and below: Eaton Pow-R-Line 1a/2a, Schneider Electric NQ/NF, or approved equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Panelboards shall be installed as indicated on the Drawings and in accordance with the manufacturer's instructions.
- B. Provide neutral-ground bonding at service entrances as shown on the Drawings and as required by the NEC.
- C. Provide grounding where shown on the drawings and as required by the NEC. Grounding shall be in accordance with Section 16450.



### 3.02 IDENTIFICATION

- A. Provide a nameplate for each panelboard as required by Section 16010.
- B. Provide a typewritten and printed circuit schedule in each panelboard. Handwritten schedules will not be accepted. Circuit schedule shall be placed within a clear pocket affixed to the inside of the hinged panelboard door.

### 3.03 FIELD ACCEPTANCE TESTS

- A. Test per Specification 16950.

END OF SECTION

## SECTION 16180

### PROTECTIVE DEVICES AND SWITCHES

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included: Provide all necessary labor, tools and material to install circuit protective devices as shown on the Drawings and as described in these Specifications.

##### 1.02 REFERENCE STANDARDS

- A. American National Standards Institute (ANSI) Publication:
  - 1. Z55.1 Gray Finishes for Industrial Apparatus and Equipment
- B. National Electrical Manufacturers Association (NEMA) Publications:
  - 1. ICS 3 Industrial Systems
  - 2. ICS 6 Enclosures for Industrial Controls and Systems
  - 3. 250 Type 1 Enclosures for Electrical Equipment (1,000 Volts Maximum)
- C. Federal Specifications (FS):
  - 1. W C 375 Circuit Breakers, Molded Case, Branch Circuit and Series Service, Series Trip
  - 2. W F 1726 Class H Cartridge Fuses
- D. Underwriters Laboratories (UL) Standards:
  - 1. 50 Electrical Cabinets and Boxes
  - 2. 198C Fuses, High-Interrupting-Capacity-Current Limiting Types
  - 3. 489 Molded Case Circuit Breakers and Enclosures
  - 4. 698 Industrial Control Equipment for Use in Hazardous (Classified) Locations
  - 5. 894 Switches for Use in Hazardous (Classified) Locations
- E. National Fire Protection Association (NFPA) Publication:
  - 1. 70 National Electric Code

##### 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.

##### 1.04 LOCATIONS

- A. Refer to Section 16010 for definitions of types of locations.

## PART 2 - PRODUCTS

### 2.01 FUSIBLE SWITCHES

- A. Fusible switches shall be heavy duty safety switches with the voltage ratings, current ratings, and number of poles as indicated by the Drawings. The switches shall be horsepower rated. Auxiliary contacts shall be provided as indicated on the Drawings. Stationary contacts shall be equipped with arc chutes. Fuse clips shall accept only Class J current limiting cartridge fuses. Where indicated on the Drawings, units shall have service entrance labels and shall be equipped with an insulated neutral lug. Switches shall be Square D, Type HD; Westinghouse Type H600; or equal.
- B. Enclosures shall be as follows:
  - 1. Wet locations: NEMA Type 3R.
- C. Nameplates: Provide an engraved plastic nameplate for each disconnect switch identifying the equipment it protects.
- D. Fuses:
  - 1. General: Provide one complete set of fuses of each ampere rating shown on the Drawings plus one spare set for each size shown.
  - 2. Fuse Type: Units shall be Class J current limiting, 700 volt, in the ampere ratings shown. Plug fuses are unacceptable. Barrels shall be non-hygroscopic with brass knurled ferrules.
  - 3. Fuses shall conform to FS W F 1726 and UL 198B, and shall carry labels showing UL class, interrupting rating, time delay characteristics, and voltage rating.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Install units plumb within 1/8 inch of vertical, and in accordance with manufacturer's instructions. Make sure that fuse ratings are as shown on the Drawings, and that breaker trip settings are per the Engineer's instructions.

### 3.02 MOUNTING HEIGHTS

- A. Fusible switches and enclosed circuit breakers shall be centered 5' 0" above the floor.

### 3.03 FIELD TESTS

- A. Insulation Resistance Tests: Perform insulation resistance tests on circuits to be energized with a line-to-neutral voltage of 120 volts or more. Make these tests after all equipment has been connected, except that equipment which may be damaged by the test voltage shall not be connected. Test the insulation with a 500 Vdc insulation resistance tester with a scale reading 100 megohms. The insulation resistance shall be 20 megohms or more. Submit results for review.
- B. Continuity Tests: Perform circuit continuity tests from a low powered dc test source to operate a buzzer or bell. Tests shall be made prior to energizing the protected circuit.

- C. Operating Tests: Demonstrate that the protected circuit can be manually controlled by the installed equipment.

END OF SECTION



## SECTION 16280

### SURGE PROTECTIVE DEVICES

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. This Section describes the materials and installation requirements for surge protective devices (SPD). These devices are used to protect AC electrical circuits from the effect of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and or capacitive load switching.

##### 1.02 REFERENCES

- A. Underwriters Laboratories (UL):
  - 1. 67 – Standards for Panelboards
  - 2. 1558 – Standard for Safety Metal Enclosed Low Voltage Switchgear
  - 3. 1449 Fourth Edition 2016 - Surge Protective Devices (SPD)
  - 4. 1283 - Electromagnetic Interference Filters
- B. American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE):
  - 1. C62.41.1-2002 - IEEE Guide on the Surge Environment in Low Voltage (1000 V and Less) AC Power Circuits
  - 2. C62.41.2-2002 - IEEE Recommended Practice on Characterization of Surge Voltages in Low Voltage AC Power Circuits
  - 3. C62.45-2002 - IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits
- C. National Fire Protection Association (NFPA):
  - 1. 70 - National Electrical Code (NEC) Article 285

##### 1.03 SUBMITTALS

- A. Submit surge protective device catalog cut sheets, dimensional data, and shop drawings with the applicable equipment in which the device is installed or to which it is connected.

#### PART 2 - PRODUCTS

##### 2.01 GENERAL

- A. SPD shall be Listed in accordance with UL 1449 Fourth Edition 2016 and UL 1283, Electromagnetic Interference Filters.
- B. SPD shall be Component Recognized in accordance with UL 1449 Fourth Edition, at the standard's highest short circuit current rating (SCCR) of 200 kA.
- C. SPD shall be tested with the ANSI/IEEE Category C High exposure waveform (20kV-1.2/50 s, 10kA-8/20 s).
- D. SPD shall provide suppression for all modes of protection: L-N, L-G, and N-G in WYE systems.

- E. The manufacturer of the SPD shall be the same as the manufacturer of the service entrance and distribution equipment in which the devices are installed and shipped or coordinated with the manufacturer of the panel in which it is installed so as to maintain the proper UL listing.

2.02 SPD RATINGS

- A. Minimum surge current rating shall be 250 kA per phase (100 kA per mode) for service entrance and 120 kA per phase (50 kA per mode) for distribution applications.
- B. UL 1449 voltage protection rating (VPR) must not exceed the following:

<u>VOLTAGE</u>	<u>L-N</u>	<u>L-G</u>	<u>N-G</u>
240/120	700V	700V	700V
208Y/120	700V	700V	700V
480Y/277	1200V	1200V	1200V

- C. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE Category C High transients without failure or degradation of clamping voltage by more than 10%.
- D. SPD shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
- E. SPD shall be constructed using multiple surge current diversion thermally protected metal oxide varistors (TPMOV). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing.
- F. Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the enclosure as well as on the module.
- G. SPD shall be equipped with an audible alarm which shall activate when any one of the surge current modules has reached an end-of-life condition. An alarm on/off switch shall be provided to silence the alarm. The switches and alarm shall be located on the front cover of the enclosure.
- H. SPD shall be equipped with dry contacts (normally open or normally closed) to allow connection to a remote monitor or other system for the following conditions:
  1. End-of-life condition for the complete SPD or module.
  2. SPD has operated to protect the equipment from a surge.
- I. Terminals shall be provided for necessary power and ground connections.

2.03 MANUFACTURERS

- A. Eaton SPD, Square D, Surgelogic IMA Series, ASCO Power Technologies (APT), or approved equal.

PART 3 - EXECUTION

3.01 NOT USED

END OF SECTION

## SECTION 16402

### UNDERGROUND ELECTRICAL WORK

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.

##### 1.02 APPLICABLE STANDARDS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.
  - 1. Federal Specifications (Fed. Spec.):
    - a. RR-F-621C Frames, Covers, Gratings, Steps, Sump and Catch Basin, Manhole
    - b. RR-G-661D Grating, Metal, Bar Type (Floor, except for Naval Vessels)
  - 2. American Concrete Institute (ACI) Publication:
    - a. 318 Building Code Requirements for Reinforced Concrete
  - 3. American Society of Testing and Materials (ASTM) Publications:
    - a. A36 Structural Steel
    - b. A153 Specifications for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
    - c. A615 Deformed and Plain Billet - Steel Bars for Concrete Reinforcement
    - d. C33 Concrete Aggregates
    - e. C139 Concrete Masonry Units for Construction of Catch Basins and Manholes, Specification for
    - f. C150 Portland Cement
    - g. C478 Precast Reinforced Concrete Manhole Sections, Specification for
    - h. C857 Recommended Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures
    - i. C858 Standard Specification for Underground Precast Concrete Utility Structures
  - 4. American Association of State Highway and Transportation Officials (AASHTO) Publication:
    - a. HB-13 Standard Specifications for Highway Bridges
  - 5. American National Standard Institute (ANSI) Publication:
    - a. C2 National Electrical Safety Code
  - 6. National Fire Protection Association (NFPA) Publication:
    - a. 70 National Electrical Code (NEC)
  - [7. Pacific Gas and Electric Company (PG&E) Standard:
    - a. Drawing Primary Electric Underground Equipment 062000 enclosures.]
  - [8. State of California Public Utilities Commission (Cal. PUC) Publication:
    - a. G.O.128 Construction of Underground Electric Supply and Communication System, Rule for]



## 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.
- B. Manufacturer's Data and Shop Drawings:
  - 1. Manhole and Handhole - Include a table of dimensions which shows proposed size of each manhole and handhole.
  - 2. Manhole Frame and Cover
  - 3. Handhole Frame and Cover
  - 4. Sealing Material for Precast Manhole and Handhole Joints
- C. Certificates
  - 1. Test Reports: Submit for approval 30 days before the materials are used, copies of laboratory test reports for the following:
    - a. Arc-proofing test for cable fireproofing materials

## PART 2 - PRODUCTS

### 2.01 GENERAL

- A. Materials and equipment shall conform to the respective specifications and standards and to the specifications herein. Electrical ratings shall be as indicated.
- B. Conduit: Provide per Section 16110.
- C. Wire and Cable: Provide per Section 16120, Section 16122, and Section 16124.

## PART 3 - EXECUTION

### 3.01 TRENCHING, BACKFILL, AND COMPACTION

- A. See Section 02300.

### 3.02 WIRE AND CABLE INSTALLATION

- A. See Section 16120, Section 16122, and Section 16124.

### 3.03 UNDERGROUND RACEWAYS WITH CONCRETE ENCASEMENT

- A. All underground raceways shall be encased in concrete unless otherwise specifically shown otherwise on the Drawings.
  - 1. Concrete encasement shall be minimum of 3 inches around outer walls of raceways and minimum of 2 inches between raceways. Conduits shall be PVC Type EB.
  - 2. Concrete shall be portland cement type with 4 sacks cement per cubic yard of concrete, maximum coarse aggregate size of 3/8-inches and shall have minimum strength of 2,000 psi after 28 days. Amount of water shall not exceed slump required for placement. Five pounds red lead oxide shall be added per cubic yard of concrete for medium voltage raceway encasement only.
  - 3. Underground raceways shall slope toward manholes, pullboxes, etc., at minimum rate of 3 inches per 100 feet unless indicated otherwise on Drawings. Raceway entrances in manholes, handholes, etc., shall be by

means of bell ends and shall be sealed against entry of silt, debris, rodents, etc., into raceways.

4. Top of concrete encasement shall be minimum of 24 inches below grade.
  5. Minimum radius of all horizontal bends in underground duct banks shall be 25 feet. Bends shall be formed of factory made sweeps or continuous assembly of bend segments or curved segments, except that polyvinyl chloride conduits may be field formed. Minimum radius of all vertical bends in underground raceways shall be ten times nominal size of conduit. Vertical bends shall be made of rigid steel or permanently coated aluminum conduit.
  6. Underground raceways within roadways shall be run parallel or perpendicular to road centerline.
  7. Pull wires left in underground raceways shall be 1/8-inch nylon rope or 3/16-inch polypropylene.
  8. Terminate conduits in end-bells where duct lines enter manholes and handholes. Provide structural support for concrete encased duct banks at the point where they terminate. Separators shall be of precast concrete, high impact polystyrene, steel, or any combination of these. Stagger the joints of the conduits by rows and layers so as to provide a duct line having the maximum strength. During construction, protect partially completed duct lines from the entrance of debris such as mud, sand and dirt by means of suitable conduit plugs. As each section of a duct line is completed, draw a brush through having the diameter of the duct, and having stiff bristles until the conduit is clear of all particles of earth, sand, and gravel; then immediately install conduit plugs.
- B. See Section 16110 for additional requirements.

END OF SECTION

## SECTION 16450

### ELECTRICAL GROUNDING

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included: Furnish all labor, material, equipment, tools and services necessary for the installation, connection and testing of all grounding as specified herein and as shown on the Drawings.

##### 1.02 REFERENCE STANDARD

- A. American Society for Testing and Materials (ASTM) Publication:
  - 1. B228 Copper Clad Steel Conductors Specification
  - 2. D178 Specifications for Rubber Insulating Matting
- B. Institute of Electrical and Electronics Engineers:
  - 1. 142 Grounding of Industrial and Commercial Power Systems (Green Book)
- C. International Electrical Testing Association (NETA) Publication:
  - 1. ATS Acceptance Testing Specifications for Electrical Equipment for Power Systems
- D. National Fire Protection Association (NFPA):
  - 1. 70 National Electrical Code (NEC)
- E. Telecommunications Industry Association (TIA)
  - 1. 607 Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
- F. Underwriters Laboratories (UL) Standards:
  - 1. 467 UL Standard for Safety Grounding and Bonding Equipment

##### 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Information category of the General Conditions and the submittal requirements of Section 16010.

#### PART 2 - PRODUCTS

##### 2.01 GENERAL

- A. The grounding systems shall consist of the ground rods, grounding conductors, ground bus, ground fittings and clamps, and bonding conductors to water piping, structural steel and UFER grounding as shown on the Drawings. One system shown provides service and separately derived system grounds. A second system is an electronic ground system to provide for the discharge of static electricity.

## 2.02 SYSTEM COMPONENTS

- A. Ground Rods: Ground rods shall be cone pointed copper clad Grade 40 HS steel rods conforming to UL 467. The welded copper encased steel rod shall have a conductivity of not less than 27% of pure copper. Rods shall be not less than 3/4-inch in diameter and 10 feet long, unless otherwise indicated. Rods longer than 10 feet shall be made up of 10-foot units joined together with threaded couplings. The manufacturer's trademark shall be stamped near the top.
- B. Ground Conductors: Buried conductors shall be medium-hard drawn bare copper; other conductors shall be soft drawn copper. Sizes over No. 6 AWG shall be stranded. Coat all ground connections except the exothermic welds with electrical joint compound, non-petroleum type, UL listed for copper and aluminum applications.
- C. Ground Connections: Connection to ground rods and buried connections shall be by exothermic weld. Lugs for attachment of cables to steel enclosures shall be of the binding post type with a 1/2-13NC stud. Each post shall accommodate cables from #4 AWG to #4/0 AWG.
- D. Ground Rod Boxes: Boxes shall be a 12-inch-diameter (minimum) precast concrete traffic rated unit with cast iron lid. Units shall be 12-inches deep. Covers shall be embossed with the wording "Ground Rod."
- E. Exothermic Welds: Exothermic welded connections shall be Erico CADWELD, Hubbell BURNDYWeld, or approved equal.
- F. Insulating Tape: Insulating tape for copper conductors passing through concrete slabs shall be UL Listed, premium grade, 10-mil thick, pressure-sensitive vinyl insulating tape. Tape shall have elastic backing with strong adhesive strength. Tape shall be 3M/Scotch Vinyl Insulation Tape 22, or approved equal.
- G. Ground Enhancement Material (GEM): GEM must be permanent and maintenance free (no recharging with salts or chemicals which may be corrosive), maintain its earth resistance with time and not depend on water to maintain its conductivity. GEM in its set form shall have a resistivity of not more than 20 ohm-cm. GEM shall be suitable for installation in dry form or slurry form, set up firmly and not dissolve or decompose or otherwise pollute the soil or local water table. GEM shall be manufactured by Erico Products or approved equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Ground all equipment for which a ground connection is required per NEC whether or not the ground connection is specifically shown on the Drawings.
- B. Provide a ground wire in every conduit carrying a circuit of over 50 volts to ground.
- C. Sizes shall be as indicated on the Conduit/Cable Schedule and in accordance with NEC Article 250.
- D. Provide a grounding-type bushing for secondary feeder conduits that originate from the secondary section of each MCC section, switchboard, or panelboard.
- E. Individually bond the raceway to the ground bus in the secondary section.



- F. Provide a separate grounding conductor in each individual raceway for parallel feeders. Connect the parallel ground conductors together at each end of the parallel run, as required by the NEC.
- G. Interconnect the panelboard neutral bus to the ground bus in the secondary switchgear compartment only at the service entrance point. For wye connected, 3 phase, separately derived systems with 3 wire distribution, connect the transformer neutral to the grounding electrode system at the transformer. Connections shall be in accordance with the NEC.
- H. Provide a ground ring with minimum burial depth of 36 inches or as indicated on the Drawings, whichever is greater.
- I. Embed a grounding conductor in every duct bank as indicated. The ground conductor shall be terminated at the ground grid at each end of the duct bank. Where no ground grid is installed, terminate at a suitable grounding electrode conductor near the end of the duct bank in accordance with the NEC.
- J. Provide a ground rod box for each ground rod so as to permit ready access for the connection and/or removal of any pressure connectors to facilitate testing.
- K. Install ground enhancement material around each ground rod per GEM manufacturer's installation instructions. GEM shall extend 6 inches in all directions around the ground rod surface. GEM shall extend from 8 inches below top of ground rod to bottom of ground rod.
- L. Bond metallic water piping at its entrance into each building. Ground separately derived electrical system neutrals to the metallic water piping in addition to the system driven ground, per NEC requirements.
- M. Make embedded or buried ground connections, taps and splices with exothermic welds. Do not conceal or cover ground connections until the Engineer or an authorized representative has established that every grounding connection conforms to the requirements of the Contract Documents and has given the Contractor written confirmation.
- N. Where bare copper ground conductor is installed through a new concrete slab, wrap the conductor with insulating tape before pouring concrete. Apply tape in half-lapped layers with sufficient tension to produce a uniform wind, with no tension on the last wrap to prevent flagging.
- O. Provide supplemental external bonding jumpers from equipment to the grounding electrode system as shown on the Drawings.
- P. Shielded instrumentation cable shall have its shield grounded at one end only unless the approved Shop Drawings indicate otherwise. The grounding point shall be at the control panel or at the receiving end of the signal carried by the cable. The termination of the shield drain wire shall be on its own terminal. Form a instrument signal ground block by jumping together the shield drain wire terminals, using manufactured terminal block jumpers or a #14 AWG green insulated conductor. Bond the instrument signal ground block to the main ground bus for the panel via a #12 AWG green insulated conductor.

### 3.02 TESTING

- A. Testing shall be in accordance with Specification 16950– Electrical Tests.

- B. Furnish to the Engineer a test report with recorded data of each ground rod location.

END OF SECTION

## SECTION 16500

### LIGHTING

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.
- B. Work Included: Provide a lighting system complete, including fixtures, lamps, standards, bases, hangers, reflectors, glassware, lenses, auxiliary equipment, ballasts, sockets, and photoelectric cells.

##### 1.02 REFERENCE STANDARDS

- A. Federal Regulations
  - 1. Title 21 Performance Standards for Light Emitting Products CFR 1040
- B. Underwriters Laboratories (UL) Standards
  - 1. 57 Electric Lighting Fixtures
  - 2. 844 Electric Lighting Fixtures for Use in Hazardous (Classified) Locations

##### 1.03 SUBMITTALS

- A. Submit material or equipment data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010.
- B. Submit photometric curves for each fixture configuration proposed. Substitutions will not be considered unless the photometric distribution curve indicates the proposed fixture is equal to or exceeds the specified luminaire.
- C. Submit shop drawings showing proposed methods for mounting interior lighting fixtures which are not attached directly to the ceiling or wall.
- D. Submit seismic design certifications and anchorage descriptions as required by Section 01190.

##### 1.04 GUARANTEE

- A. Lamps which fail within 90 days after acceptance by the Owner shall be replaced at no cost to the Owner.

#### PART 2 - PRODUCTS

##### 2.01 FIXTURES

- A. Fixtures shall be of the types, wattages and voltages shown on the Drawings, comply with UL 57, and be UL classified and labeled for intended use. Fixtures for use in hazardous locations shall be UL listed per UL Standard 844.
- B. Luminaire wire, and the current carrying capacity thereof, shall be in accordance with the NEC.

- C. Luminaires and lighting equipment shall be delivered to the project site complete, with suspension accessories, aircraft cable, stems, canopies, hickeys, castings, sockets, holders, ballasts, diffusers, louvers, frames, recessing boxes and related items, including supports and braces.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

#### A. General:

1. All fixtures and luminaires shall be clean and lamps shall be operable at the time of acceptance.
2. Install luminaires in accordance with manufacturer's instructions ready for operation as indicated.
3. Align, mount, and level the luminaires uniformly.
4. Avoid interference with and provide clearance for equipment. Where an indicated position conflicts with equipment locations, change the location of the luminaire by the minimum distance necessary.

#### B. Mounting and Supports:

1. Mounting heights shall be as shown on the Drawings. Unless otherwise shown, mounting height shall be measured to the centerline of the outlet box for a wall mounted fixture and to the bottom of the fixture for all other types.
2. Luminaire supports shall be anchored to the structural slab or structural members as indicated. Supports shall maintain the luminaire positions after relamping and cleaning.
3. Surface mounted fixtures shall be rigidly bracketed from mounting surfaces. Luminaires installed in rows shall have a non-cumulative dimensional alignment tolerance of 1/16 inch. Nipples carrying wiring between luminaires shall be watertight.

END OF SECTION



## SECTION 16950

### ELECTRICAL TESTS

#### PART 1 - GENERAL

##### 1.01 SCOPE OF WORK

- A. This Section specifies the work necessary to test, commission, and demonstrate that the electrical system satisfies the requirements of these Specifications and functions as required by the Contract Documents. The work of this Section is applicable to both pre and post energization testing required by the Manufacturer to facilitate sign-off on their respective equipment as well as pre and post energization testing performed by an independent third party entity independent of manufacturers, suppliers and installers of electrical equipment, installations and systems.
- B. The Work shall include furnishing the labor, equipment, and power required to support the testing indicated in other Divisions of these Specifications. Electrical testing indicated herein and functional testing of power and controls not tested under Division 17 – Instrumentation, shall be completed before commencement of the Initial Operation Period as defined in Section 01650, for each phase of construction as indicated on the Drawings. This scope may require the Contractor to activate circuits, shutdown circuits, run equipment, make electrical measurements, replace blown fuses, and install temporary jumpers, etc.
- C. Carry out tests indicated herein for individual items of materials and equipment in other Sections. Testing shall be done in accordance with the manufacturer's instructions, these Specifications, and applicable NETA Acceptance Testing Specifications, NEMA, ANSI, NFPA, and ASTM Standards.
- D. Factory Acceptance Testing and other off-site test requirements are included in other Sections.
- E. Corrections and Replacements
  1. Before final acceptance, each part of the work shall be thoroughly tested, and each test shall be documented and submitted in accordance with the Contract Documents.
  2. Any materials or equipment failing any test shall be corrected or replaced as required to pass the test at no additional cost to the Owner.
  3. Any materials or equipment failing any test shall be re-tested after correction or replacement to verify compliance.
  4. Any failures shall again be corrected or replaced, and then re-tested.
  5. The correction/replacement/re-testing cycle shall continue until the item passes the required test(s).

##### 1.02 REFERENCE STANDARDS

- A. Electric equipment, materials, installation, and testing shall comply with the National Electrical Code (NEC), and shall also conform to the following codes and standards:
  1. American National Standards Institute (ANSI)
  2. InterNational Electrical Testing Association (NETA)
  3. Institute of Electrical and Electronics Engineers (IEEE)

4. Occupational Health and Safety Administration (OSHA)
5. ASTM International Standard E329
6. IEEE 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems
7. IEEE 576, Recommended Practice for Installation, Termination, and Testing of Insulated Power Cable as Used in Industrial and Commercial Applications
8. National Fire Protection Association (NFPA) 70B, NEC for Maintenance
9. Telecommunications Industry Association (TIA) 568-C.2, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.

### 1.03 SUBMITTALS

- A. Submit complete system test procedures and test record forms for review. Test procedures shall include but not be limited to:
  1. Detailed procedures, both pre and post energization testing requirements of the Manufacturer and independent third-party entity, in sufficient detail to verify conformance with these Specifications.
  2. Incorporation of data collection and measurement values as shown in the sample test record forms provided at the end of this Section. Submitted test record forms shall include space for each of the fields listed, at a minimum.
  3. Detailed comprehensive testing schedule including:
    - a. Electrical testing of each major area.
    - b. Each major piece of electrical distribution equipment.
    - c. Each major electrical subsystem.
    - d. Duration of each test.
    - e. Milestone test completion date.
    - f. Date of test results submittals following completion of the tests.
    - g. Names and qualifications of the individual(s) responsible for performing the testing, including a copy of current NETA Technician cards.
    - h. Proof of NETA accreditation for the testing agency.
- B. Following completion of the test submit the completed test results to the Engineer for review. The results shall include a dedicated section with the "as-left" settings of all devices, relays, circuit breakers, etc.
- C. Test results shall be submitted in one submittal.
- D. Test reports shall be based on NETA's latest Acceptance Testing Specifications having a sign-off, pass/fail data filed for each line item covered by NETA's Acceptance Testing Specifications latest edition.

### 1.04 QUALITY ASSURANCE

- A. Testing Firm Qualifications:
  1. Corporately and financially independent organization functioning as an unbiased testing authority.
  2. Professionally independent of manufacturers, suppliers, and installers of electrical equipment and systems being tested.
  3. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
  4. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years testing experience on similar projects.
  5. Technicians certified by NICET or NETA.

6. Registered Professional Engineer to provide comprehensive project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
  7. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.
- B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.
- C. Test instrument calibration shall be in accordance with NETA ATS.

#### 1.05 FIELD TESTS

- A. All testing shall be performed in the presence of the Owner.
- B. Any system material or workmanship that is found to be defective on the basis of acceptance tests shall be reported directly to the Owner.

### PART 2 - PRODUCTS

#### 2.01 PRE-ENERGIZATION AND OPERATING TESTS

- A. The complete electrical system for each phase of construction shall be performance tested when first installed on-site. Each protective, switching, and control circuit shall be adjusted in accordance with the recommendations of the Protective Device Coordination Study required by Section 16961 and tested by actual operation using current injection or equivalent methods as necessary to ensure that each and every such circuit operates correctly to the satisfaction of the Owner.
  1. Instrument Transformers. All instrument transformers shall be tested to verify correct polarity and burden.
  2. Protective Relays. Each protective relay shall be demonstrated to operate by injecting current or voltage, or both, at the associated instrument transformer output terminal and observing that the associated switching and signaling functions occur correctly and in proper time and sequence to accomplish the protective function intended.
  3. Switching Circuits. Each switching circuit shall be observed to operate the associated equipment being switched.
  4. Control and Signal Circuits. Each control or signal circuit shall be observed to perform its proper control function or produce a correct signal output.
  5. Metering Circuits. All metering circuits shall be verified to operate correctly from voltage and current sources, similarly to protective relay circuits.
  6. Acceptance Tests. Complete acceptance tests shall be performed, after the station installation is completed, on all assemblies, equipment, conductors, and control and protective systems, as applicable, to verify the integrity of all the systems.
  7. Relays and Metering Utilizing Phase Differences. All relays and metering that use phase differences for operation shall be verified by measuring phase angles at the relay under actual load conditions after operation commences.
- B. Test Report. A test report covering the results of the tests required in the Pre-Energization and Operating Tests shall be delivered to the Engineer prior to energization. Acceptance Testing shall be in accordance with NETA ATS-2017, *Standard for Acceptance Testing Specifications for Electrical Power Equipment*

*and Systems*, published by the InterNational Electrical Testing Association. Tests shall be provided by both the manufacturer representative and independent third-party NETA accredited testing agency where required.

## 2.02 FIELD TESTS BY MANUFACTURER'S OR SUPPLIERS

A. All field tests shall be performed by the Manufacturers or Suppliers.

## 2.03 TEST REQUIREMENTS

A. The following test requirements supplement test and acceptance criteria that may be stated elsewhere.

1. Lighting: Switching. Circuitry is in accordance with panel schedules. All interior and exterior lighting shall be checked for proper operation.
2. Activate ground fault tripping by operating test features provided with ground current protective systems and by injecting a known and reasonable current in the ground current sensor circuit. In general, ground fault tripping should occur at a ground current equivalent to 20 percent of phase current. Current injection is not required of circuit 400 amperes or less.

B. Low Voltage Cables-600 volts Maximum

1. Visual and Mechanical Inspection
  - a. Compare cable data with Drawings and Specifications.
  - b. Inspect exposed sections of cables for physical damage and correct connection in accordance with single-line diagram.
  - c. Inspect bolted electrical connections for high resistance using one of the following methods:
    - 1) Use of low-resistance ohmmeter
    - 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.
  - d. Inspect compression-applied connectors for correct cable match and indentation.
  - e. Inspect for correct identification and arrangements.
  - f. Inspect cable jacket insulation and condition.
2. Electrical Tests
  - a. Perform insulation-resistance test on each conductor with respect to ground and adjacent conductors. Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. Test duration shall be 1 minute.
    - 1) Motor feeders tested with motors disconnected and controller open.
    - 2) Motor control circuits tested and verified for proper operation with control stations and overcurrent devices connected.
    - 3) Panelboard feeders tested with feeder breaker open and panelboard connected. If a lighting transformer is associated with the panelboard, it shall be connected and the test made for both primary and secondary sides.
    - 4) Conductors of main lighting feeders, including lighting panel with branch circuits open.
    - 5) Prior to performing insulation resistance tests on cables, verify that they are not connected to a solid state device.



- 6) Equipment which may be damaged during this test shall be disconnected.
  - 7) The Engineer shall be consulted if minimum insulation values cannot be obtained.
  - b. Perform resistance measurements through all bolted connections with low-resistance ohmmeter, if applicable.
  - c. Perform continuity test to ensure correct cable connection.
  - d. Perform the following industry-standard operational and performance tests on each Category 6 Ethernet cable as detailed in ANSI/EIA-568-C:
    - 1) Wire map (pass/fail)
    - 2) Propagation delay (pass/fail)
    - 3) Delay skew (pass/fail)
    - 4) Cable length
    - 5) Insertion loss (attenuation)
    - 6) Return loss (pass/fail)
    - 7) Near-end crosstalk (NEXT) (pass/fail)
    - 8) Power sum near-end crosstalk (PSNEXT) (pass/fail)
    - 9) Equal level far-end crosstalk (ELFEXT)
    - 10) Power sum equal level far-end crosstalk (PSELFEXT).
  - 3. Test Values - Visual and Mechanical
    - a. Compare bolted connection resistance to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - b. Bolt-torque levels shall be in accordance with NETA ATS Table 100.12 unless otherwise specified by the manufacturer.
  - 4. Test Values - Electrical
    - a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
    - b. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations shall be investigated.
    - c. Cable shall exhibit continuity.
    - d. Deviations in resistance between parallel conductors shall be investigated.
    - e. Compare Category 6 Ethernet test values against TIA 568-C for determination of pass/fail status.
- C. Low Voltage Safety Switches
- 1. Visual and Mechanical Inspection
    - a. Compare equipment nameplate data with drawings and specifications.
    - b. Inspect physical and mechanical condition.
    - c. Inspect anchorage, alignment, grounding, and required clearances.
    - d. Verify the unit is clean.
    - e. Verify correct blade alignment, blade penetration, travel stops, and mechanical operation.
    - f. Verify that fuse sizes and types are in accordance with drawings, short-circuit studies, and coordination study.
    - g. Verify that each fuse has adequate mechanical support and contact integrity.

- h. Inspect bolted electrical connections for high resistance using one or more of the following methods:
    - 1) Use of a low-resistance ohmmeter.
    - 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
  - i. Verify operation and sequencing of interlocking systems.
  - j. Verify correct phase barrier installation.
  - k. Verify correct operation of all indicating and control devices.
  - l. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
2. Electrical Tests
- a. Perform resistance measurements through bolted electrical connections with a low-resistance ohmmeter, if applicable.
  - b. Measure contact resistance across each switchblade and fuse holder.
  - c. 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 the absence of manufacturer's published data, use NETA ATS Table 100.1
  - d. Measure fuse resistance.
3. Test Values – Visual and Mechanical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
4. Test Values – Electrical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - b. Microohm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of the lowest value.
  - c. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated. Dielectric withstand voltage tests shall not proceed until insulation-resistance levels are raised above minimum values.
  - d. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
- D. Molded and Insulated Case Circuit Breakers
1. Visual and Mechanical Inspection
- a. Compare equipment nameplate data with drawings and specifications.
  - b. Inspect physical and mechanical condition.
  - c. Inspect anchorage and alignment.
  - d. Verify the unit is clean.

- e. Operate the circuit breaker to insure smooth operation.
  - f. Inspect bolted electrical connections for high resistance using one or more of the following methods:
    - 1) Use of a low-resistance ohmmeter.
    - 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
  - g. Inspect operating mechanism, contacts, and arc chutes in unsealed units.
  - h. Perform adjustments for final protective device settings in accordance with the coordination study.
2. Electrical Tests
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
  - b. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with the circuit breaker closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1.
  - c. Perform a contact/pole-resistance test.
  - d. Determine long-time pickup and delay by primary current injection.
  - e. Determine short-time pickup and delay by primary current injection.
  - f. Determine ground-fault pickup and time delay by primary current injection.
  - g. Determine instantaneous pickup by primary current injection.
  - h. Test functions of the trip unit by means of secondary injection.
  - i. Perform minimum pickup voltage tests on shunt trip and close coils in accordance with manufacturer's published data.
  - j. 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 all trip logs and indicators
  - k. Verify operation of charging mechanism.
3. Test Values – Visual and Mechanical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - b. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
  - c. Settings shall comply with coordination study recommendations.
4. Test Values – Electrical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - b. Insulation-resistance values shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.1. Values of insulation resistance less than this table or manufacturer's recommendations should be investigated.
  - c. Microohm or dc millivolt drop values shall not exceed the high levels of the normal range as indicated in the manufacturer's published data. If manufacturer's published data is not available, investigate values that

deviate from adjacent poles or similar breakers by more than 50 percent of the lowest value.

- d. Insulation-resistance values of control wiring shall not be less than two megohms.
- e. Long-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current characteristic tolerance band, including adjustment factors. If manufacturer's curves are not available, trip times shall not exceed the value shown in NETA ATS Table 100.7.
- f. Short-time pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- g. Ground fault pickup values shall be as specified, and the trip characteristic shall not exceed manufacturer's published time-current tolerance band.
- h. Instantaneous pickup values shall be as specified and within manufacturer's published tolerances. In the absence of manufacturer's published data, refer to NETA ATS Table 100.8.
- i. Pickup values and trip characteristics shall be within manufacturer's published tolerances.
- j. Minimum pickup voltage of the shunt trip and close coils shall conform to the manufacturer's published data. In the absence of the manufacturer's published data, refer to NETA ATS Table 100.20.
- k. Breaker open, close, trip, trip-free, anti-pump, and auxiliary features shall function as designed.
- l. The charging mechanism shall operate in accordance with manufacturer's published data.

#### E. Metering Devices

##### 1. Visual and Mechanical Inspection

- a. Compare equipment nameplate data with drawings and specifications.
- b. Inspect meters and cases for physical damage.
- c. Clean front panel and remove shipping restraint material.
- d. Verify tightness of electrical connections.
- e. Record model number, serial number, firmware revision, software revision, and rated control voltage.
- f. Verify operation of display and indicating devices.
- g. Record passwords.
- h. Verify unit is grounded in accordance with manufacturer's instructions.
- i. Verify unit is connected in accordance with manufacturer's instructions and project drawings.
- j. Set all required parameters including instrument transformer ratios, system type, frequency, power demand methods/intervals, and communications requirements.

##### 2. Electrical Tests

- a. Apply voltage or current as appropriate to each analog input and verify correct measurement and indication.
- b. Confirm correct operation and setting of each auxiliary input/output feature including mechanical relay, digital, and analog.
- c. After initial system energization, confirm measurements and indications are consistent with loads present.

##### 3. Test Values – Visual and Mechanical



- a. Nameplate data shall be per drawings and specifications.
  - b. Tightness of electrical connections shall assure a low resistance connection.
  - c. Display and indicating devices shall operate per manufacturer's published data.
4. Test Values – Electrical
- a. Measurement and indication of applied values of voltage and current shall be within manufacturer's published tolerances for accuracy.
  - b. All auxiliary input/output features shall operate per settings and manufacturer's published data.
  - c. Measurements and indications shall be consistent with energized system loads.
- F. Grounding System
1. Visual and Mechanical Inspection
- a. Verify ground system is in compliance with drawings, specifications, and NFPA 70 National Electrical Code Article 250.
  - b. Inspect physical and mechanical condition.
  - c. Inspect bolted electrical connections for high resistance using one or more of the following methods:
    - 1) Use of low-resistance ohmmeter.
    - 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.
  - d. Inspect anchorage.
2. Electrical Tests
- a. Perform resistance measurements through bolted connections with a low-resistance ohmmeter.
  - b. Perform fall-of-potential or alternative test in accordance with ANSI/IEEE 81 on the main grounding electrode or system.
  - c. Perform point-to-point tests to determine the resistance between the main grounding system and all major electrical equipment frames, system neutral, and derived neutral points.
3. Test Values – Visual and Mechanical
- a. Grounding system electrical and mechanical connections shall be free of corrosion.
  - b. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - c. Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
4. Test Values – Electrical
- a. Compare bolted connection resistance values to values of similar connections. Investigate values which deviate from those of similar bolted connections by more than 50 percent of the lowest value.
  - b. The resistance between the main grounding electrode and ground shall be no greater than five ohms for large commercial or industrial systems and one ohm or less for generating or transmission station grounds unless otherwise specified by the owner. (Reference ANSI/IEEE Standard 142)
  - c. Investigate point-to-point resistance values that exceed 0.5 ohm.

- G. Test ground fault interrupter (GFI) receptacles and circuit breakers for proper operation by methods sanctioned by the receptacle manufacturer.
- H. A functional test and check of electrical components is required prior to performing subsystem testing and commissioning. Compartments and equipment shall be cleaned as required by other provisions of these Specifications before commencement of functional testing. Functional testing shall comprise:
  - 1. Visual and physical check of cables, circuit breakers, transformers, and connections associated with each item of new and modified equipment.
  - 2. Verification that electrical equipment has been labeled with Arc Flash protection boundary and PPE levels, as required by Section 16961.
  - 3. Setting of protective relays in conformance with results of the Short Circuit Study required by Section 16961 and testing of relays to assure that relays will trip at the current value and time required by the Study.
  - 4. Circuit Breakers:
    - a. Circuit breakers that have adjustable time or pick-up settings for ground current, instantaneous overcurrent, short-time overcurrent, or long-time overcurrent, shall be field-adjusted by a representative of the circuit breaker manufacturer.
    - b. Time and pickup setting shall correspond to the recommendations of the Short Circuit Study.
    - c. Setting shall be tabulated and proven for each circuit breaker in its installed position.
    - d. Test results shall be certified by the person performing the tests and shall be submitted to the Engineer.
- I. Subsystem testing for each phase of construction shall occur after the proper operation of alarm and status contacts has been demonstrated or otherwise accepted by the Owner and after process control devices have been adjusted as accurately as possible. Alarm conditions shall be simulated for each alarm point, and alarm indicators shall be checked for proper operation. It is intended that the Contractor will adjust limit switches and level switches to their operating points prior to testing and will set pressure switches, flow switches, and timing relays as dictated by operating results.
- J. Subsystems shall be defined as individual and groups of pumps, conveyor systems, chemical feeders, air conditioning units, ventilation fans, air compressors, etc.
- K. After initial settings have been completed, each subsystem shall be operated in the manual mode and it shall be demonstrated that operation is in compliance with the Contract Documents. Once the manual mode of operation has been proven, automatic operation shall be demonstrated to verify such items as proper start and stop sequence of pumps, proper operation of valves, proper speed control, etc.
- L. Voltage Field Test:
  - 1. Check and record voltage at point of termination of Xcel Energy supply system after the installation is essentially complete and has been made operational.
  - 2. Check and record voltage amplitude and balance between phases for loaded and unloaded conditions.
  - 3. Unbalance Corrections:

- a. Notify the Owner if balance (as defined by NEMA) exceeds 1%, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4% of nominal.
- 4. Voltage Balance Report:
  - a. Submit Voltage Balance Report for each switchboard, distribution panel-board, load center, motor control center, and transformer.
- M. Equipment Line Current Tests:
  - 1. Check and record line current in each phase for each major piece of electrically-operated equipment.
  - 2. Make a line current check after Xcel Energy has made final adjustments to supply voltage magnitude or balance.
  - 3. If any phase current for any piece of equipment is above rated nameplate current, prepare a supplement to the Equipment Line Current Report that identifies any causes of problems and corrective action that was taken.
  - 4. Submit Equipment Line Current Report for each point of connection to motors, transformers, branch circuit distribution connections, and incoming utility service connection.

## 2.04 TEST REPORTS

- A. The test report shall include the following:
  - 1. Summary of project.
  - 2. Description of equipment tested.
  - 3. Description of test.
  - 4. Test data.
  - 5. Analysis and recommendations.
- B. Test data records shall include the following minimum requirements:
  - 1. Identification of the testing organization.
  - 2. Equipment identification.
  - 3. Humidity, temperature, and other atmospheric conditions that may affect the results of the tests/calibrations.
  - 4. Date of inspections, tests, maintenance, and/or calibrations.
  - 5. Identification of the testing technician.
  - 6. Indication of inspections, tests, maintenance, and/or calibrations to be performed and recorded.
  - 7. Indication of expected results when calibrations are to be performed.
  - 8. Indication of "as-found" and "as-left" results.
  - 9. Sufficient spaces to allow all results and comments to be indicated.
- C. The Contractor shall submit the complete report to the Engineer for review.

## PART 3 - EXECUTION

### 3.01 FIELD TESTS

- A. The Contractor shall provide ten Working Days' notice to the Owner prior to any field testing to permit witnessing of the testing.

## TEST RECORD SHEETS

The test record sheets listed below are provided as an example to demonstrate the minimum requirements to be included on test record sheets for electrical equipment and of the electrical installation as required by these specifications. Sample copies of each sheet are attached.

Sheet No.	Title
1	Insulation Resistance (Power, Control Wire, and Cable) Test Record
2	Insulation Resistance (Instrument Wire and Cable) Test Record
3	Ground Electrode Testing Test Record
4	Neutral Grounding Resistor Test Record
5	Bonding Resistance Readings (Nonelectrical Equipment/Structures) Test Record
6	Bonding Resistance Readings (Electrical Equipment) Test Record
7	Insulation Resistance (Equipment) Test Record
8	Equipment Absorption Ratio and Polarization Index Test Record



**INSULATION RESISTANCE  
(POWER, CONTROL WIRE, AND CABLE)  
TEST RECORD**

TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_  
 TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_  
 AMBIENT TEMPERATURE: \_\_\_\_\_ °C \_\_\_\_\_ °F DATE: \_\_\_\_\_

- NOTES: 1. Perform Insulation Resistance Test (megger) between each conductor and all other conductors and metallic sheath for cables with nonshielded conductors. Test between each conductor and shield for multiconductor cables with shielded conductors. Record lowest reading for each cable.
2. Use 1,000-V test set for cable rated 600 volts and 2,500-V test set for cable rated over 600 volts.
3. Readings will vary inversely with temperature and cable length. When the use of temperature correction factors is specified, attach a second sheet with computed values. Indicate on each sheet "measured" or "temperature corrected."

Panel No. Circuit No. Feeder No.	Wire Tagging	Cable Rated Voltage	Wire or Cable				Insulation Resistance (megohms) *	Initial s
			Quantity	Size	From	To		

\*Minimum acceptable values:

Cable Rated <u>Voltage</u>	Test <u>Duration</u>	Resistance for <u>Cable Only</u>	Cable/Wire Size <u>or Amperage</u> (megohms)	Resistance When Cable <u>Connected to Equipment</u> (ohms)
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 DISTRIBUTION: \_\_\_\_\_ CONTRACTOR/Date \_\_\_\_\_

**INSULATION RESISTANCE  
(INSTRUMENT WIRE AND CABLE)  
TEST RECORD**

TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_  
 TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_  
 AMBIENT TEMPERATURE: \_\_\_\_\_ °C \_\_\_\_\_ °F DATE: \_\_\_\_\_

- NOTES: 1. Record only the lowest value.  
 2. MP - Multi-pair cable. SP - Single pair cable.  
 3. Megger with instruments disconnected.  
 4. Use 250 volt (or lower voltage, when specified) range on DC test set.  
 5. Readings will vary with temperature and cable length.

Cable Number or Instrument Number	Indicate MP or SP Type (2)	Conductor to Conduit (Single Pair Non-Shielded Cables) (megohms)	Conductor to Conductor (megohms) (1)	Shield to Conductor to Shield (megohms) (1)	Overall Shield to Shield (Multipair Cables Only) (megohms) (1)	Lead and Armor (Multipair Cables Only) (megohms)	Shield to Conduit (Single Pair Cables Only) (megohms)	Initials

DISTRIBUTION: \_\_\_\_\_ CONTRACTOR/Date \_\_\_\_\_

**GROUND ELECTRODE TESTING  
TEST RECORD**

TEST EQUIPMENT: \_\_\_\_\_ (Note 1) \_\_\_\_\_ (Note 2)

REFERENCE DRAWING: \_\_\_\_\_

- NOTES: 1. Record resistance-to-earth for each electrode with all other conductors disconnected. Resistance not to exceed 25 ohms for any single anode.
2. Check continuity from each electrode to any test bar or other electrode such that the complete ground loop is tested.

Rod Number	Resistance to Earth (ohms)	Ambient Temperature (°C/°F)	Weather	Taps	Initials/Date

-----  
 DISTRIBUTION: \_\_\_\_\_ CONTRACTOR/Date \_\_\_\_\_

**NEUTRAL GROUNDING RESISTOR  
TEST RECORD**

TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_

TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_

- NOTES: 1. Use 1,000-volt test set for 600-volt equipment and below, 2,500-volt test set for equipment rated over 600 volts.
2. Resistor must be disconnected from ground and neutral during Insulation Resistance (megger) and DC Overpotential Tests.
3. Resistor must be disconnected from neutral during Cold Resistance Test.
4. Apply DC Overpotential Test between terminals and ground for the complete device. (The voltage applied between the terminals of each assembly and its grounded enclosure shall be twice the rated AC voltage plus 1000 V when rated 600 V or less, or 2.25 times the rated AC voltage plus 2000 V when rated over 600 V for 1 minute.) This test is a Pass/Fail test based purely on withstand alone.
5. Inspect assembly for damage and missing parts.
6. Check to assure that the center tap ratio is correct, when CT is supplied with resistor.

Verify resistor reterminated.

Tag No.	Cold Res. (ohms)	Insul. Res. (megohms)*	Overpot. (4)	CT Ratio Pri-Sec	Reterm (4)	Initials/Date

\*Minimum acceptable values:

VOLTAGE CLASS

INSULATION RESISTANCE (megohms)

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DISTRIBUTION:

CONTRACTOR/Date \_\_\_\_\_





**BONDING RESISTANCE READINGS  
(ELECTRICAL EQUIPMENT)  
TEST RECORD**

TEST EQUIPMENT USED: \_\_\_\_\_ WEATHER: \_\_\_\_\_

- NOTES: 1. Electrical equipment bonded to the main grounding system or dedicated ground rod, as indicated on drawings listed below.
2. Measure resistance from ground wiretap to tagged equipment bus bars, tagged equipment enclosures, and any other points indicated on the drawings.

EQUIPMENT TAG NO. OR STRUCTURE	DRAWING	MEASURED RESISTANCE (ohms)	INITIALS/DATE

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DISTRIBUTION: \_\_\_\_\_ CONTRACTOR/Date \_\_\_\_\_

**INSULATION RESISTANCE (EQUIPMENT)  
TEST RECORD**

TEST EQUIPMENT: \_\_\_\_\_ SUBSTATION: \_\_\_\_\_  
AMBIENT TEMPERATURE: \_\_\_\_\_ °C \_\_\_\_\_ °F DATE: \_\_\_\_\_  
REFERENCE DRAWING: \_\_\_\_\_ REF. SEC.: \_\_\_\_\_

- NOTES: 1. Use 1,000-V test set for equipment rated 600 volts and below, 2,500/5,000-V test set for equipment rated over 600 volts.
2. For equipment with solid state control circuits, consult manufacturer's literature for maximum test voltages.

Switchgear or MCC (or other)	INSULATION RESISTANCE (megohms) *						Test Voltage (kV)	Rated Voltage (kV)	Initials/Date
	ØA to G	ØB to G	ØC to G	ØA to ØB	ØB to ØC	ØC to ØA			

\*Minimum acceptable values:  
EQUIPMENT VOLTAGE CLASS RESISTANCE (megohms)

TESTER'S INITIALS/DATE \_\_\_\_\_

-----  
DISTRIBUTION: \_\_\_\_\_ CONTRACTOR/Date \_\_\_\_\_

**EQUIPMENT ABSORPTION RATIO AND POLARIZATION INDEX  
TEST RECORD**

TEST EQUIPMENT: \_\_\_\_\_ TEST VOLTAGE: \_\_\_\_\_  
 AMBIENT TEMPERATURE: \_\_\_\_\_ °C \_\_\_\_\_ °F DATE: \_\_\_\_\_  
 EQUIP. TEMP., IF KNOWN: \_\_\_\_\_ °C \_\_\_\_\_ °F REL. HUMIDITY: \_\_\_\_\_

NOTES: 1. Perform test as indicated on Test Records for each individual equipment type. Reference the following sheets:

Transformers 8  
 Equipment 9  
 Motors and Generators 10

2. Absorption Ratio =  $\frac{\text{1-Minute Resistance Value}}{\text{30-Second Resistance Value}}$   
 3. Polarization Index =  $\frac{\text{10-Minute Resistance Value}}{\text{1-Minute Resistance Value}}$

OHMS TO GROUND 30-SECOND READING ØA TO GROUND	OHMS TO GROUND 1-MINUTE READING ØA TO GROUND	OHMS TO GROUND 10-MINUTE READING ØA TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX
OHMS TO GROUND 30-SECOND READING ØB TO GROUND	OHMS TO GROUND 1-MINUTE READING ØB TO GROUND	OHMS TO GROUND 10-MINUTE READING ØB TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX
OHMS TO GROUND 30-SECOND READING ØC TO GROUND	OHMS TO GROUND 1-MINUTE READING ØC TO GROUND	OHMS TO GROUND 10-MINUTE READING ØC TO GROUND	DIELECTRIC ABSORPTION RATIO	POLARIZATION INDEX

TESTER'S INITIALS/DATE \_\_\_\_\_

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 DISTRIBUTION:

CONTRACTOR/Date \_\_\_\_\_



## SECTION 16961

### POWER SYSTEM STUDIES

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Provisions: Applicable provisions of Section 16010 become a part of this Section as if repeated herein.

##### 1.02 SCOPE OF WORK

- A. Obtain the services of an independent firm to provide complete Short-Circuit and Protective Device Coordination studies, and Arc Flash Risk Assessment for the electrical system as defined below. The firm performing the work shall have been regularly engaged in short-circuit and protective device coordination services for a period of at least 10 years.
- B. The firm performing the work shall be responsible for the collection of all data required to perform the studies, including the electrical utility company's short-circuit current contribution.
- C. For the purpose of this specification Section, the "Electrical System" shall be defined as the entire power distribution system, including the utility company's main service disconnect down through the main circuit breaker on each 240/120VAC and 208/120 VAC panelboard of all distributed branch circuits. Some equipment not modified as part of this contract is required to be included in the studies defined in this Section. Items within the "Electrical System" are comprised of:
  - 1. All utility transformers
  - 2. All medium voltage equipment
  - 3. All medium voltage to low voltage transformers
  - 4. All 240 VAC panelboards and distribution equipment
- D. The Short-Circuit Study shall provide for the calculation of fault currents at each piece of gear in the Electrical System for the entire Site. Fault currents shall be calculated for scenarios of utility and standby power, as outlined in this Section.
- E. The Protective Device Coordination Study shall include trip characteristics for all protective devices in the Site Electrical System, from the utility company's main service disconnect through the main circuit breaker on each 208/120 VAC panelboard of all distributed branch circuits. Trip characteristics shall be analyzed for scenarios of utility and standby power, as outlined in this Section.
- F. The Arc Flash Risk Assessment shall provide for arc flash incident energy calculations at all panels as required by IEEE 1584 (2018 Edition) and NFPA 70E.
- G. Reports:
  - 1. Reports for the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be stamped and signed by a *California* Registered Electrical Engineer.
  - 2. Report calculations shall be generated by a software analysis application with proven accuracy and reliability at performing 3-phase fault calculations.

### 1.03 REFERENCE STANDARDS

- A. Institute of Electrical and Electronics Engineers, Inc. (IEEE)
- B. American National Standards Institute (ANSI)
- C. The National Fire Protection Association (NFPA)
- D. InterNational Electrical Testing Association (NETA) Standard for Acceptance Testing Specifications (ATS)
- E. NFPA 70E, Standard for Electrical Safety in the Workplace
- F. IEEE 1584 (2018 Edition), Guide for Performing Arc-Flash Hazard Calculations
- G. Occupational Safety and Health Administration (OSHA) (29 CFR PART 1910), Occupational Safety and Health Standards for General Industry

### 1.04 SUBMITTALS

- A. Submit data in accordance with the Product Review category of the General Conditions and the submittal requirements of Section 16010 (26 05 00).
- B. Submit credentials of firm performing the studies to demonstrate sufficient experience with performing this type of work, as specified herein.
- C. Preliminary: Preliminary Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be submitted to the Engineer for review prior to release of equipment drawings for manufacturing. If formal completion of the studies may cause delay in equipment manufacturing, approval from the Engineer may be obtained for preliminary submittal of sufficient study data to ensure that the selection of device and characteristics will be satisfactory.
- D. Results of the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be summarized in a final report. Submit hardbound copies of the complete final report and one digital copy in PDF on a CD. Electronic delivery shall contain full searchable text, and include any computer models developed for the studies at no additional cost.
- E. Sample arc flash warning labels for each piece of equipment. Submit copies of labels at full size, with all required information as calculated by the Arc Flash Risk Assessment.

### 1.05 DATA COLLECTION

- A. The firm performing the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall furnish the Contractor with a listing of required data. The Contractor shall collect and furnish all required data. The Contractor shall expedite collection of the data to eliminate unnecessary delays and assure completion of the studies as required for final acceptance of the equipment shop drawings and/or prior to the release of the equipment for manufacturing.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.01 GENERAL REQUIREMENTS

- A. The Short-Circuit Study and Protective Device Coordination Study shall be performed as outlined in International Electrical Testing Association (NETA) Standard for Acceptance Testing Specifications, Section 6 with exceptions as included in this Section.
- B. In order to select relays and fuse characteristics as required for optimum coordination, the coordination study shall be performed as soon as the vendors for the new electrical equipment are identified. Relays and fuse selection by the power distribution equipment suppliers shall be based on the results of the favorably reviewed study.
- C. The studies shall be submitted to the Engineer for acceptance before final acceptance of power distribution equipment submittals and before any settings are made on equipment.
- D. The final report for the Short-Circuit Study, Protective Device Coordination Study, and Arc Flash Risk Assessment shall be bound in a standard 8 1/2-inch by 11 inch sized report. The selection of all protective relay types, current transformers, and fuse types and ratings shall be the responsibility of the manufacturer and shall be based on the preliminary draft of the coordination study, which shall be submitted with the equipment shop drawings (or earlier). The studies shall be accepted by the Engineer before any equipment is shipped. See Paragraph 1.04 for submittal requirements.
- E. The report shall include a single line diagram depicting the entire Electrical System included in the analysis. At a minimum, the single line diagram shall be on an 11-inch by 17-inch sheet, and include the following information:
  - 1. Equipment/bus tags which match the contract documents
  - 2. Equipment/bus ampacity ratings
  - 3. Motor horsepower
  - 4. Protective device frame rating, trip setting, and curve options, as applicable
  - 5. Transformer primary/secondary voltages, kVA rating, and impedance
  - 6. Conductor materials, insulation types, and lengths
- F. The studies shall be run on each of the following scenarios:
  - 1. Utility power

3.02 SHORT-CIRCUIT STUDY

- A. Provide a complete Short-Circuit Study. The study shall include, but shall not be limited to, the following, as applicable:
  - 1. Full compliance with applicable ANSI and IEEE Standards.
  - 2. Performed on nationally recognized computer software, such as ETAP or SKM Power Tools.
  - 3. Overall system impedance diagram. The diagram shall include the power company's impedance and X/R ratios and circuit element impedances (e.g.,

- transformers, generators, motors, VFDs, feeders, distribution buses as applicable).
4. Available three phase and ground fault asymmetrical and symmetrical short-circuit fault currents at each piece of electrical equipment, bus, transformer, etc.
  5. The momentary and interrupting rating of all elements of the distribution system shall be listed. The maximum available short-circuit fault current available at each element shall be calculated.
  6. Executive summary describing the distribution system, the procedures used to develop the study, utility related information furnished by the utility company, including the name and telephone number of the individual supplying the information, identification of all assumptions made in the preparation of the study, identification of any problem areas, and a definitive statement concerning the adequacy of the distribution system to interrupt and withstand the maximum possible short-circuit fault current.
  7. Computer printouts for the three phase, single phase and ground fault studies. Printouts shall indicate the short-circuit fault current available at each major equipment and distribution bus within the medium and low voltage distribution systems.

### 3.03 PROTECTIVE DEVICE COORDINATION STUDY

- A. Provide a complete Protective Device Coordination Study. The Protective Device Coordination Study shall include, but shall not be limited to:
  1. Utility protective devices.
  2. Service entrance and distribution switchgear.
  3. Medium and low voltage power system transformers.
  4. Low voltage switchgear, switchboards, power distribution panels and motor control centers.
  5. Power factor correction and harmonic mitigation equipment.
  6. Motor starters and variable frequency drives.
  7. Standby generators.
  8. A tabulation of all the settings for every over current protective device, timer, power system relays (e.g., ANSI 50, 51), circuit breaker, recommended fuse and current transformer ratings, etc.
  9. Transformer excitation current.
  10. Motor and cable damage curves in accordance with the manufacturer's recommendations.
  11. Select relay types (e.g., inverse, very inverse, extremely inverse, overcurrent with or without voltage restraint, timers), current transformer ratings and types, fuse, residually or zero sequence connected ground faults protection, etc. that will allow the system to be protected within the equipment fault ratings and provide the maximum possible coordination between the protective devices.
  12. Provide recommended settings for protective devices, such as relays and circuit breakers, to achieve the best selectivity to minimize system disturbances during fault clearing.
  13. Provide a complete set of time-current coordination curves on log-log paper for every protective relay, circuit breaker, fuse, timer, etc. serving or located in the electrical equipment furnished for the project, including the utility protective devices. Provide a separate time-current curve for each unique feeder system, without displaying parallel devices powered from a common



bus. The time-current curves shall display the coordination from the lowest device in the distribution system up through the utility's protective device. Clearly identify each device curve displayed on the graph, by color coding and text callouts. Include specific settings used for the curve (as applicable) in the text callout. A single line diagram depicting the portion of the distribution system under study shall appear with each curve. The minimum size log paper to be submitted shall be 11-inch by 17-inch.

14. Time current curves shall include transformer ANSI damage and inrush curves, cable damage curves, circuit breaker and fuse ratings and settings, protective relay settings, and any other information required by ANSI and good design practices. As a minimum, provide curves for:
    - a. Each medium voltage and low voltage feeder down to 480-volt motor control centers and panelboards.
    - b. Each main, tie and feeder circuit breakers located in medium voltage and low voltage switchgear, motor control centers and panelboard. Include the largest feeder circuit breaker in each motor control center and panelboard.
    - c. Each ground fault protective device provided for the medium voltage and low voltage power distribution systems.
- B. The report shall include a reference to any part of the Electrical System where selectivity cannot be achieved, and a brief explanation of the cause. Provide recommendations where applicable for alternate methods that would improve selectivity.

#### 3.04 ARC FLASH RISK ASSESSMENT

- A. Provide a detailed Arc Flash Risk Assessment. The analysis shall include, but shall not be limited to:
1. Determine potential arc flash incident energies, arc flash boundaries, shock hazard boundaries and proper personal protection equipment (PPE) for all energized electrical equipment.
  2. The study shall determine worst-case scenarios for the arc flash energy level calculations, and any suggested changes to the protection scheme or equipment selection that will result in improved system reliability and safety.
  3. The study shall indicate the worst-case values for each of the scenarios listed in Paragraph 3.01F. Provide values in tabular format including at a minimum, location of fault, incident energy, arc flash boundary, working distance, acting protective device, protective device activation time, and arcing fault current.
  4. Provide executive summary, including introduction, methodology, information sources, key assumptions, NFPA 70E considerations and calculations.
  5. Develop and install arc flash warning labels based on arc flash study results.

#### 3.05 FIELD ADJUSTMENT

- A. All field adjustment and modifications shall be performed in the presence of the Owner, before energizing equipment.
- B. Adjust relay and protective device settings according to the recommended settings table provided by the coordination study. Field adjustments shall be completed by the equipment manufacturer.
- C. Make minor modifications to equipment as required to accomplish conformance with Short-Circuit and Protective Device Coordination studies.

### 3.06 MODIFICATIONS

- A. Notify the Owner in writing of any required major equipment modifications. Major modifications to the equipment shall not be allowed unless otherwise approved in writing by the Engineer and the Owner.

### 3.07 ARC FLASH WARNING LABELS

- A. The vendor shall provide a 4 inch by 4 inch thermal transfer type label of high adhesion polyester for each work location analyzed. Labels shall be machine printed, with no field markings.
- B. The label shall have an orange header, compliant with ANSI Z535, with the wording, "WARNING, SHOCK & ARC FLASH HAZARD", and shall include the following information:
  - 1. Location designation (equipment identification tag)
  - 2. Nominal voltage
  - 3. Arc flash boundary
  - 4. Incident energy at working distance (in calories/centimeter-squared)
  - 5. Working distance
  - 6. Shock boundaries
    - a. Limited approach distance
    - b. Restricted approach distance
  - 7. Required personal protective equipment,
  - 8. Engineering report number, revision number and issue date.
  - 9. Where voltage exceeds 600 VAC or incident energy is greater than 40 cal/cm<sup>2</sup>, label header shall be changed to "DANGER, SHOCK & ARC FLASH HAZARD."
- C. Arc flash labels shall be provided in the following manner and all labels shall be based on recommended overcurrent device settings.
  - 1. For each 600, 480 and applicable 240 and 208 VAC panelboards and disconnects, one arc flash label shall be provided.
  - 2. For each industrial control panel, provide one arc flash label.
  - 3. For each transformer, provide one arc flash label at both the front and rear access points, as applicable.
  - 4. For each low voltage motor control center, at least one arc flash label shall be provided. Motor control centers larger than five sections shall bear one arc flash label for each five sections. Back-to-back or turned corner configurations shall be treated as two motor control centers for the purpose of labeling.
  - 5. For each 96-inches of low voltage switchboard, one arc flash label shall be provided.
  - 6. For each standalone VFD or motor starter, one arc flash label shall be provided.
  - 7. For each switchgear, provide one arc flash label for each the front and rear of the incoming compartment and one arc flash label on each compartment that houses a draw-out device.
  - 8. For each medium voltage motor control center, provide one arc flash label each for the front and rear of the incoming compartment, one label for each individual starter or switch operating handle, and one label each for any draw-out power drawers.
  - 9. Where equipment includes a "maintenance mode" bypass setting on a protective device as a temporary arc-flash reduction measure, provide one

arc flash label at the applicable protective device which indicates the calculated values when maintenance mode is enabled. This label shall be clearly marked to indicate what it represents.

- D. The Contractor shall affix the labels in accordance with the following:
1. Labels shall be in a clearly visible location on the front panel of the equipment near the incoming service or main protective device. Labels on equipment with bottom-entry incoming service shall be placed a minimum of 60-inches from the bottom of the equipment.
  2. Labels affixed to outdoor equipment which includes an outer door and inner deadfront panel shall be placed on the deadfront panel to avoid fading due to exposure to the elements.
  3. For labels affixed to removable compartment doors or covers, the removable cover shall be clearly marked to identify the specific compartment for which it is intended to be used.

END OF SECTION

## SECTION 17010

### INSTRUMENTATION AND CONTROLS, GENERAL REQUIREMENTS

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

###### A. Work Included:

1. Provide all tools, equipment, materials, and supplies and be responsible for all labor required to complete the installation, startup and operational testing of a complete and operable Instrumentation and Control (I&C) System as indicated on the Drawings and as specified herein.
2. Provide all the necessary equipment components and interconnections along with the services of manufacturers' engineering representatives necessary to ensure that the Owner receives a completely integrated and operational I&C system as herein specified.
3. Provide all terminations for wiring at field mounted instruments, equipment enclosures, alarm and status contacts.
4. Provide all Instrumentation and Control wire required for a fully functioning Instrumentation and Controls System as shown on the Drawings except for wire specifically specified in Division 16. See Section 16010.

##### 1.02 REFERENCE STANDARDS

###### A. American National Standard Institute (ANSI) Publications:

1. Y14.15a Drafting Practice
2. C62.1 Surge Arrestors

###### B. Instrumentation Society of America (ISA) Publications:

1. S5.4 Instrument Loop Diagrams
2. S20 Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves

##### 1.03 I&C SUBCONTRACTOR QUALIFICATIONS

- A. An I&C Subcontractor shall be an electrical contractor who has demonstrated experience in purchasing, calibrating, fabricating, installing and testing the Instrumentation and Control (I&C) products listed in this Specification Section. Normally, the I&C Subcontractor is a systems house regularly engaged in the business of panel fabrication, control component procurement, programmable logic controller and personal computer (PC) application in the process control industry.
- B. The I&C Subcontractor has been regularly engaged for a period greater than five years in performing all aspects of the type of work specified in this Section and shown on the Drawings and must prequalify as specified below.

##### 1.04 I&C SUBCONTRACTOR SYSTEM RESPONSIBILITIES

- A. General: The I&C equipment as specified in this Division shall be considered an integrated system. Entire system installation including calibration, verification, startup, operation testing, and training shall be performed by qualified personnel, possessing all the necessary skills and equipment, and who have had experience performing similar installations. Instrumentation and control systems drawings are



diagrammatic only; it is the responsibility of the Contractor to obtain technical data, determine performance requirements, develop instrumentation detail installation designs, and coordinate the selection of specified equipment with Contractor supplied equipment to meet the design conditions stated.

**B. System Responsibilities:**

1. Instrumentation and control system drawings are diagrammatic only. Ensure that all components of the instrumentation system, including primary measuring, indicating, transmitting, receiving, recording, totalizing, controlling, and alarming devices and all appurtenances are completely compatible and shall function as outlined and shall furnish and install such additional equipment, accessories, etc., as are necessary to meet these objectives at no cost to the Owner.
2. Compatibility: See that all components of the instrumentation system, including equipment specified under other Divisions, are completely compatible and function properly as a system. Provide such additional equipment, accessories, etc., as are necessary to meet these objectives at no cost to the Owner.
3. Coordination: As shown on the Drawings.
  - a. Provide technical advice to mechanical and electrical subcontractors as necessary regarding their installation of instruments.
  - b. Verify the correctness of installation of all instruments.
  - c. Verify that the proper type, size, and number of control wires with their conduits are provided.
  - d. Verify that the proper type, size, and number of pneumatic tubes with their conduits are provided.
  - e. Verify that proper electric power circuits provided for all components and systems.
  - f. Resolve all manufacturers' installation discrepancies between requirements and the detail requirements of the Drawings and Specifications.
  - g. Supervise final signal connections, both electric and pneumatic, to all process instrumentation and control equipment.
  - h. Adjust, startup, and test all process instrumentation and control equipment.
  - i. Provide specified documentation and training.
4. Performance: While the Drawings provide sufficient information to establish the form and function of the systems and their relationships, the responsibility for system integration and performance rests solely with the Contractor. The Engineer provides technical instruction and guidance where needed.
5. Site and Instrument Inspection: Inspect site for conformance to Drawings, paying special attention to space allocation and dimensions shown or required on Drawings. Inspect completed work and verify that it is ready for installation of instruments and equipment. Inspect each instrument and piece of equipment for damage, defects, completeness, and correct operation before installing.

**1.05 SUBMITTALS**

- A. Refer to Division 1 for required method of preparation and transmittal and conform to requirements herein.

- B. Shop Drawings: Submit shop drawings (diagrams) for review in complete bound sets indexed by Specification number, with exterior tabs marked by subject. Submit manufacturer's catalog cuts for each item for which shop drawings are not required. Manufacturer's catalog cuts, specifications or data sheets shall be clearly marked to delineate the options or styles to be furnished. Show dimensions, physical configurations, methods of connecting instruments together, mounting details, and wiring schematics. Drawings shall be complete with device tag numbers, wire numbers and terminal board numbers. Submit fabrication details, nameplate legends, and control panel internal wiring and piping schematic drawings. Submit panel graphic drawings where applicable. Include material lists and/or bills of material.
1. Loop/Interconnect Diagrams: Submit a set of analog and discrete wiring diagrams that shows the complete details of installation of instruments and control system components. Include on each drawing the conduit number, wire numbers, the conduit run (via pullboxes, handholes, terminal cabinets, etc.) wiring interconnection and termination points.
- C. Specification Forms:
1. Submit completed Specification Forms per ISA S20, including those instrumentation and control components directly related to process control, but specified in other Divisions of these Specifications.
  2. Include on each form the assigned tag numbers, manufacturer's part numbers, and device data. More than one tag numbered item may be included on a sheet.
- D. As-Built Drawings: Submit a revised set of shop drawings that incorporates all change orders and modifications made during performance of the work. In addition to updated loop diagrams, submit equipment and device wiring diagrams (see Sketch 17010-4) and other drawings as necessary to depict the "as-built" condition of equipment. Include all installed field and panel conduit and piping/tubing runs and routing, tray systems, supports, mounting details, interconnection diagrams with cable, wire, tube and termination numbers. Coordinate all drawings with the conductor identification requirements in Section 16120 and Section 16124.
- E. Operation and Maintenance Manuals: Furnish Operation and Maintenance Manuals, including Instruction Manuals and Part Lists, for equipment provided under Division 17 as required by Division 1. Obtain data from manufacturers, and format and bind as specified. Obtain distribution method instructions from the Owner or his representative.
1. Schedule: Deliver at least two (2) copies of manuals in 3-ring binders (8-1/2 by 11-inch format) not later than the equipment shipment date.
  2. Contents: Include in manuals not less than the following information, as applicable, for each instrument, equipment, subsystem and/or control loop:
    - a. General, introduction and overall description, purpose, functions, simplified theory of operations, etc.
    - b. Specifications (including equipment specification data sheet as described above under Shop Drawings), sufficiently detailed for reordering exact duplicates of the original items.
    - c. Installation instructions, procedures, sequences, tolerances, and precautions.
    - d. Operational procedures.
    - e. Shutdown procedures.

- f. Maintenance, calibration, and repair instructions.
  - g. Parts list and spare parts recommendations.
  - h. Calibration curves, rating tables, and any other data showing the relationship of the variable inputs and the calibrated output of all measuring devices and controlled equipment.
3. Format:
- a. Use drawings and pictorials to illustrate the text to the extent necessary to insure a clear, concise presentation. If manuals have been written to cover a family of similar instruments or equipment, strike out inapplicable information in a neat fashion or emphasize applicable portion by heavily weighted arrows, circles or boxes; whichever provides the clearest and neatest presentation.
  - b. Group manuals by system control panels, including field instrumentation connected or associated with the panel. Where identical instruments are used in more than one control loop or subsystem, include only one instruction manual, per panel grouping; however, an index by tag number for all instruments shall identify its location in that manual.
  - c. Provide control loop and/or subsystem operational descriptions to identify the function of each instrument and its relation to the other instruments in the loop.
4. Binding: Bind each manual in a cover which indicates the panel or process area to which it applies, manufacturer's name, local address and telephone number, and year of purchase. Punch and bind manuals in standard three ring binders and include system name and subcontractor's name on binding.
- F. Accessory and Maintenance Materials: Submit data for the following items:
- 1. Special Tools and Accessories: Special tools, instruments, and accessories for maintaining instruments and equipment requiring periodic repair and adjustment as specified elsewhere herein. Also, furnish special lifting and handling devices for equipment requiring such devices.
  - 2. Maintenance Materials and Spare Parts: Submit a list of manufacturer recommended spare parts for each item specified. Refer to other sections of these Specifications.
- G. Test Reports: Submit the following test reports as described herein:
- 1. Instrument Calibration Data Sheets (para. 2.13)
  - 2. Factory Testing of Control Panels (para. 2.14)
  - 3. Instrument Verification Report (para. 3.08.B)
  - 4. Final Operational Testing (para. 3.08.C)
- H. Demonstration and Final Operation Test Plan and Results: Submit a document that outlines all procedures to be used in final operational testing of instrument and control systems. Include a description of each system, the scope of testing, test methods and materials, testing instruments and recorders, a list of functional parameters to be recorded on each item, and Shop Drawings showing temporary bypasses, jumpers, and devices.

## 1.06 QUALITY ASSURANCE

- A. Standard of Quality: The Contractor shall provide equipment of the types and sizes specified which has been demonstrated to operate successfully. Provide equipment which is new and of recent proven design.

## 1.07 INSPECTIONS

- A. The Engineer may inspect the fabricated equipment at the factory before shipment to job site. Provide the Engineer with sufficient prior notice so that an inspection can be arranged at the factory.
- B. Inspection of the equipment at the factory by the Engineer will be made after the manufacturer has performed satisfactory checks, adjustments, tests and operations.
- C. Favorable review of the equipment at the factory only allows the manufacturer to ship the equipment to the project site. The Contractor shall be responsible for the proper installation and satisfactory startup operation of the equipment to the satisfaction of the manufacturer and the Engineer.

## 1.08 DRAWINGS

- A. Drawings: The Instrumentation Drawings are diagrammatic; exact locations of instrumentation products shall be determined in the field by the Engineer. Except where special details are used to illustrate the method of installation of a particular piece or type of equipment or material, the requirements or descriptions in this Specification shall take precedence in the event of conflict.
  - 1. Locations of equipment, inserts, anchors, motors, panels, pull boxes, manholes, conduits, stub-ups, fittings, power and convenience outlets, and ground wells are approximate unless dimensioned; verify locations with the Engineer prior to installation. Field verify scaled dimensions on Drawings.
  - 2. Review the Drawings and Specification Divisions of other trades and perform the instrumentation work that will be required for the installations.
  - 3. Should there be a need to deviate from the Instrumentation Drawings and Specifications, submit written details and reasons for all changes to the Engineer for favorable review.
  - 4. Resolution of varying interpretations of the Contract Documents shall conform to Division 0, General and Supplementary Conditions.
  - 5. The Drawings provide details of installation and supersede the manufacturer's recommendation where a conflict exists.

## 1.09 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Box, crate, or otherwise enclose and protect instruments and equipment during shipment, handling, and storage. Keep all equipment dry and covered from exposure to weather, moisture, corrosive liquids and gases or any element that could degrade the equipment. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Notify the Engineer in writing in the event that any equipment or material is damaged. Obtain prior favorable review by the Engineer before making repairs to damaged products.



## 1.10 INSTRUMENT SCHEDULE

Page No. 1									
INSTRUMENT SCHEDULE ATTACHMENT TO SPECIFICATION 17010									
Type	Location	Description	I/O	Signal	Range Calib. Range Setpoint	P&ID	Spec. Para.	PNL	Manufacturer Serial No.
LIT	001	Level Transmitter Parshall Flume (Flow)	AI	4-20 MA	0-20,000 GPM	I-011	17120	N/A	See Spec
LE	001A	Radar Level Element Flume Influent	N/A	4-20 MA	0-5FT	I-011	17120	N/A	See Spec
LE	001B	Radar Level Element Flume Effluent	N/A	4-20 MA	0-5FT	I-011	17120	N/A	See Spec
ZS	001	Metro Metering Vault Hatch Switch	N/A	120 VA C	0-1	I-011	17170	N/A	See Spec
AIT/AE-011	001	Autosampler	DI					N/A	See Spec

## PART 2 - PRODUCTS

### 2.01 MATERIALS AND STANDARD SPECIFICATIONS

- A. Provide instruments, equipment and materials suitable for service conditions and meeting standard specifications such as ANSI, ASTM, ISA, and SAMA. The intent of this Specification is to secure instruments and equipment of a uniform quality and manufacture throughout the plant. All instruments in the plant of the same type shall be made by the same manufacturer.

### 2.02 DATA LOGGER

- A. Integrate data logger with the radio communication system using Ethernet/IP, as depicted in the drawings. Ensure seamless connectivity for efficient data transfer.

- B. Include a high-capacity SD Card with a minimum storage capacity of 32GB to be used in conjunction with the data logger.
- C. Manufacturer: Data logger shall be Sutron Xlite 3210B or engineer-approved equal.

## 2.03 RADIO COMMUNICATIONS

- A. Radio
  - 1. Securely mount radio within Metro Electrical Cabinet with a radio shelf. Radio Shelf shall be Saginaw SCE-FS1212 or engineer-approved equal.
  - 2. Manufacturer: GE MDS SD4MD-CES-NNSNN or engineer-approved equal.
- B. Antenna
  - 1. Existing Yagi Style Antenna (suitable for communication in the 450MHZ to 470MHZ shall be re-utilized).
  - 2. Existing polyphaser at each location shall be re-purposed.
- C. Polyphaser (Antenna Cable Surge Protector)
  - 1. Manufacturer: Talley Polyphaser IS-B50LN-C2 or engineer-approved equal.

## 2.04 NAMEPLATES

- A. For each piece of equipment, provide a manufacturer's nameplate showing his name, location, the pertinent ratings and the model designation.
- B. Identify each piece of equipment and related controls with a rigid laminated engraved phenolic nameplate. Engrave nameplates with the inscriptions indicated on the Drawings and, if not so indicated, with the equipment name. Securely fasten nameplates in place using two stainless steel screws or, where favorably reviewed by the Engineer, with epoxy cement. Where no inscription is indicated on the Drawings, furnish nameplates with an appropriate inscription furnished by the Engineer upon prior request by the Contractor.
- C. Each control device, including pushbuttons, control switches, and indicating lights, shall have an integral legend plate or nameplate indicating the device function. These shall be inscribed as indicated on the Drawings or as favorably reviewed by the Engineer.
- D. Provide CAUTION or SAFETY nameplates to alert operators of special conditions that may result in faulty equipment operations. Devices containing batteries that must be replaced periodically must be clearly identified. Nameplates are not required if the device senses and displays a low battery warning.

## 2.05 NAME TAGS

- A. All instrumentation and equipment items or systems shall be identified by name tags. Field equipment shall be tagged with the assigned instrumentation tag number listed in the Instrument Schedule.
- B. Name tags shall be stainless steel with engraved or stamped black characters of 3/16 inch minimum height. Tags shall be attached to equipment with a tag holder and stainless steel band with a worm screw clamping device. Use 20-gauge stainless steel wire where banding is impractical. For field panels or large equipment cases use stainless steel screws; however, such permanent attachment shall not be on an ordinarily replaceable part.

## 2.06 FIELD-MOUNTED EQUIPMENT

- A. All instrument and control equipment mounted outside of protective structures shall be equipped with suitable surge arresting devices to protect the equipment from damage due to electrical transients induced in the interconnecting lines from lightning discharges or nearby electrical devices. Protective devices used on 120 Vac inputs to field mounted equipment shall be secondary valve surge protectors conforming to the requirements of ANSI C62.1.

## 2.07 EQUIPMENT OPERATING CONDITIONS

- A. All equipment shall be rated for normal operating performance with varying operating conditions over the following minimum ranges:
  - 1. Electrical Power: 120 Vac  $\pm$ 10%, 60 Hz, unregulated, except where specifically stated otherwise on the Drawings or in the Specifications, or when two-wire, loop-powered devices are specified.
  - 2. Field Instruments:
    - a. Outdoor Areas:  
Ambient Temperature: 0°F to +120°F  
Ambient Relative Humidity: 5% to 100%  
Weather: Rain, sleet, snow and ice

## 2.08 EQUIPMENT LOCATIONS

- A. Provide equipment and materials suitable for the types of locations in which they are located as defined under Division 16. All equipment specified for field mounting shall be weatherproof and splash proof as a minimum.

## 2.09 ANALOG SIGNAL INDICATED UNITS

- A. For all instruments with local or remote indicators, provide indicators scaled in actual engineering units, i.e., gallons per minute, feet, psi, etc., rather than 0 to 100%, unless noted otherwise on the Drawings or Instrument Schedule.

## 2.10 SIGNAL TRANSMISSION

- A. Analog:
  - 1. Signal transmission between electric or electronic instruments shall be 4 20 mA and shall operate at 24 Vdc. Signal output from all transmitters and controllers shall be current regulated and shall not be affected by changes in load resistance within the unit's rating. Where practical, milliampere signals from the field shall be converted to a voltage signal at the external terminals of each panel, and all instruments within a panel shall be parallel wired.
  - 2. Nonstandard transmission systems such as impulse duration, pulse rate, and voltage regulated will not be permitted except where specifically noted in the Instrument Schedule or shown on the Drawings. When transmitters with nonstandard outputs do occur, their output shall be converted to 4 20 mA prior to transmission.
- B. Discrete: All alarm and status signals shall be 120 Vac unless specified otherwise on the Instrument Schedule.

## 2.11 PAINTING

- A. Factory paint all instruments and equipment except where installed in pipelines. Where instrument panels are installed adjacent to electrical control panels provided under Division 16, provide instrument panels of identical color to that of electrical control panels. Paint as required in Division 9 for structural supports, brackets, etc. Repair damaged factory paint to satisfaction of the Engineer. Feathering, priming and painting shall produce a reasonable match to the surrounding paint work.

## 2.12 FASTENERS

- A. Fasteners for securing equipment to walls, floors and the like shall be either hot-dip galvanized after fabrication or stainless steel. Provide stainless steel fasteners in corrosive locations. When fastening to existing walls, floors, and the like, provide capsule anchors, not expansion shields. Size capsule anchors to meet load requirements. Minimum size capsule anchor bolt is 3/8 inch.

## 2.13 INSTRUMENT CALIBRATION

- A. Each field instrument shall be calibrated at 0%, 25%, 50%, 75% and 100% of span using test instruments to simulate inputs and read outputs that are rated to an accuracy of at least 5 times greater than the specified accuracy of the instrument being calibrated. Such test instruments have accuracies traceable to the National Institute of Standards and Technology (NIST).
- B. Submit a written report to the Engineer on each instrument. This report shall include a laboratory calibration sheet or the manufacturer's standards calibration sheet on each instrument and calibration reading as finally adjusted within tolerances.
- C. The Contractor may, at his option, choose to perform calibration on an instrument by acquiring the services of an independent test lab, or by obtaining the required test instruments and performing the calibration.

## 2.14 FACTORY TESTING OF PANELS

- A. All fabricated equipment shall be tested before it leaves the factory.
- B. Factory testing of control panels/devices/equipment shall be accomplished. Refer to individual Specification sections for tests requiring favorable review.
- C. Upon completion of factory testing, submit a report certifying the control panels/devices/equipment are operable and meet the Specifications.

## PART 3 - EXECUTION

### 3.01 MOUNTINGS

- A. Mount and install equipment as indicated. Mount field instruments on pipe mounts or other similar means in accordance with suppliers' recommendation. Where mounted in control panels, mount according to requirements of that section.
- B. Equipment specified for field mounting shall be suitable for direct pipe mounting or surface mounting, surface-mounted indicators and equipment with calibration



adjustments or requiring periodic inspection shall be mounted not lower than 3 feet 6 inches nor higher than 6 feet above walkways, platforms, catwalks, and the like.

- C. Note that applicable specifications require detail drawings showing seismic sway bracing design and anchorage requirements for their equipment. Seismic zone requirements are specified in Division 1.
- D. All devices shall be accessible to operators for servicing, operating, reading, etc. Provide permanent platforms to assure devices are continuously accessible.

### 3.02 PROCESS CONNECTIONS

- A. Provide instrument impulse tubing (see Part 2) to meet the intended process service and ambient environmental condition for corrosion resistance, etc. Install impulse tubing with a continuous slope according to service to promote self-draining or venting back to the process. Terminate connection to process lines or vessels in a service rated roof valve, provided under other Divisions, that will permit closing off the impulse line or removal of the element without requiring shut down of the process. Include blowdown of drip legs and valves for terminations of impulse lines at the instruments.
- B. Process vessels, line penetrations, and root valves shall be furnished and installed under other Divisions of these Specifications. Instrument tubing and valve manifolds are installed as part of this Specification.

### 3.03 FIELD WIRING

- A. Ring out signal wiring prior to termination and perform surge withstand tests where required (see Section 16010 (26 05 00), Part 3 for methods). Verify wire number and terminations are satisfactory as designated on the Loop and Interconnect Diagrams. Verify all terminations are tight and shields are uniformly grounded at one location.

### 3.04 ELECTROMAGNETIC INTERFERENCE (EMI)

- A. Construction shall proceed in a manner which minimizes the introduction of noise (RFI/EMI) into the I&C System.
- B. Cross signal wires and wires carrying ac power or control signals at right angles.
- C. Separate signal wires from wires carrying ac power or switched ac/dc control signals within control panels, terminal cabinets, telemetry equipment, multiplexer cabinets, and data loggers as much as possible. Provide the following minimum separations within such equipment unless indicated otherwise on the Drawings:

<b>Power Wiring Capacity</b>	<b>Separation (Inches)</b>
120 volts ac or 10 amps	12
240 volts ac or 50 amps	18
480 volts ac or 200 amps	24
4,160 volts ac or 800 amps	48

### 3.05 SIGNAL GROUNDING

- A. Proper grounding of equipment and systems in this Division is critical. The Drawings and Division 16, Section 16450, specify safety grounding for all equipment in this Division.
- B. A single-point grounding system for instrument signals is required for all panels. This instrument single point grounding system does not use building steel or conduit systems for its ground path.
  - 1. Ground all signal shields, signal grounds, and power supplies at an isolated signal bus within each instrument panel, rack, or enclosure. The shields at the far ends of these signal cables must be disconnected (floated) from any ground to prevent ground loops.
  - 2. Do not connect the rack or enclosure frames to the signal grounding buses.
  - 3. Connect each isolated signal ground bus within each panel using a stranded, insulated copper wire of size 6 AWG or larger directly to a system ground rod installed per the Drawings.

### 3.06 PREPARATION

- A. Ensure that installation areas are clean and that concrete or masonry operations are completed prior to installing instruments and equipment. Maintain the areas in a broom-clean condition during installation operations.
- B. Panels shall be protected during construction to prevent damage to front panel devices and prevent dust accumulation in the intervals. Other protective measures (lamp, strip heaters, etc.) shall be included as weather conditions dictate.

### 3.07 FIELD TESTING

- A. General: The purpose of the field testing is to verify instruments are calibrated and operationally performing their intended function. Provide the services of factory trained and experienced engineers to perform verification and operational testing as prescribed below. Since the initial calibration of instruments may not satisfy the final operation of system, perform recalibration or adjust setpoints as required to satisfy the performance requirements of the system. Notify the Engineer and Owner in writing a minimum of 48 hours prior to the proposed date for commencing final operational testing and acceptance.
- B. System Verification Testing: Verify that each instrument shown on the Instrument Schedule is operating and calibrated as specified in the Instrument Schedule by simulating inputs at the primary element in each system loop and verify performance at loop output devices (i.e. recorder, indicator, alarm, etc., except controllers). Simulate inputs at 0%, 25%, 50%, 75%, and 100% of span or with on-off inputs, as applicable. During system verification:
  - 1. Make initial or provisional settings on levels, alarms, etc. listed in the Instrument Schedule.
  - 2. Verify controllers by observing that the final control element moves in the proper direction to correct the process variable as compared to the set point.
  - 3. Cause malfunctions to sound alarms or switch to standby to check system operation.
  - 4. Check all loop instruments thoroughly for correct operation.
  - 5. Immediately correct all defects and malfunctions disclosed by tests.
  - 6. Submit a report certifying completion of verification of each instrument system. This report shall include a data sheet on each instrument tested that

indicates instrument tolerances, instrument calibration verification, data and initial settings made to devices.

- C. Final Operational Testing: Upon completion of instrument verification, test all systems under process conditions in the presence of the Owner or designated representative. System testing shall be accomplished in accordance with the approved Test Plan (Paragraph 1.071) The test for each portion thereof shall be witnessed, documented and signed off upon completion by the Engineer. The intent of this test is to demonstrate and certify the operational interrelationship of plant instrumentation and control systems. This testing shall include, but not be limited to:
1. Making final adjustments to levels, alarms, etc.
  2. Optimum tuning of controllers.
  3. Checking all alarms, failure interlocks, and operational interlocks.
  4. Immediately correcting all defects and malfunctions and retesting.
  5. Submit the witnessed test results and a transmittal letter indicating that all required systems have been tested satisfactorily and the systems meet all the functional requirements of their applicable specifications.

END OF SECTION

## SECTION 17110

### PROCESS ANALYTICAL INSTRUMENTS

#### PART 1 - GENERAL

##### 1.01 SUMMARY

- A. Section includes:
  - 1. Autosamplers for wastewater
- B. Provide all instruments identified in the Contract Documents.

##### 1.02 REFERENCES

- A. As specified in Section 17010 - Instrumentation and Controls, General Requirements.
- B. CSA International (CSA).

##### 1.03 DEFINITIONS

- A. As specified in Section 17010 - Instrumentation and Controls, General Requirements.

##### 1.04 SUBMITTALS

- A. Shop Drawings:
  - 1. Shop drawings to be submitted in this Section shall be made in one package under Product Review category of shop drawings.
  - 2. In addition to the requirements of Section 17010, shop drawings shall include for each type of instrument: physical dimensions, supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.
  - 3. Where the Drawings indicate a process analytical instrument installed as part of an analyzer panel, the shop drawings shall include scaled fabrication drawings of the complete analyzer panel showing the process analytical instruments and associated accessories.
  - 4. All shop drawings, catalog pages, and cut sheets shall be clearly marked with the unique tag for the instrument(s) to which they apply.
  - 5. Shop drawings shall include a completed ISA S20 form for each device.
  - 6. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.
- B. Manuals:
  - 1. Submit manuals in accordance with the requirements of Section 17010.
  - 2. ISA S20 forms: Include a completed final S20 form for each device with the manuals. S20 forms shall be updated to include final values or notes from testing, startup, and commissioning.
  - 3. Parts List: Include a parts list showing current net prices and a list of recommended spares with the manuals.



## 1.05 QUALITY ASSURANCE

- A. As specified in Section 17010 - Instrumentation and Controls, General Requirements.
- B. Examine the complete set of Contract Documents and verify that the instruments are compatible with the installed conditions including:
  - 1. Process conditions: Fluids, pressures, temperatures, flows, materials, etc.
  - 2. Physical conditions:
    - a. Installation and mounting requirements.
    - b. Location within the process.
    - c. Accessories: Verify that all required accessories are provided and are compatible with the process conditions and physical installation.
- C. Notify the Engineer if any installation condition does not meet the instrument manufacturer's recommendations or specifications.
- D. Provide instruments manufactured at facilities certified to the quality standards of ISO 9001.

## 1.06 DELIVERY, STORAGE, AND HANDLING

- A. As specified in Section 17010 - Instrumentation and Controls, General Requirements.

## 1.07 PROJECT OR SITE CONDITIONS

- A. Project environmental conditions as specified in Section 17010 - Instrumentation and Controls, General Requirements.
  - 1. Provide instruments suitable for the installed site conditions including, but not limited to, material compatibility, site altitude, site seismic conditions, humidity, and process and ambient temperatures.

## 1.08 WARRANTY

- A. As specified in Section 17010 - Instrumentation and Controls, General Requirements.

## 1.09 MAINTENANCE

- A. Furnish all parts, materials, fluids, etc. necessary for operation, maintenance, and calibration purposes throughout the warranty period. Deliver all these supplies before project substantial completion.

## PART 2 - PRODUCTS

### 2.01 AUTOSAMPLER

- A. General:
  - 1. Contractor shall furnish and install a fixed site wastewater autosampler with integral refrigeration. The unit shall sit within its own compartment within the meter vault electrical cabinet.
  - 2. Ambient Operating Temperature: 32°F to 122°F.
- B. Sampling Pump:

1. Pump Type: High-speed peristaltic, dual roller
  2. Pump tubing diameter: 1/4" to 3/8" ID
  3. Pump tubing material: Silicone or Norprene
  4. Air Purge System: Air shall be purged automatically before and after each sample.
  5. Performance Requirements:
    - a. Required pump vertical lift: 15 feet
    - b. Sample flow required: 0 to 4,800 mL/min
    - c. Sample type: Composite
    - d. Solids Handling: Pump shall be able to transport solids up to the diameter of the pump tubing.
- C. Cooling/Refrigeration System:
1. Air sensing thermostat capable of maintaining sample liquid temperature at 39°F.
  2. Accuracy:  $\pm 1.5^{\circ}\text{F}$
- D. Sample Materials:
1. Intake strainer: 316 stainless steel
  2. Intake tubing diameter: 1/4" to 3/8" ID
  3. Intake tubing material: Reinforced PVC polyethylene flexible tubing, PTFE lined polyethylene with protective outer cover, or reinforced black PVC.
  4. General requirements:
    - a. Minimum length: 40'
    - b. Intake tubing shall successfully intake wastewater samples from the flume and transport to the sampling unit in one complete tubing unit. No tubing pieces shall be joined together.
  5. Sample bottle: 25-liter or 2.5-gallon polyethylene container with cap
- E. Controller:
1. Enclosure: NEMA Type 4X
  2. Power supply: 120VAC Receptacle
  3. Backup power supply: Minimum 5 amp-hour gel lead acid battery
- F. Spare Parts:
1. One (1) bottle kit including all appurtenances for transferring samples from the pump to the storage container.
  2. Ten (10) feet of additional intake tubing
  3. Five (5) feet of additional pump tubing
  4. One (1) intake strainer
- G. Manufacturers:
1. Endress Hauser: Liquistation CSF28
  2. Or approved equal.
- H. Controls
1. Sample interval: Programmable from 1 to 1,440 minutes, in one-minute increments.
  2. Sample volume: Programmable from 10 to 500 mL, in 10 mL increments.

## PART 3 - EXECUTION

### 3.01 IDENTIFICATION

- A. Provide identification tags in accordance with Section 17010.

### 3.02 INSTALLATION

- A. Installation, testing, calibration, validation, startup, and instruction shall be in accordance with Section 17010.
- B. Adjust location of analytical instruments and sensors in the field to provide optimum accessibility and readability.
- C. Install intake sample tubing in conduit as required by the electrical documents.
- D. Provide solutions as required by the manufacturer for testing and calibration of analyzers.
- E. Provide manufacturer's services to perform installation inspection, start-up, and calibration/verification.

### 3.03 FIELD SERVICES

- A. The manufacturer shall be on site for a minimum of one (1) field day for a total of eight (8) hours to program the autosampler per Metro Water Recovery requirements. Contractor shall coordinate an on-site meeting with the manufacturer and Metro Water Recovery and ensure that the programming requirements for sample intervals, sample volumes, and other pertinent items are completed and tested prior to acceptance.

END OF SECTION

## SECTION 17120

### FLOW MEASUREMENT

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Requirements of Division 1 and Section 17010 form a part of this Section. This Section specifies flow measurement devices for process instrumentation, auxiliary equipment, and supplies directly related to the installation of and operation of these flow measurement devices, to perform the required functions in conjunction with information and equipment specified in other sections of Division 17.
- B. Provide all instruments identified in the Drawings.

##### 1.02 REFERENCES

- A. US Department of Interior Bureau of Reclamation – Water Measurement Manual

##### 1.03 SUBMITTALS

- A. Shop drawings and product data to be submitted in this Section shall be made in one package under the Product Review Category of Shop Drawings. See Section 01300.
- B. Shop Drawings and Product Data:
  - 1. In addition to the requirements of section 17010, shop drawings shall include for each type of instrument: supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.
  - 2. Furnish Shop Drawings and Product Data for each item of mechanical equipment presenting sufficient data to determine compliance to these Specifications. Submit completed ISA S20 forms for each device and physical dimensions. Also submit manufacturer's recommended upstream and downstream straight piping lengths, recommended location of any pressure taps, and estimates of pressure losses through the device.
  - 3. Operations and Maintenance Manuals.
- C. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.
- D. Parts List: Submit a Parts List with current net prices and a list of recommended spares.
- E. Factory Testing and Calibration:
  - 1. The flume supplier shall provide product information data to the transmitter supplier or, where practical, test the flume and transmitter as an integral assembly in the field. The integral test shall be accomplished at no extra cost to the customer.
- F. Manuals: Furnish manufacturer's installation, lubrication, operation and maintenance manuals, bulletins, and spare parts lists.



- G. Affidavits: Furnish affidavits from the manufacturers stating that transmitters have been properly installed and tested and each is ready for full time operation.

#### 1.04 QUALITY ASSURANCE

- A. Manufacturer: In addition to the requirements of Section 17010, flow measurement devices furnished shall be manufactured by firms regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.
- B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover.
- C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Drawings or as specified.
  - 1. Provide instruments suitable for the site conditions including, but not limited to, ambient temperatures, altitude, humidity, material compatibility, and process conditions.

#### 1.05 INDICATING UNITS

- A. Provide flow indication in engineering units (GPM, CFS, MGD, etc.). Indicators which read 0 to 100%, 4-20 mA, etc. shall not be acceptable.

#### 1.06 SERVICE CONDITIONS

- A. The flume shall measure raw municipal wastewater flows from an upstream sanitary sewer system prior to discharge to Metro Water Recovery. Typical characteristics of raw municipal wastewater should be anticipated for the design of flow measurement devices.

### PART 2 - PRODUCTS

#### 2.01 OPEN CHANNEL FLOW MEASUREMENT

- A. Parshall Flume with Level Measurement
  - 1. General: Uses the geometry of the flume to predict a flow rate based on a level measurement. Flume liners shall have throat widths and dimensions as shown on the Drawings. Other dimensions of Parshall flume liners shall conform with the standard design dimension for flumes of the specified throat widths stated in the latest edition of the Bureau of Reclamation Water Measurement Manual. Flume liners shall be equipped for installing an ultrasonic or radar level sensor suspended above the surface of the flume. Accuracy shall be 5% or greater.
  - 2. Construction: Flume liners shall be molded in one piece from fiberglass reinforced polyester (FRP) with sufficient wall thickness and reinforcing ribs to

- prevent distortion while being shipped or installed. Stainless steel inside surfaces of the liner shall be smooth and free from irregularities. Outside surfaces shall be furnished with side clips for fastening to rebar with the wire in grout or concrete. Liners shall be equipped with removable top cross ties to facilitate installation.
- a. Cross braces shall be fiberglass material.
  - b. Interconnection piping shall be fiberglass or stainless steel.
3. Design and Fabrication Requirements:
- a. Wall thickness: 5/16 inch
  - b. Smooth gel-coat on wetted surfaces
  - c. Integral reinforcing ribs
  - d. Flume dimensions shall be per the Bureau of Water Reclamation Water Measurement Manual
  - e. Minimum number of top cross braces: 4
    - 1) Cross braces shall be 4 x 4 x 1/4 inch angle
  - f. Head gage:
    - 1) Mount on sidewall at  $H_a$  and  $H_b$  locations
    - 2) Markings:
      - a) Inches, tenths of inches, and mgd
      - b) 3/8 inch high characters
    - 3) Scale protected from fluid by smooth clear fiberglass laminate
    - 4) Smooth and flush with sidewall
    - 5) Head gage for determining whether submerged flow conditions exist shall be mounted at the  $H_b$  position in the throat of the flume as specified in the Bureau of Reclamation Water Measurement Manual.
      - a) Same side as  $H_a$  gage
      - b) Same elevation as  $H_a$  gage
      - c) Elevation markings only
  - g. Anchor clips:
    - 1) Permanently attached to exterior sidewall, midway up side.
  - h. Removable block to prevent distortion during shipment and installation
  - i. Self-supporting
  - j. Designed for grouted-in installation in channel with no additional internal or external supports.
  - k. Inlet and outlet transition pieces with calking collar.
4. Measuring well connections shall be cast into the side of the flume at the  $H_a$  and  $H_b$  dimension points. Measuring wells shall extend below the invert. The supplier shall coordinate with sonic probe supplier for exact mounting method and location above the fluid surface.
5. Level sensor using radar used in conjunction with the channel dimensions shall be used to obtain a cross-sectional flow area. This level sensor shall be capable of computing flows utilizing flume head-flow calculations. Instruments within hazardous areas shall be intrinsically safe, explosion proof.
6. Manufacturer:
- a. Plasti-Fab
  - b. Or approved equal

## 2.02 LEVEL TRANSMITTER – RADAR TYPE

### A. Pulsed Time-of-Flight (PTOF) Radar

#### 1. General:

- a. This type of level sensor shall use the following principle: A burst of microwave energy in the form of a “chirp” of a specific frequency profile is directed toward a target surface of interface. The interface may be air-liquid, air-solid, liquid-solid, and liquid-liquid if the densities of the two liquids are sufficiently different and provide a clearly definable interface. The return time and frequency profile of the reflected radiation is measured and converted into an electrical signal proportional to the distance from the sensor to the interface, or alternatively the distance from another reference level, such as the flume bottom, when the sensor is top mounted. As such, these are radio emitters regulated by FCC Part 15, and all applications must be approved by the vendor as conforming.

#### 2. Specific Requirements:

- a. Specific applications shall be as shown on the Drawings.
- b. Sensor shall be certified by the vendor as complying with FCC Part 15 for the specific application and mounting geometry in the design.
- c. Level ranges, output signals and setpoints are specified in the Instrument List.
- d. Frequency Band: 80 GHz.
- e. The sensor beam angle shall be 10 degrees maximum.
- f. Accuracy: +/- 2 mm.

#### 3. Construction:

- a. The unit shall consist of sensing probes with remote mounted electronic transmitter as indicated in the Instrument List and the Drawings. In a remote mount application, the interconnecting cable between sensing probes and electronic transmitter shall be provided by the manufacturer with the instrument.
- b. A level indicator shall be provided on the transmitter where indicated in the Instrument List or on the Drawings. The indicator shall be of the type and in the units specified in the Instrument List.
- c. The housing for the probe and transmitter shall be rated NEMA 4X.
- d. All instruments and sensors to be installed in hazardous locations shall be rated for the class, division, and group indicated on the Drawings.

#### 4. Mounting:

- a. The probes shall be suspended, and the transmitter shall be panel mounted as indicated on the Drawings. Probe installation shall be per manufacturer’s instructions.

#### 5. Signal/Output:

- a. 4 to 20 milliamperes into 0 to 600 ohms with Hart.

#### 6. Power:

- a. The system shall operate from 120 Vac, 60 Hertz power.
- b. Variations of  $\pm 10\%$  in voltage or frequency shall not affect the accuracy in excess of 0.5%.

#### 7. Accessories:

- a. Manufacturer (PTOF Type): Siemens SITRANS LT500 Transmitter with SITRANS LR100 Radar Elements, or engineer-approved equal.

## 2.03 STOP PLATES AND GUIDES

### A. Materials

1. General: Stop plates shall be comprised of engineered composite FRP completely encapsulating an internal reinforcing structure.
  - a. Molded to create a seamless corrosion barrier impervious to moisture.
  - b. Reinforce with carbon steel as needed.
  - c. Internal core foam: 6 lb polyisocyanurate closed cell rigid foam
2. Guide Frames:
  - a. Materials: FRP
3. Handles and Gate Hardware:
  - a. Materials: 316 stainless steel
4. Seals
  - a. Side seals shall be hollow bulb J-seal molded of extruded EPDM
  - b. Bottom seals shall be flush bottom seal of extruded EPDM
5. J-Seal Clamping Bar and Fasteners
  - a. Materials: 316 stainless steel
6. Anchor bolts
  - a. Materials: 316 stainless steel

### B. Design criteria

1. Deflection across the plates shall be limited to length/360 or 1/4", whichever is less, at the maximum operating head.
2. Plates shall be designed to withstand head pressure from a gravity sewer system with an expected maximum head differential of 42".
3. All plates shall be flat and level. Warpage throughout the entire plate shall not produce a crown of more than 1/16" in any direction.
4. Guides shall have a slot suitable for mating with the plate body.
5. Each plate shall be sealed on the sides and bottom with extruded EPMD material.

### C. Manufacturers:

1. National Oilwell Varco (NOV)
2. Or approved equal

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Provide installation, testing, calibration, verification, and startup instructions in accordance with Section 17010 and the manufacturer's instructions. Coordinate the installation with all trades to ensure the mechanical system is proper for the instrument.
- B. Startup Assistance and commissioning shall be provided by a factory certified representative.
- C. Where instruments are located outdoors provide surge protectors at the transmitters. Provide isolators, relays, conditions, or other devices as required for a functional system.
- D. Instruments without approved submittals shall not be installed.



- E. Top-Mounted Non-Contact Instruments:
  - 1. Level instruments which rely upon ultrasonic, radar, or laser type sensing shall be mounted such that the emitted beam can measure the full range of the medium without interference or obstruction.
- F. Where instrument cables exit the open end of a conduit into a tank or wet well, provide a removable bushing around the cable at the conduit opening. The bushing shall support the cable to prevent chafing and seal the opening to reduce moisture accumulation in the conduit. Bushings shall be Emerson/OZ Gedney Type CSBI or equal.
- G. The Contract Drawings and Specifications are intended show basic functional requirements. Insufficient detail does not relieve the Contractor from the responsibility to provide a complete and functioning system.
- H. The Parshall flume manufacturer shall be present for the flume installation and shall provide written verification to the Engineer that the flume was installed per the manufacturer's specifications.

### 3.02 FIELD TESTING

- A. The installation shall be examined to verify the instrument will work properly when installed and the Project Engineer promptly notified if it does not meet manufacturer recommendations or the Specifications.
- B. Verify factory calibration of instruments in accordance with the manufacturer's instructions.
- C. All instrumentation calibration and configuration shall be completed prior to the start of field testing.
- D. Totalizer tests are not to be performed in the field.

END OF SECTION

## SECTION 17170

### POSITION AND MOTION MEASUREMENT

#### PART 1 - GENERAL

##### 1.01 SECTION INCLUDES

- A. Requirements of Division 1 and Section 17010 form a part of this Section. This Section specifies position and motion measurement devices, auxiliary equipment and supplies directly related to the installation of and operation of these position and motion measurement devices, to perform the required functions in conjunction with information and equipment specified in other sections of Division 17.

##### 1.02 SUBMITTALS

- A. Shop Drawings:
  - 1. Shop drawings to be submitted in this Section shall be made in one package under Product Review category of shop drawings.
  - 2. In addition to the requirements of Section 17010, shop drawings shall include for each type of instrument: physical dimensions, supply voltage and frequency, electrical load, accuracy, description of operation, operating instructions, and calibration procedure.
  - 3. All shop drawings, catalog pages, and cut sheets shall be clearly marked with the unique tag for the instrument(s) to which they apply.
  - 4. Shop drawings shall include a completed ISA S20 form for each device.
  - 5. Installation Method: The proposed method of mounting sensors and instruments shall accompany all shop drawings.
- B. Manuals:
  - 1. Submit manuals in accordance with the requirements of Section 17010.
  - 2. ISA S20 forms: Include a completed final S20 form for each device with the manuals. S20 forms shall be updated to include final values or notes from testing, startup, and commissioning.
  - 3. Parts List: Include a parts list showing current net prices and a list of recommended spares with the manuals.

##### 1.03 QUALITY ASSURANCE

- A. Manufacturer: In addition to the requirements of Section 17010, position and motion measurement devices furnished shall be provided from manufacturers regularly and currently engaged in the design and manufacture of similar equipment. All equipment furnished shall be new and of current design.
- B. Maintainability: All equipment shall be designed for ease of maintenance and repair, and access to critical parts shall not require a major disassembly. Internal field adjustments where permitted or required herein shall be easily accessible upon removal of a panel or cover or through use of an external handheld device.
- C. Materials and Installation: Materials and installation shall comply with the requirements of the current editions of referenced electrical codes and standards, and the codes and standards referred to shall be used for establishing the minimum quality of the materials and equipment supplied and installed. All equipment of the

same type shall be products of the same manufacturer. Capacities of all equipment shall not be less than that indicated on the Instrument List.

## PART 2 - PRODUCTS

### 2.01 INTRUSION SWITCHES – LIMIT TYPE

- A. Limit switches used for intrusion detection shall be heavy duty snap action type, with the following features:
  - 1. Metal body
  - 2. -20°F to 185°F temperature operating range
  - 3. Single-pole, double-throw
  - 4. Spring return
  - 5. 600V class contacts
  - 6. NEMA enclosure rated for the environment in which the switch is installed.
    - a. Intrusion Switches shall be rated for a Classified environment, Class I, Division I,
  - 7. 1/2-inch NPT conduit entry
  - 8. Provide lever arm where required.
- B. Manufacturer: Eaton 10316 series, or approved equal.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Installation, testing, calibration, validation, startup, and instruction shall be in accordance with Section 17010.
- B. Provide brackets as needed, and adjust location of intrusion switches in the field for proper operation with the hatch, door, or cover with which they are used.

END OF SECTION

SECTION 17330

PROCESS CONTROL STRATEGY- FLOW MEASUREMENT

PART 1 - GENERAL

1.01 AREA

- A. South end of Project adjacent to Tennyson Street at the subgrade meter vault and above grade electrical cabinet. Station approximately 01+56.

1.02 RELATED EQUIPMENT:

- A. Level Rader Element, LE-001A
- B. Level Rader Element, LE-001B
- C. Level Transmitter, LIT-001

1.03 SUMMARY

- A. General
  - 1. Water level measurements shall be taken at points LE-001A and LE-001B as indicated on the drawings. These measurements shall be used to determine flow rate through the flume.
- B. Control Strategy Narrative
  - 1. If  $001B / 001A < 70\%$  then the formula F.1 shall be used to determine the flow rate.

$$Q_{free} = K * H_a^n \qquad \qquad \qquad F.1$$

Q	discharge	Variable to solve for	
H <sub>a</sub>	depth at primary point of measurement (ft)	Input from transmitter	
H <sub>b</sub>	depth at secondary point of measurement (ft)	Input from transmitter	
S	Submergence ratio	(H <sub>b</sub> /H <sub>a</sub> )	
K	Flume discharge constant	Constant	8
n	Free-flow exponent	Constant	1.55



2. If  $H_b / H_a > 70\%$  then the free flow equation shall be corrected using equation F.2 and Peck's Equation F.3. where Q is the flow rate in cfs, and  $H_a$  is measured in feet.

$$Q_{net} = Q_{free} - Q_{correction} \quad \text{F.2}$$

$$Q_{correction} = M(0.000132 * h_a^{2.123} e^{9.2845}) \quad \text{F.3}$$

M	Multiplying Factor	Constant	1.8
---	--------------------	----------	-----

3. The flow rate shall be transmitted to the data logger. The data logger shall communicate with the radio system and be transmitted to Metro's SCADA interface.

END OF SECTION

Appendix A: Water Sampling Results

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# ANALYTICAL REPORT

## PREPARED FOR

Attn: Erica Wirski  
Kennedy/Jenks Consultants  
143 Union Blvd  
Lakewood, Colorado 80228

Generated 8/10/2023 11:44:01 AM

## JOB DESCRIPTION

Arvada NTS Metro Water Quality Analysis

## JOB NUMBER

280-178681-1

# Eurofins Denver

## Job Notes

This report may not be reproduced except in full, and with written approval from the laboratory. The results relate only to the samples tested. For questions please contact the Project Manager at the e-mail address or telephone number listed on this page.

The test results in this report relate only to the samples as received by the laboratory and will meet all requirements of the methodology, with any exceptions noted. This report shall not be reproduced except in full, without the express written approval of the laboratory. All questions should be directed to the Eurofins TestAmerica Project Manager.

## Authorization



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# Definitions/Glossary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Qualifiers

### GC/MS Semi VOA

Qualifier	Qualifier Description
D	Sample results are obtained from a dilution; the surrogate or matrix spike recoveries reported are calculated from diluted samples.
S1+	Surrogate recovery exceeds control limits, high biased.

### HPLC/IC

Qualifier	Qualifier Description
H	Sample was prepped or analyzed beyond the specified holding time. This does not meet regulatory requirements.

### LCMS

Qualifier	Qualifier Description
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

### General Chemistry

Qualifier	Qualifier Description
*-	LCS and/or LCSD is outside acceptance limits, low biased.
*1	LCS/LCSD RPD exceeds control limits.
b	Result Detected in the Unseeded Control blank (USB).
F1	MS and/or MSD recovery exceeds control limits.
F5	Duplicate RPD exceeds limit, and one or both sample results are less than 5 times RL, and the absolute difference between results is < the upper reporting limits for both.
HF	Field parameter with a holding time of 15 minutes. Test performed by laboratory at client's request.
J	Result is less than the RL but greater than or equal to the MDL and the concentration is an approximate value.

### Rad

Qualifier	Qualifier Description
G	The Sample MDC is greater than the requested RL.
U	Result is less than the sample detection limit.

## Glossary

Abbreviation	These commonly used abbreviations may or may not be present in this report.
α	Listed under the "D" column to designate that the result is reported on a dry weight basis
%R	Percent Recovery
CFL	Contains Free Liquid
CFU	Colony Forming Unit
CNF	Contains No Free Liquid
DER	Duplicate Error Ratio (normalized absolute difference)
Dil Fac	Dilution Factor
DL	Detection Limit (DoD/DOE)
DL, RA, RE, IN	Indicates a Dilution, Re-analysis, Re-extraction, or additional Initial metals/anion analysis of the sample
DLC	Decision Level Concentration (Radiochemistry)
EDL	Estimated Detection Limit (Dioxin)
LOD	Limit of Detection (DoD/DOE)
LOQ	Limit of Quantitation (DoD/DOE)
MCL	EPA recommended "Maximum Contaminant Level"
MDA	Minimum Detectable Activity (Radiochemistry)
MDC	Minimum Detectable Concentration (Radiochemistry)
MDL	Method Detection Limit
ML	Minimum Level (Dioxin)
MPN	Most Probable Number
MQL	Method Quantitation Limit
NC	Not Calculated
ND	Not Detected at the reporting limit (or MDL or EDL if shown)
NEG	Negative / Absent
POS	Positive / Present
PQL	Practical Quantitation Limit
PRES	Presumptive

# Definitions/Glossary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Glossary (Continued)

**Abbreviation**      **These commonly used abbreviations may or may not be present in this report.**

QC	Quality Control
RER	Relative Error Ratio (Radiochemistry)
RL	Reporting Limit or Requested Limit (Radiochemistry)
RPD	Relative Percent Difference, a measure of the relative difference between two points
TEF	Toxicity Equivalent Factor (Dioxin)
TEQ	Toxicity Equivalent Quotient (Dioxin)
TNTC	Too Numerous To Count

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
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- 12
- 13
- 14
- 15
- 16
- 17

# Case Narrative

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

**Job ID: 280-178681-1**

**Laboratory: Eurofins Denver**

**Narrative**

## CASE NARRATIVE

**Client: Kennedy/Jenks Consultants**

**Project: Arvada NTS Metro Water Quality Analysis**

**Report Number: 280-178681-1**

With the exceptions noted as flags or footnotes, standard analytical protocols were followed in the analysis of the samples and no problems were encountered or anomalies observed. In addition all laboratory quality control samples were within established control limits, with any exceptions noted below. Each sample was analyzed to achieve the lowest possible reporting limit within the constraints of the method. In some cases, due to interference or analytes present at high concentrations, samples were diluted. For diluted samples, the reporting limits are adjusted relative to the dilution required.

Calculations are performed before rounding to avoid round-off errors in calculated results.

All holding times were met and proper preservation noted for the methods performed on these samples, unless otherwise detailed in the individual sections below.

Any minimum detectable concentration (MDC), critical value (DLC), or Safe Drinking Water Act detection limit (SDWA DL) is sample-specific unless otherwise stated elsewhere in this narrative. Radiochemistry sample results are reported with the count date/time applied as the Activity Reference Date.

### **RECEIPT**

The samples were received on 7/6/2023 11:21 AM. Unless otherwise noted below, the samples arrived in good condition, and where required, properly preserved and on ice. The temperatures of the 2 coolers at receipt time were 1.3°C and 14.7°C.

### **RECEIPT EXCEPTIONS**

There are multiple sample IDs and sample collection times listed on the Chain of Custody (COC). Per client instruction, all of the containers except for the field rinse blanks were logged as one sample using the sample ID "S-1" with the latest sample collection time listed on the COC.

The containers for the field rinse blank (FRB) were logged as the following sample using the latest time listed on the containers: FRB (280-178681-2).

The container label for the following sample did not match the information listed on the Chain-of-Custody (COC): S-1 (280-178681-1). The container labels list 10:52, while the COC lists 10:55.

The container label for the following sample did not match the information listed on the Chain-of-Custody (COC): S-1 (280-178681-1). The container labels list S-2.5 and S-2.6, while the COC lists S-1.

### **ORGANIC PREP**

Method 8270E: The following sample was pale yellow and exhibited mild turbidity: S-1 (280-178681-1).

Method 8270E: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-619045.

Method 1633\_B24: In preparation batch 280-619039, the following sample was diluted due to the nature of the sample matrix: S-1 (280-178681-1) (10x dilution). Elevated reporting limits (RLs) are provided. Because the sample was extracted as a dilution, the original sample container could not be rinsed.

Method D7065\_11: In preparation batch 280-619212, the following sample was pale yellow in color: S-1 (280-178681-1).



# Case Narrative

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Job ID: 280-178681-1 (Continued)

### Laboratory: Eurofins Denver (Continued)

Method D7065\_11: In preparation batch 280-619212, the following sample exhibited moderate turbidity: S-1 (280-178681-1).

Method D7065\_11: In preparation batch 280-619212, the following sample formed emulsions during the extraction procedure: S-1 (280-178681-1). The emulsions were broken up using the pour back method for the second extraction only.

Method 1633\_B24: In preparation batch 280-619208, the following sample was diluted due to the nature of the sample matrix: FRB (280-178681-2) (2x dilution). Elevated reporting limits (RLs) are provided. Because the sample was extracted at a dilution, the original sample container could not be rinsed.

Method 8081B: The following sample was brown in color, exhibited high turbidity, and contained brown sediment: S-1 (280-178681-1).

Method 8081B: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-619392.

Method 1633\_B24: In preparation batch 280-619711, the following sample was diluted due to the nature of the sample matrix: FRB (280-178681-2) (4x). Elevated reporting limits (RLs) are provided. Because the sample was extracted at a dilution, the original sample container could not be rinsed.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### SEMIVOLATILE ORGANIC COMPOUND (GC/MS)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### NONYLPHENOLS

4-nonylphenol monoethoxylate (Surr) failed the surrogate recovery criteria high for S-1 (280-178681-1). Refer to the QC report for details.

Sample S-1 (280-178681-1)[5X] required dilution prior to analysis. The reporting limits have been adjusted accordingly.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### ORGANOCHLORINE PESTICIDES (GC)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### FORMALDEHYDE

The following sample was received with less than 2 days remaining on the holding time or less than one shift (8 hours) remaining on a test with a holding time of 48 hours or less. As such, the laboratory had insufficient time remaining to perform the analysis within holding time: S-1 (280-178681-1).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### PERFLUORINATED HYDROCARBONS (PFAS)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### TOTAL METALS (ICPMS)

The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 280-618940 and analytical batch 280-619314 were outside control limits for one or more analytes. See QC Sample Results for detail. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery is within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### TOTAL DISSOLVED SOLIDS

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### TOTAL SUSPENDED SOLIDS

The laboratory control sample (LCS) and laboratory control sample duplicate (LCSD) for analytical batch 280-619138 recovered outside

# Case Narrative

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Job ID: 280-178681-1 (Continued)

### Laboratory: Eurofins Denver (Continued)

control limits for the following analytes: Total Suspended Solids. These analytes were biased low in the LCS and LCSD and were not detected in the associated samples as confirmed by reanalysis; therefore, the data have been reported. No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### ANIONS (28 DAYS)

Sample S-1 (280-178681-1)[10X] required dilution prior to analysis. The reporting limits have been adjusted accordingly.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### AMMONIA

The continuing calibration verification low (CCVL) associated with batch 280-619790 recovered above the upper control limit for ammonia. The samples associated with this CCVL were non-detects for the affected analytes; therefore, the data have been reported. The associated sample is impacted: (CCVL 280-619790/85).

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### TOTAL KJELDAHL NITROGEN

The matrix spike and matrix spike duplicate (MS/MSD) recoveries for preparation batch 280-621028 and analytical batch 280-621184 were outside control limits for one or more analytes. See QC Sample Results for detail. Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery is within acceptance limits.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### NITRATE-NITRITE AS NITROGEN

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### TOTAL PHOSPHORUS

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### CHEMICAL OXYGEN DEMAND

Chemical Oxygen Demand was detected in method blank MB 280-621436/5 at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged. Refer to the QC report for details.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### CORROSIVITY (PH)

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### TOTAL NITROGEN

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

### BIOCHEMICAL OXYGEN DEMAND

Biochemical Oxygen Demand was detected in method blank SCB 280-618771/1 at a level that was above the method detection limit but below the reporting limit. The value should be considered an estimate, and has been flagged. If the associated sample reported a result above the MDL and/or RL, the result has been flagged. Refer to the QC report for details.

Biochemical Oxygen Demand exceeded the RPD limit for the duplicate of sample S-1DU (280-178681-1). Refer to the QC report for details.

The sample duplicate (DUP) precision for analytical batch 280-618771 was outside control limits. Sample matrix interference is suspected.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

# Case Narrative

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

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## Job ID: 280-178681-1 (Continued)

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### Laboratory: Eurofins Denver (Continued)

#### ISOTOPIC URANIUM (ALPHA SPECTROMETRY)

The following sample was prepared at a reduced aliquot due to matrix interference: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

The detection goal was not met for the following sample: S-1 (280-178681-1). Sample was prepped at a reduced volume due to the presence of matrix interferences. Analytical results are reported with the detection limit achieved.

No analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

#### RADIUM-226 (GFPC)

The following sample was prepared at a reduced aliquot due to the matrix: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

#### RADIUM-228 (GFPC)

The following sample was prepared at a reduced aliquot due to the matrix: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

The detection goal was not met for the following sample: S-1 (280-178681-1). Sample was prepped at a reduced volume due to the presence of matrix interferences. Analytical results are reported with the detection limit achieved.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

#### ISOTOPIC THORIUM (ALPHA SPECTROMETRY)

The following sample was prepared at a reduced aliquot due to discoloration and heavy sediment levels: S-1 (280-178681-1). A laboratory control sample/ laboratory control sample duplicate (LCS/LCSD) were prepared instead of a sample duplicate (DUP) to demonstrate batch precision.

The detection goal was not met for the following sample: S-1 (280-178681-1). Sample was prepped at a reduced volume due to the presence of matrix interferences. Analytical results are reported with the detection limit achieved.

No additional analytical or quality issues were noted, other than those described above or in the Definitions/Glossary page.

# Detection Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Client Sample ID: S-1

## Lab Sample ID: 280-178681-1

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorohexanoic acid (PFHxA)	15	J	40	9.9	ng/L	1		Draft 1633	Total/NA
Perfluorooctanoic acid (PFOA)	24	J	40	13	ng/L	1		Draft 1633	Total/NA
Perfluorobutanesulfonic acid (PFBS)	14	J	40	6.0	ng/L	1		Draft 1633	Total/NA
Perfluorohexanesulfonic acid (PFHxS)	11	J	40	11	ng/L	1		Draft 1633	Total/NA
Perfluorooctanesulfonic acid (PFOS)	120		40	9.9	ng/L	1		Draft 1633	Total/NA
Manganese	4300		3.0	0.51	ug/L	1		200.8	Total/NA
Chloride	270		30	10	mg/L		10	300.0	Total/NA
Sulfate	59		5.0	1.0	mg/L	1		300.0	Total/NA
Ammonia	0.13		0.10	0.029	mg/L	1		350.1	Total/NA
Nitrate Nitrite as N	4.3		0.10	0.044	mg/L	1		353.2	Total/NA
Phosphorus, Total	0.65		0.050	0.025	mg/L	1		365.1	Total/NA
pH adj. to 25 deg C	7.3	HF	0.1	0.1	SU	1		9040C	Total/NA
Temperature	21.2	HF	1.0	1.0	Degrees C	1		9040C	Total/NA
Total Inorganic Nitrogen	4.4		0.10	0.019	mg/L	1		Inorganic N	Total/NA
Total Dissolved Solids (TDS)	700		10	4.7	mg/L	1		SM 2540C	Total/NA
Total Suspended Solids	500	*- *1	40	11	mg/L	1		SM 2540D	Total/NA
Biochemical Oxygen Demand	7.1	b	5.0	0.59	mg/L	1		SM5210B	Total/NA

## Client Sample ID: FRB

## Lab Sample ID: 280-178681-2

Analyte	Result	Qualifier	RL	MDL	Unit	Dil Fac	D	Method	Prep Type
Perfluorobutanoic acid (PFBA)	9.0	J	16	4.0	ng/L	1		Draft 1633	Total/NA
Perfluoropentanoic acid (PFPeA)	10		8.0	2.0	ng/L	1		Draft 1633	Total/NA
Perfluorohexanoic acid (PFHxA)	11		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluoroheptanoic acid (PFHpA)	7.9		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluorooctanoic acid (PFOA)	17		4.0	1.3	ng/L	1		Draft 1633	Total/NA
Perfluorononanoic acid (PFNA)	6.5		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluorodecanoic acid (PFDA)	7.1		4.0	1.0	ng/L	1		Draft 1633	Total/NA
Perfluorobutanesulfonic acid (PFBS)	14		4.0	0.60	ng/L	1		Draft 1633	Total/NA
6:2 FTS	20		16	5.0	ng/L	1		Draft 1633	Total/NA
Perfluorohexanesulfonic acid (PFHxS) - RE	6.3	J	8.0	2.3	ng/L	1		Draft 1633	Total/NA
Perfluorooctanesulfonic acid (PFOS) - RE	130		8.0	2.0	ng/L	1		Draft 1633	Total/NA

This Detection Summary does not include radiochemical test results.

Eurofins Denver



# Method Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

Method	Method Description	Protocol	Laboratory
8270E	Semivolatile Organic Compounds (GC/MS)	SW846	EET DEN
D7065-11	Determination of Nonylphenols	ASTM	EET DEN
8081B	Organochlorine Pesticides (GC)	SW846	EET DEN
8315A	Carbonyl Compounds by HPLC	SW846	ELLE
Draft 1633	Per- and Polyfluoroalkyl Substances by LC/MS/MS	EPA	EET DEN
200.8	Metals (ICP/MS)	EPA	EET DEN
300.0	Anions, Ion Chromatography	EPA	EET DEN
350.1	Nitrogen, Ammonia	EPA	EET DEN
351.2	Nitrogen, Total Kjeldahl	EPA	EET DEN
353.2	Nitrogen, Nitrate-Nitrite	EPA	EET DEN
365.1	Phosphorus, Total	EPA	EET DEN
410.4	COD	EPA	EET DEN
9040C	pH	SW846	EET DEN
Inorganic N	Nitrogen, Total Inorganic	EPA	EET DEN
SM 2540C	Solids, Total Dissolved (TDS)	SM	EET DEN
SM 2540D	Solids, Total Suspended (TSS)	SM	EET DEN
SM5210B	BOD, 5 Day	SM	EET DEN
903.0	Radium-226 (GFPC)	EPA	EET SL
904.0	Radium-228 (GFPC)	EPA	EET SL
A-01-R	Isotopic Thorium (Alpha Spectrometry)	DOE	EET SL
A-01-R	Isotopic Uranium (Alpha Spectrometry)	DOE	EET SL
1633	Solid-Phase Extraction (SPE)	EPA	EET DEN
200.8	Preparation, Total Metals	EPA	EET DEN
351.2	Nitrogen, Total Kjeldahl	EPA	EET DEN
3510C	Liquid-Liquid Extraction (Separatory Funnel)	SW846	EET DEN
365.2/365.3/365	Phosphorus, Total	EPA	EET DEN
8315A Prep	Solid Phase Extraction (SPE)	SW846	ELLE
D7065-11	Liquid-Liquid Extraction (Continuous)	ASTM	EET DEN
ExtChrom	Preparation, Extraction Chromatography Resin Actinide Separation	None	EET SL
PrecSep_0	Preparation, Precipitate Separation	None	EET SL
PrecSep-21	Preparation, Precipitate Separation (21-Day In-Growth)	None	EET SL

**Protocol References:**

- ASTM = ASTM International
- DOE = U.S. Department of Energy
- EPA = US Environmental Protection Agency
- None = None
- SM = "Standard Methods For The Examination Of Water And Wastewater"
- SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

**Laboratory References:**

- EET DEN = Eurofins Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100
- EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566
- ELLE = Eurofins Lancaster Laboratories Environment Testing, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300

# Sample Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

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Lab Sample ID	Client Sample ID	Matrix	Collected	Received
280-178681-1	S-1	Water	07/06/23 10:55	07/06/23 11:21
280-178681-2	FRB	Water	07/06/23 09:44	07/06/23 11:21

- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10
- 11
- 12
- 13
- 14
- 15
- 16
- 17

# Client Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: SW846 8270E - Semivolatile Organic Compounds (GC/MS)

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Butyl benzyl phthalate	ND		3.8	1.5	ug/L		07/11/23 09:25	07/12/23 12:56	1

## Method: ASTM D7065-11 - Determination of Nonylphenols

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nonylphenol	ND		26000	5900	ng/L		07/12/23 10:53	07/13/23 14:47	5
<b>Surrogate</b>	<b>%Recovery</b>	<b>Qualifier</b>	<b>Limits</b>				<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
4-nonylphenol (Surr)	61	D	58 - 115				07/12/23 10:53	07/13/23 14:47	5
4-nonylphenol monoethoxylate (Surr)	175	S1+ D	54 - 139				07/12/23 10:53	07/13/23 14:47	5

## Method: SW846 8081B - Organochlorine Pesticides (GC)

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
beta-BHC	ND		0.051	0.0093	ug/L		07/13/23 12:16	07/17/23 21:03	1
delta-BHC	ND		0.051	0.0080	ug/L		07/13/23 12:16	07/17/23 21:03	1
<b>Surrogate</b>	<b>%Recovery</b>	<b>Qualifier</b>	<b>Limits</b>				<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
DCB Decachlorobiphenyl (Surr)	17		10 - 157				07/13/23 12:16	07/17/23 21:03	1
Tetrachloro-m-xylene (Surr)	88		12 - 129				07/13/23 12:16	07/17/23 21:03	1

## Method: SW846 8315A - Carbonyl Compounds by HPLC

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Formaldehyde	ND	H	120	54	ug/L		07/10/23 17:06	07/11/23 10:21	1
<b>Surrogate</b>	<b>%Recovery</b>	<b>Qualifier</b>	<b>Limits</b>				<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
Butyraldehyde	101		60 - 130				07/10/23 17:06	07/11/23 10:21	1

## Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		160	40	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoropentanoic acid (PFPeA)	ND		79	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
<b>Perfluorohexanoic acid (PFHxA)</b>	<b>15</b>	<b>J</b>	40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoroheptanoic acid (PFHpA)	ND		40	10	ng/L		07/11/23 10:52	07/12/23 16:12	1
<b>Perfluorooctanoic acid (PFOA)</b>	<b>24</b>	<b>J</b>	40	13	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorononanoic acid (PFNA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorodecanoic acid (PFDA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoroundecanoic acid (PFUnA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1

Eurofins Denver

# Client Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorododecanoic acid (PFDoA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorotridecanoic acid (PFTriA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorotetradecanoic acid (PFTeDA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
<b>Perfluorobutanesulfonic acid (PFBS)</b>	<b>14</b>	<b>J</b>	40	6.0	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoropentanesulfonic acid (PFPeS)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
<b>Perfluorohexanesulfonic acid (PFHxS)</b>	<b>11</b>	<b>J</b>	40	11	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		40	7.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
<b>Perfluorooctanesulfonic acid (PFOS)</b>	<b>120</b>		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorononanesulfonic acid (PFNS)	ND		40	7.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorodecanesulfonic acid (PFDS)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorododecanesulfonic acid (PFDoS)	ND		40	18	ng/L		07/11/23 10:52	07/12/23 16:12	1
4:2 FTS	ND		160	34	ng/L		07/11/23 10:52	07/12/23 16:12	1
6:2 FTS	ND		160	50	ng/L		07/11/23 10:52	07/12/23 16:12	1
8:2 FTS	ND		160	52	ng/L		07/11/23 10:52	07/12/23 16:12	1
Perfluorooctanesulfonamide (PFOSA)	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
NMeFOSA	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
NEtFOSA	ND		40	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
NMeFOSAA	ND		79	24	ng/L		07/11/23 10:52	07/12/23 16:12	1
NEtFOSAA	ND		40	14	ng/L		07/11/23 10:52	07/12/23 16:12	1
NMeFOSE	ND		400	99	ng/L		07/11/23 10:52	07/12/23 16:12	1
NEtFOSE	ND		400	99	ng/L		07/11/23 10:52	07/12/23 16:12	1
HFPO-DA (GenX)	ND		160	40	ng/L		07/11/23 10:52	07/12/23 16:12	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		160	30	ng/L		07/11/23 10:52	07/12/23 16:12	1
PFMBA	ND		79	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
NFDHA	ND		79	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
PFMPA	ND		79	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
9CI-PF3ONS	ND		160	20	ng/L		07/11/23 10:52	07/12/23 16:12	1
11CI-PF3OUdS	ND		160	40	ng/L		07/11/23 10:52	07/12/23 16:12	1
PFEESA	ND		79	9.9	ng/L		07/11/23 10:52	07/12/23 16:12	1
3:3 FTCA	ND		200	30	ng/L		07/11/23 10:52	07/12/23 16:12	1
5:3 FTCA	ND		990	200	ng/L		07/11/23 10:52	07/12/23 16:12	1
7:3 FTCA	ND		990	200	ng/L		07/11/23 10:52	07/12/23 16:12	1
<b>Isotope Dilution</b>	<b>%Recovery</b>	<b>Qualifier</b>	<b>Limits</b>				<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
13C4 PFBA	72		10 - 130				07/11/23 10:52	07/12/23 16:12	1
13C5 PFPeA	71		35 - 150				07/11/23 10:52	07/12/23 16:12	1
13C5 PFHxA	71		55 - 150				07/11/23 10:52	07/12/23 16:12	1
13C4 PFHpA	68		55 - 150				07/11/23 10:52	07/12/23 16:12	1
13C8 PFOA	70		60 - 140				07/11/23 10:52	07/12/23 16:12	1
13C9 PFNA	66		55 - 140				07/11/23 10:52	07/12/23 16:12	1
13C6 PFDA	67		50 - 140				07/11/23 10:52	07/12/23 16:12	1
13C7 PFUnA	66		30 - 140				07/11/23 10:52	07/12/23 16:12	1
13C2 PFDoA	58		10 - 150				07/11/23 10:52	07/12/23 16:12	1
13C2 PFTeDA	34		10 - 130				07/11/23 10:52	07/12/23 16:12	1
13C3 PFBS	66		55 - 150				07/11/23 10:52	07/12/23 16:12	1

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# Client Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Isotope Dilution	%Recovery	Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C3 PFHxS	58		55 - 150	07/11/23 10:52	07/12/23 16:12	1
13C8 PFOS	63		45 - 140	07/11/23 10:52	07/12/23 16:12	1
13C8 FOSA	86		30 - 130	07/11/23 10:52	07/12/23 16:12	1
d3-NMeFOSAA	93		45 - 200	07/11/23 10:52	07/12/23 16:12	1
d5-NEtFOSAA	83		10 - 200	07/11/23 10:52	07/12/23 16:12	1
M2-4:2 FTS	85		60 - 200	07/11/23 10:52	07/12/23 16:12	1
M2-6:2 FTS	91		60 - 200	07/11/23 10:52	07/12/23 16:12	1
M2-8:2 FTS	120		50 - 200	07/11/23 10:52	07/12/23 16:12	1
13C3 HFPO-DA	71		25 - 160	07/11/23 10:52	07/12/23 16:12	1
d7-N-MeFOSE-M	57		10 - 150	07/11/23 10:52	07/12/23 16:12	1
d9-N-EtFOSE-M	48		10 - 150	07/11/23 10:52	07/12/23 16:12	1
d5-NEtPFOSA	41		10 - 130	07/11/23 10:52	07/12/23 16:12	1
d3-NMePFOSA	45		15 - 130	07/11/23 10:52	07/12/23 16:12	1

**Client Sample ID: FRB**  
**Date Collected: 07/06/23 09:44**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-2**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	9.0	J	16	4.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluoropentanoic acid (PFPeA)	10		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorohexanoic acid (PFHxA)	11		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluoroheptanoic acid (PFHpA)	7.9		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorooctanoic acid (PFOA)	17		4.0	1.3	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorononanoic acid (PFNA)	6.5		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorodecanoic acid (PFDA)	7.1		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluoroundecanoic acid (PFUnA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorododecanoic acid (PFDoA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorotridecanoic acid (PFTriA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorotetradecanoic acid (PFTeDA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorobutanesulfonic acid (PFBS)	14		4.0	0.60	ng/L		07/12/23 11:15	07/13/23 18:07	1
4:2 FTS	ND		16	3.4	ng/L		07/12/23 11:15	07/13/23 18:07	1
6:2 FTS	20		16	5.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
8:2 FTS	ND		16	5.2	ng/L		07/12/23 11:15	07/13/23 18:07	1
Perfluorooctanesulfonamide (PFOSA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NMeFOSA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NEtFOSA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NMeFOSAA	ND		8.0	2.4	ng/L		07/12/23 11:15	07/13/23 18:07	1
NEtFOSAA	ND		4.0	1.4	ng/L		07/12/23 11:15	07/13/23 18:07	1
NMeFOSE	ND		40	10	ng/L		07/12/23 11:15	07/13/23 18:07	1
NEtFOSE	ND		40	10	ng/L		07/12/23 11:15	07/13/23 18:07	1
HFPO-DA (GenX)	ND		16	4.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		16	3.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
PFMBA	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
NFDHA	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
PFMPA	ND		8.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
9CI-PF3ONS	ND		16	2.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
11CI-PF3OUdS	ND		16	4.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
PFEESA	ND		8.0	1.0	ng/L		07/12/23 11:15	07/13/23 18:07	1

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# Client Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Client Sample ID: FRB**  
**Date Collected: 07/06/23 09:44**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-2**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
3:3 FTCA	ND		20	3.0	ng/L		07/12/23 11:15	07/13/23 18:07	1
5:3 FTCA	ND		100	20	ng/L		07/12/23 11:15	07/13/23 18:07	1
7:3 FTCA	ND		100	20	ng/L		07/12/23 11:15	07/13/23 18:07	1
Isotope Dilution	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
13C4 PFBA	68		10 - 130				07/12/23 11:15	07/13/23 18:07	1
13C5 PFPeA	70		35 - 150				07/12/23 11:15	07/13/23 18:07	1
13C5 PFHxA	70		55 - 150				07/12/23 11:15	07/13/23 18:07	1
13C4 PFHpA	71		55 - 150				07/12/23 11:15	07/13/23 18:07	1
13C8 PFOA	66		60 - 140				07/12/23 11:15	07/13/23 18:07	1
13C9 PFNA	71		55 - 140				07/12/23 11:15	07/13/23 18:07	1
13C6 PFDA	64		50 - 140				07/12/23 11:15	07/13/23 18:07	1
13C7 PFUnA	50		30 - 140				07/12/23 11:15	07/13/23 18:07	1
13C2 PFDoA	37		10 - 150				07/12/23 11:15	07/13/23 18:07	1
13C2 PFTeDA	21		10 - 130				07/12/23 11:15	07/13/23 18:07	1
13C3 PFBS	65		55 - 150				07/12/23 11:15	07/13/23 18:07	1
13C8 FOSA	57		30 - 130				07/12/23 11:15	07/13/23 18:07	1
d3-NMeFOSAA	66		45 - 200				07/12/23 11:15	07/13/23 18:07	1
d5-NEtFOSAA	58		10 - 200				07/12/23 11:15	07/13/23 18:07	1
M2-4:2 FTS	131		60 - 200				07/12/23 11:15	07/13/23 18:07	1
M2-6:2 FTS	98		60 - 200				07/12/23 11:15	07/13/23 18:07	1
M2-8:2 FTS	70		50 - 200				07/12/23 11:15	07/13/23 18:07	1
13C3 HFPO-DA	72		25 - 160				07/12/23 11:15	07/13/23 18:07	1
d7-N-MeFOSE-M	28		10 - 150				07/12/23 11:15	07/13/23 18:07	1
d9-N-EtFOSE-M	19		10 - 150				07/12/23 11:15	07/13/23 18:07	1
d5-NEtPFOSA	29		10 - 130				07/12/23 11:15	07/13/23 18:07	1
d3-NMePFOSA	35		15 - 130				07/12/23 11:15	07/13/23 18:07	1

## Method: EPA Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS - RE

**Client Sample ID: FRB**  
**Date Collected: 07/06/23 09:44**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-2**  
**Matrix: Water**

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluoropentanesulfonic acid (PFPeS)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 18:21	1
<b>Perfluorohexanesulfonic acid (PFHxS)</b>	<b>6.3</b>	<b>J</b>	8.0	2.3	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		8.0	1.6	ng/L		07/17/23 11:33	07/18/23 18:21	1
<b>Perfluorooctanesulfonic acid (PFOS)</b>	<b>130</b>		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorononanesulfonic acid (PFNS)	ND		8.0	1.6	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorodecanesulfonic acid (PFDS)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 18:21	1
Perfluorododecanesulfonic acid (PFDoS)	ND		8.0	3.6	ng/L		07/17/23 11:33	07/18/23 18:21	1
Isotope Dilution	%Recovery	Qualifier	Limits				Prepared	Analyzed	Dil Fac
13C3 PFHxS	67		55 - 150				07/17/23 11:33	07/18/23 18:21	1
13C8 PFOS	66		45 - 140				07/17/23 11:33	07/18/23 18:21	1

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# Client Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: EPA 200.8 - Metals (ICP/MS)

Client Sample ID: S-1  
 Date Collected: 07/06/23 10:55  
 Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1  
 Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Manganese	4300		3.0	0.51	ug/L		07/11/23 09:04	07/12/23 03:34	1

## General Chemistry

Client Sample ID: S-1  
 Date Collected: 07/06/23 10:55  
 Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1  
 Matrix: Water

Analyte	Result	Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chloride (EPA 300.0)	270		30	10	mg/L			07/28/23 04:03	10
Sulfate (EPA 300.0)	59		5.0	1.0	mg/L			07/28/23 03:46	1
Ammonia (EPA 350.1)	0.13		0.10	0.029	mg/L			07/13/23 15:52	1
Nitrogen, Kjeldahl (EPA 351.2)	ND	F1	1.0	0.69	mg/L		07/27/23 15:27	07/28/23 15:10	1
Nitrate Nitrite as N (EPA 353.2)	4.3		0.10	0.044	mg/L			07/11/23 11:50	1
Phosphorus, Total (EPA 365.1)	0.65		0.050	0.025	mg/L		07/07/23 10:34	07/07/23 15:21	1
Chemical Oxygen Demand (EPA 410.4)	ND		20	8.7	mg/L			08/01/23 11:15	1
pH adj. to 25 deg C (SW846 9040C)	7.3	HF	0.1	0.1	SU			07/13/23 14:56	1
Temperature (SW846 9040C)	21.2	HF	1.0	1.0	Degrees C			07/13/23 14:56	1
Total Inorganic Nitrogen (EPA Inorganic N)	4.4		0.10	0.019	mg/L			07/20/23 12:08	1
Total Dissolved Solids (TDS) (SM 2540C)	700		10	4.7	mg/L			07/11/23 11:19	1
Total Suspended Solids (SM 2540D)	500	*- *1	40	11	mg/L			07/11/23 14:50	1
Biochemical Oxygen Demand (SM5210B)	7.1	b	5.0	0.59	mg/L			07/07/23 11:16	1

## Method: EPA 903.0 - Radium-226 (GFPC)

Client Sample ID: S-1  
 Date Collected: 07/06/23 10:55  
 Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1  
 Matrix: Water

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	4.79		0.993	1.08	1.00	0.763	pCi/L	07/13/23 09:29	08/04/23 09:40	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Ba Carrier	62.3		30 - 110					07/13/23 09:29	08/04/23 09:40	1

## Method: EPA 904.0 - Radium-228 (GFPC)

Client Sample ID: S-1  
 Date Collected: 07/06/23 10:55  
 Date Received: 07/06/23 11:21

Lab Sample ID: 280-178681-1  
 Matrix: Water

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-228	8.65	G	2.83	2.94	1.00	3.34	pCi/L	07/13/23 09:38	07/28/23 12:44	1
Carrier	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Ba Carrier	62.3		30 - 110					07/13/23 09:38	07/28/23 12:44	1
Y Carrier	82.2		30 - 110					07/13/23 09:38	07/28/23 12:44	1

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# Client Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: DOE A-01-R - Isotopic Thorium (Alpha Spectrometry)

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Thorium-228	6.03	G	2.60	2.65	1.00	2.32	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-230	3.13	G	1.90	1.92	1.00	1.83	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-232	3.74	G	1.90	1.92	1.00	1.10	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Thorium-229	80.7		30 - 110					07/11/23 12:12	07/18/23 13:12	1

## Method: DOE A-01-R - Isotopic Uranium (Alpha Spectrometry)

**Client Sample ID: S-1**  
**Date Collected: 07/06/23 10:55**  
**Date Received: 07/06/23 11:21**

**Lab Sample ID: 280-178681-1**  
**Matrix: Water**

Analyte	Result	Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Uranium-233/234	3.60	G	1.97	2.00	1.00	1.74	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Uranium-235/236	0.914		1.06	1.06	1.00	0.914	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Uranium-238	4.60	G	2.13	2.17	1.00	1.11	pCi/L	07/11/23 12:22	07/18/23 13:17	1
Tracer	%Yield	Qualifier	Limits					Prepared	Analyzed	Dil Fac
Uranium-232	78.6		30 - 110					07/11/23 12:22	07/18/23 13:17	1



# Surrogate Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: D7065-11 - Determination of Nonylphenols

Matrix: Water

Prep Type: Total/NA

Lab Sample ID	Client Sample ID	Percent Surrogate Recovery (Acceptance Limits)	
		4NPH (58-115)	4NPME (54-139)
280-178681-1	S-1	61 D	175 S1+
LCS 280-619212/2-A	Lab Control Sample	86	115
MB 280-619212/1-A	Method Blank	65	70

**Surrogate Legend**  
 4NPH = 4-nonylphenol (Surr)  
 4NPME = 4-nonylphenol monoethoxylate (Surr)

## Method: 8081B - Organochlorine Pesticides (GC)

Matrix: Water

Prep Type: Total/NA

Lab Sample ID	Client Sample ID	Percent Surrogate Recovery (Acceptance Limits)	
		DCBP1 (10-157)	TCX1 (12-129)
280-178681-1	S-1	17	88
LCS 280-619392/2-A	Lab Control Sample	75	73
LCSD 280-619392/3-A	Lab Control Sample Dup	67	65
MB 280-619392/1-A	Method Blank	68	81

**Surrogate Legend**  
 DCBP = DCB Decachlorobiphenyl (Surr)  
 TCX = Tetrachloro-m-xylene (Surr)

## Method: 8315A - Carbonyl Compounds by HPLC

Matrix: Water

Prep Type: Total/NA

Lab Sample ID	Client Sample ID	Percent Surrogate Recovery (Acceptance Limits)
		BTRA (60-130)
280-178681-1	S-1	101
LCS 410-395283/2-A	Lab Control Sample	105
LCSD 410-395283/3-A	Lab Control Sample Dup	105
MB 410-395283/1-A	Method Blank	103

**Surrogate Legend**  
 BTRA = Butyraldehyde

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 8270E - Semivolatile Organic Compounds (GC/MS)

**Lab Sample ID: MB 280-619045/1-A**  
**Matrix: Water**  
**Analysis Batch: 619193**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619045**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Butyl benzyl phthalate	ND		4.0	1.5	ug/L		07/11/23 09:25	07/12/23 09:56	1

**Lab Sample ID: LCS 280-619045/2-A**  
**Matrix: Water**  
**Analysis Batch: 619193**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619045**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Butyl benzyl phthalate	80.0	62.6		ug/L		78	49 - 141

**Lab Sample ID: LCSD 280-619045/3-A**  
**Matrix: Water**  
**Analysis Batch: 619193**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**  
**Prep Batch: 619045**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Butyl benzyl phthalate	80.0	73.8		ug/L		92	49 - 141	16	35

## Method: D7065-11 - Determination of Nonylphenols

**Lab Sample ID: MB 280-619212/1-A**  
**Matrix: Water**  
**Analysis Batch: 619388**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619212**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nonylphenol	ND		5000	1100	ng/L		07/12/23 10:53	07/13/23 10:38	1

Surrogate	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
4-nonylphenol (Surr)	65		58 - 115	07/12/23 10:53	07/13/23 10:38	1
4-nonylphenol monoethoxylate (Surr)	70		54 - 139	07/12/23 10:53	07/13/23 10:38	1

**Lab Sample ID: LCS 280-619212/2-A**  
**Matrix: Water**  
**Analysis Batch: 619388**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619212**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Nonylphenol	51300	47800		ng/L		93	56 - 125

Surrogate	LCS %Recovery	LCS Qualifier	Limits
4-nonylphenol (Surr)	86		58 - 115
4-nonylphenol monoethoxylate (Surr)	115		54 - 139

## Method: 8081B - Organochlorine Pesticides (GC)

**Lab Sample ID: MB 280-619392/1-A**  
**Matrix: Water**  
**Analysis Batch: 619741**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619392**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
beta-BHC	ND		0.050	0.0091	ug/L		07/13/23 12:16	07/17/23 19:36	1

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 8081B - Organochlorine Pesticides (GC) (Continued)

**Lab Sample ID: MB 280-619392/1-A**  
**Matrix: Water**  
**Analysis Batch: 619741**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619392**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
delta-BHC	ND		0.050	0.0078	ug/L		07/13/23 12:16	07/17/23 19:36	1
Surrogate	%Recovery	MB Qualifier	Limits				Prepared	Analyzed	Dil Fac
DCB Decachlorobiphenyl (Surr)	68		10 - 157				07/13/23 12:16	07/17/23 19:36	1
Tetrachloro-m-xylene (Surr)	81		12 - 129				07/13/23 12:16	07/17/23 19:36	1

**Lab Sample ID: LCS 280-619392/2-A**  
**Matrix: Water**  
**Analysis Batch: 619741**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619392**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits	
beta-BHC	0.500	0.405		ug/L		81	58 - 120	
delta-BHC	0.500	0.449		ug/L		90	63 - 128	
Surrogate	LCS %Recovery	LCS Qualifier	Limits					
DCB Decachlorobiphenyl (Surr)	75		10 - 157					
Tetrachloro-m-xylene (Surr)	73		12 - 129					

**Lab Sample ID: LCSD 280-619392/3-A**  
**Matrix: Water**  
**Analysis Batch: 619741**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**  
**Prep Batch: 619392**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
beta-BHC	0.500	0.361		ug/L		72	58 - 120	12	21
delta-BHC	0.500	0.406		ug/L		81	63 - 128	10	22
Surrogate	LCSD %Recovery	LCSD Qualifier	Limits						
DCB Decachlorobiphenyl (Surr)	67		10 - 157						
Tetrachloro-m-xylene (Surr)	65		12 - 129						

## Method: 8315A - Carbonyl Compounds by HPLC

**Lab Sample ID: MB 410-395283/1-A**  
**Matrix: Water**  
**Analysis Batch: 395541**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 395283**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Formaldehyde	ND		60	27	ug/L		07/10/23 17:06	07/11/23 09:48	1
Surrogate	MB %Recovery	MB Qualifier	Limits				Prepared	Analyzed	Dil Fac
Butyraldehyde	103		60 - 130				07/10/23 17:06	07/11/23 09:48	1

**Lab Sample ID: LCS 410-395283/2-A**  
**Matrix: Water**  
**Analysis Batch: 395541**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 395283**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits	
Formaldehyde	500	492		ug/L		98	77 - 122	

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 8315A - Carbonyl Compounds by HPLC (Continued)

Surrogate	LCS %Recovery	LCS Qualifier	Limits
Butyraldehyde	105		60 - 130

Lab Sample ID: LCSD 410-395283/3-A  
 Matrix: Water  
 Analysis Batch: 395541

Client Sample ID: Lab Control Sample Dup  
 Prep Type: Total/NA  
 Prep Batch: 395283

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Formaldehyde	500	479		ug/L		96	77 - 122	3	30

Surrogate	LCSD %Recovery	LCSD Qualifier	Limits
Butyraldehyde	105		60 - 130

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Lab Sample ID: MB 280-619039/1-A  
 Matrix: Water  
 Analysis Batch: 619263

Client Sample ID: Method Blank  
 Prep Type: Total/NA  
 Prep Batch: 619039

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Perfluorobutanoic acid (PFBA)	ND		8.0	2.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoropentanoic acid (PFPeA)	ND		4.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorohexanoic acid (PFHxA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoroheptanoic acid (PFHpA)	ND		2.0	0.52	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorooctanoic acid (PFOA)	ND		2.0	0.64	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorononanoic acid (PFNA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorodecanoic acid (PFDA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoroundecanoic acid (PFUnA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorododecanoic acid (PFDoA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorotridecanoic acid (PFTriA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorotetradecanoic acid (PFTeDA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorobutanesulfonic acid (PFBS)	ND		2.0	0.30	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoropentanesulfonic acid (PFPeS)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorohexanesulfonic acid (PFHxS)	ND		2.0	0.57	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		2.0	0.40	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorooctanesulfonic acid (PFOS)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorononanesulfonic acid (PFNS)	ND		2.0	0.40	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorodecanesulfonic acid (PFDS)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorododecanesulfonic acid (PFDoS)	ND		2.0	0.90	ng/L		07/11/23 10:52	07/12/23 15:21	1
4:2 FTS	ND		8.0	1.7	ng/L		07/11/23 10:52	07/12/23 15:21	1
6:2 FTS	ND		8.0	2.5	ng/L		07/11/23 10:52	07/12/23 15:21	1
8:2 FTS	ND		8.0	2.6	ng/L		07/11/23 10:52	07/12/23 15:21	1
Perfluorooctanesulfonamide (PFOSA)	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
NMeFOSA	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
NEtFOSA	ND		2.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
NMeFOSAA	ND		4.0	1.2	ng/L		07/11/23 10:52	07/12/23 15:21	1
NEtFOSAA	ND		2.0	0.70	ng/L		07/11/23 10:52	07/12/23 15:21	1
NMeFOSE	ND		20	5.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
NEtFOSE	ND		20	5.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
HFPO-DA (GenX)	ND		8.0	2.0	ng/L		07/11/23 10:52	07/12/23 15:21	1

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: MB 280-619039/1-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		8.0	1.5	ng/L		07/11/23 10:52	07/12/23 15:21	1
PFMBA	ND		4.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
NFDHA	ND		4.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
PFMPA	ND		4.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
9CI-PF3ONS	ND		8.0	1.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
11CI-PF3OUdS	ND		8.0	2.0	ng/L		07/11/23 10:52	07/12/23 15:21	1
PFEESA	ND		4.0	0.50	ng/L		07/11/23 10:52	07/12/23 15:21	1
3:3 FTCA	ND		10	1.5	ng/L		07/11/23 10:52	07/12/23 15:21	1
5:3 FTCA	ND		50	10	ng/L		07/11/23 10:52	07/12/23 15:21	1
7:3 FTCA	ND		50	10	ng/L		07/11/23 10:52	07/12/23 15:21	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	69		10 - 130	07/11/23 10:52	07/12/23 15:21	1
13C5 PFPeA	69		35 - 150	07/11/23 10:52	07/12/23 15:21	1
13C5 PFHxA	70		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C4 PFHpA	65		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C8 PFOA	65		60 - 140	07/11/23 10:52	07/12/23 15:21	1
13C9 PFNA	68		55 - 140	07/11/23 10:52	07/12/23 15:21	1
13C6 PFDA	67		50 - 140	07/11/23 10:52	07/12/23 15:21	1
13C7 PFUnA	69		30 - 140	07/11/23 10:52	07/12/23 15:21	1
13C2 PFDoA	67		10 - 150	07/11/23 10:52	07/12/23 15:21	1
13C2 PFTeDA	60		10 - 130	07/11/23 10:52	07/12/23 15:21	1
13C3 PFBS	66		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C3 PFHxS	63		55 - 150	07/11/23 10:52	07/12/23 15:21	1
13C8 PFOS	67		45 - 140	07/11/23 10:52	07/12/23 15:21	1
13C8 FOSA	73		30 - 130	07/11/23 10:52	07/12/23 15:21	1
d3-NMeFOSAA	79		45 - 200	07/11/23 10:52	07/12/23 15:21	1
d5-NEtFOSAA	81		10 - 200	07/11/23 10:52	07/12/23 15:21	1
M2-4:2 FTS	76		60 - 200	07/11/23 10:52	07/12/23 15:21	1
M2-6:2 FTS	84		60 - 200	07/11/23 10:52	07/12/23 15:21	1
M2-8:2 FTS	94		50 - 200	07/11/23 10:52	07/12/23 15:21	1
13C3 HFPO-DA	66		25 - 160	07/11/23 10:52	07/12/23 15:21	1
d7-N-MeFOSE-M	64		10 - 150	07/11/23 10:52	07/12/23 15:21	1
d9-N-EtFOSE-M	59		10 - 150	07/11/23 10:52	07/12/23 15:21	1
d5-NEtPFOSA	53		10 - 130	07/11/23 10:52	07/12/23 15:21	1
d3-NMePFOSA	51		15 - 130	07/11/23 10:52	07/12/23 15:21	1

**Lab Sample ID: LCS 280-619039/3-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	Limits
Perfluorobutanoic acid (PFBA)	128	143		ng/L		112	58 - 148
Perfluoropentanoic acid (PFPeA)	64.0	69.5		ng/L		109	54 - 152
Perfluorohexanoic acid (PFHxA)	32.0	35.8		ng/L		112	55 - 152
Perfluoroheptanoic acid (PFHpA)	32.0	35.2		ng/L		110	54 - 154
Perfluorooctanoic acid (PFOA)	32.0	35.0		ng/L		109	52 - 161
Perfluorononanoic acid (PFNA)	32.0	35.7		ng/L		112	59 - 149

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LCS 280-619039/3-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorodecanoic acid (PFDA)	32.0	37.2		ng/L		116	52 - 147
Perfluoroundecanoic acid (PFUnA)	32.0	33.6		ng/L		105	48 - 159
Perfluorododecanoic acid (PFDoA)	32.0	36.1		ng/L		113	64 - 142
Perfluorotridecanoic acid (PFTriA)	32.0	33.3		ng/L		104	49 - 148
Perfluorotetradecanoic acid (PFTeDA)	32.0	37.8		ng/L		118	47 - 161
Perfluorobutanesulfonic acid (PFBS)	28.4	31.7		ng/L		112	62 - 144
Perfluoropentanesulfonic acid (PFPeS)	30.0	35.4		ng/L		118	59 - 151
Perfluorohexanesulfonic acid (PFHxS)	29.2	33.2		ng/L		114	57 - 146
Perfluoroheptanesulfonic acid (PFHpS)	30.5	36.3		ng/L		119	55 - 152
Perfluorooctanesulfonic acid (PFOS)	29.8	34.5		ng/L		116	58 - 149
Perfluorononanesulfonic acid (PFNS)	30.8	38.6		ng/L		125	52 - 148
Perfluorodecanesulfonic acid (PFDS)	30.8	37.0		ng/L		120	51 - 147
Perfluorododecanesulfonic acid (PFDoS)	31.0	32.4		ng/L		104	36 - 145
4:2 FTS	120	136		ng/L		114	67 - 146
6:2 FTS	121	135		ng/L		111	61 - 151
8:2 FTS	123	147		ng/L		120	63 - 152
Perfluorooctanesulfonamide (PFOSA)	32.0	34.6		ng/L		108	61 - 148
NMeFOSA	32.0	40.4		ng/L		126	63 - 145
NEtFOSA	32.0	37.2		ng/L		116	65 - 139
NMeFOSAA	32.0	34.3		ng/L		107	58 - 144
NEtFOSAA	32.0	33.7		ng/L		105	59 - 146
NMeFOSE	320	363		ng/L		113	71 - 136
NEtFOSE	320	361		ng/L		113	69 - 137
HFPO-DA (GenX)	128	138		ng/L		108	63 - 144
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	121	145		ng/L		120	68 - 146
PFMBA	64.0	74.9		ng/L		117	55 - 148
NFDHA	64.0	75.0		ng/L		117	48 - 161
PFMPA	64.0	71.6		ng/L		112	51 - 145
9Cl-PF3ONS	119	142		ng/L		119	56 - 156
11Cl-PF3OUdS	121	119		ng/L		99	46 - 156
PFEESA	57.0	60.4		ng/L		106	56 - 151
3:3 FTCA	160	186		ng/L		116	62 - 129
5:3 FTCA	800	941		ng/L		118	63 - 134
7:3 FTCA	800	885		ng/L		111	50 - 138

Isotope Dilution	LCS LCS		Limits
	%Recovery	Qualifier	
<sup>13</sup> C4 PFBA	71		10 - 130
<sup>13</sup> C5 PFPeA	70		40 - 150

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LCS 280-619039/3-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

Isotope Dilution	LCS		Limits
	%Recovery	Qualifier	
13C5 PFHxA	69		40 - 150
13C4 PFHpA	69		40 - 150
13C8 PFOA	71		30 - 140
13C9 PFNA	71		30 - 140
13C6 PFDA	74		20 - 140
13C7 PFUnA	80		20 - 140
13C2 PFDoA	76		10 - 150
13C2 PFTeDA	68		10 - 130
13C3 PFBS	70		25 - 150
13C3 PFHxS	65		25 - 150
13C8 PFOS	69		20 - 140
13C8 FOSA	83		10 - 130
d3-NMeFOSAA	97		10 - 200
d5-NEtFOSAA	100		10 - 200
M2-4:2 FTS	74		25 - 200
M2-6:2 FTS	87		25 - 200
M2-8:2 FTS	104		25 - 200
13C3 HFPO-DA	72		25 - 160
d7-N-MeFOSE-M	70		10 - 150
d9-N-EtFOSE-M	66		10 - 150
d5-NEtPFOSA	54		10 - 130
d3-NMePFOSA	53		10 - 130

**Lab Sample ID: LLCS 280-619039/2-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

Analyte	Spike Added	LLCS		Unit	D	%Rec	Limits
		Result	Qualifier				
Perfluorobutanoic acid (PFBA)	12.8	14.6		ng/L		114	44 - 157
Perfluoropentanoic acid (PFPeA)	6.40	7.74		ng/L		121	57 - 148
Perfluorohexanoic acid (PFHxA)	3.20	3.90		ng/L		122	62 - 149
Perfluoroheptanoic acid (PFHpA)	3.20	3.62		ng/L		113	56 - 150
Perfluorooctanoic acid (PFOA)	3.20	3.60		ng/L		112	57 - 161
Perfluorononanoic acid (PFNA)	3.20	3.98		ng/L		124	53 - 157
Perfluorodecanoic acid (PFDA)	3.20	3.64		ng/L		114	43 - 158
Perfluoroundecanoic acid (PFUnA)	3.20	3.94		ng/L		123	50 - 155
Perfluorododecanoic acid (PFDoA)	3.20	4.00		ng/L		125	60 - 141
Perfluorotridecanoic acid (PFTriA)	3.20	3.32		ng/L		104	52 - 140
Perfluorotetradecanoic acid (PFTeDA)	3.20	3.92		ng/L		122	52 - 156
Perfluorobutanesulfonic acid (PFBS)	2.84	3.16		ng/L		111	63 - 145
Perfluoropentanesulfonic acid (PFPeS)	3.00	3.41		ng/L		113	58 - 144
Perfluorohexanesulfonic acid (PFHxS)	2.92	3.32		ng/L		114	44 - 158
Perfluoroheptanesulfonic acid (PFHpS)	3.05	3.61		ng/L		119	51 - 150

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LLCS 280-619039/2-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorooctanesulfonic acid (PFOS)	2.98	3.45		ng/L		116	43 - 162
Perfluorononanesulfonic acid (PFNS)	3.08	3.80		ng/L		123	46 - 151
Perfluorodecanesulfonic acid (PFDS)	3.08	3.56		ng/L		115	50 - 144
Perfluorododecanesulfonic acid (PFDoS)	3.10	3.32		ng/L		107	30 - 138
4:2 FTS	12.0	14.4		ng/L		120	52 - 158
6:2 FTS	12.1	13.8		ng/L		113	48 - 158
8:2 FTS	12.3	13.6		ng/L		111	46 - 165
Perfluorooctanesulfonamide (PFOSA)	3.20	3.77		ng/L		118	47 - 163
NMeFOSA	3.20	4.04		ng/L		126	54 - 155
NEtFOSA	3.20	4.16		ng/L		130	49 - 156
NMeFOSAA	3.20	3.91	J	ng/L		122	32 - 160
NEtFOSAA	3.20	4.09		ng/L		128	51 - 154
NMeFOSE	32.0	37.7		ng/L		118	56 - 151
NEtFOSE	32.0	40.2		ng/L		126	60 - 147
HFPO-DA (GenX)	12.8	15.2		ng/L		119	58 - 154
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	12.1	15.2		ng/L		126	61 - 148
PFMBA	6.40	7.53		ng/L		118	49 - 154
NFDHA	6.40	7.38		ng/L		115	47 - 160
PFMPA	6.40	7.34		ng/L		115	48 - 150
9Cl-PF3ONS	11.9	13.8		ng/L		115	44 - 167
11Cl-PF3OUdS	12.1	12.6		ng/L		105	36 - 158
PFEESA	5.70	6.57		ng/L		115	56 - 144
3:3 FTCA	16.0	19.4		ng/L		121	32 - 161
5:3 FTCA	80.0	95.4		ng/L		119	39 - 156
7:3 FTCA	80.0	94.6		ng/L		118	36 - 149

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
13C4 PFBA	70		10 - 130
13C5 PFPeA	73		35 - 150
13C5 PFHxA	71		55 - 150
13C4 PFHpA	70		55 - 150
13C8 PFOA	68		60 - 140
13C9 PFNA	66		55 - 140
13C6 PFDA	70		50 - 140
13C7 PFUnA	66		30 - 140
13C2 PFDoA	62		10 - 150
13C2 PFTeDA	66		10 - 130
13C3 PFBS	72		55 - 150
13C3 PFHxS	68		55 - 150
13C8 PFOS	66		45 - 140
13C8 FOSA	68		30 - 130
d3-NMeFOSAA	70		45 - 200
d5-NEtFOSAA	69		10 - 200
M2-4:2 FTS	74		60 - 200

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LLCS 280-619039/2-A**  
**Matrix: Water**  
**Analysis Batch: 619263**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619039**

<i>Isotope Dilution</i>	<i>LLCS</i>	<i>LLCS</i>	<i>Limits</i>
	<i>%Recovery</i>	<i>Qualifier</i>	
M2-6:2 FTS	77		60 - 200
M2-8:2 FTS	82		50 - 200
13C3 HFPO-DA	73		25 - 160
d7-N-MeFOSE-M	64		10 - 150
d9-N-EtFOSE-M	60		10 - 150
d5-NEtPFOSA	51		10 - 130
d3-NMePFOSA	50		15 - 130

**Lab Sample ID: MB 280-619208/1-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

<i>Analyte</i>	<i>MB MB</i>		<i>RL</i>	<i>MDL</i>	<i>Unit</i>	<i>D</i>	<i>Prepared</i>	<i>Analyzed</i>	<i>Dil Fac</i>
	<i>Result</i>	<i>Qualifier</i>							
Perfluorobutanoic acid (PFBA)	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoropentanoic acid (PFPeA)	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorohexanoic acid (PFHxA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoroheptanoic acid (PFHpA)	ND		2.0	0.52	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorooctanoic acid (PFOA)	ND		2.0	0.64	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorononanoic acid (PFNA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorodecanoic acid (PFDA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoroundecanoic acid (PFUnA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorododecanoic acid (PFDoA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorotridecanoic acid (PFTriA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorotetradecanoic acid (PFTeDA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorobutanesulfonic acid (PFBS)	ND		2.0	0.30	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoropentanesulfonic acid (PFPeS)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorohexanesulfonic acid (PFHxS)	ND		2.0	0.57	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		2.0	0.40	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorooctanesulfonic acid (PFOS)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorononanesulfonic acid (PFNS)	ND		2.0	0.40	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorodecanesulfonic acid (PFDS)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorododecanesulfonic acid (PFDoS)	ND		2.0	0.90	ng/L		07/12/23 11:15	07/13/23 13:36	1
4:2 FTS	ND		8.0	1.7	ng/L		07/12/23 11:15	07/13/23 13:36	1
6:2 FTS	ND		8.0	2.5	ng/L		07/12/23 11:15	07/13/23 13:36	1
8:2 FTS	ND		8.0	2.6	ng/L		07/12/23 11:15	07/13/23 13:36	1
Perfluorooctanesulfonamide (PFOSA)	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
NMeFOSA	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
NEtFOSA	ND		2.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
NMeFOSAA	ND		4.0	1.2	ng/L		07/12/23 11:15	07/13/23 13:36	1
NEtFOSAA	ND		2.0	0.70	ng/L		07/12/23 11:15	07/13/23 13:36	1
NMeFOSE	ND		20	5.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
NEtFOSE	ND		20	5.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
HFPO-DA (GenX)	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		8.0	1.5	ng/L		07/12/23 11:15	07/13/23 13:36	1
PFMBA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
NFDHA	ND		4.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: MB 280-619208/1-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
PFMPA	ND		4.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
9CI-PF3ONS	ND		8.0	1.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
11CI-PF3OUdS	ND		8.0	2.0	ng/L		07/12/23 11:15	07/13/23 13:36	1
PFEESA	ND		4.0	0.50	ng/L		07/12/23 11:15	07/13/23 13:36	1
3:3 FTCA	ND		10	1.5	ng/L		07/12/23 11:15	07/13/23 13:36	1
5:3 FTCA	ND		50	10	ng/L		07/12/23 11:15	07/13/23 13:36	1
7:3 FTCA	ND		50	10	ng/L		07/12/23 11:15	07/13/23 13:36	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	79		10 - 130	07/12/23 11:15	07/13/23 13:36	1
13C5 PFPeA	79		35 - 150	07/12/23 11:15	07/13/23 13:36	1
13C5 PFHxA	78		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C4 PFHpA	74		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C8 PFOA	81		60 - 140	07/12/23 11:15	07/13/23 13:36	1
13C9 PFNA	80		55 - 140	07/12/23 11:15	07/13/23 13:36	1
13C6 PFDA	74		50 - 140	07/12/23 11:15	07/13/23 13:36	1
13C7 PFUnA	77		30 - 140	07/12/23 11:15	07/13/23 13:36	1
13C2 PFDoA	76		10 - 150	07/12/23 11:15	07/13/23 13:36	1
13C2 PFTeDA	80		10 - 130	07/12/23 11:15	07/13/23 13:36	1
13C3 PFBS	78		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C3 PFHxS	76		55 - 150	07/12/23 11:15	07/13/23 13:36	1
13C8 PFOS	79		45 - 140	07/12/23 11:15	07/13/23 13:36	1
13C8 FOSA	69		30 - 130	07/12/23 11:15	07/13/23 13:36	1
d3-NMeFOSAA	84		45 - 200	07/12/23 11:15	07/13/23 13:36	1
d5-NEtFOSAA	85		10 - 200	07/12/23 11:15	07/13/23 13:36	1
M2-4:2 FTS	83		60 - 200	07/12/23 11:15	07/13/23 13:36	1
M2-6:2 FTS	79		60 - 200	07/12/23 11:15	07/13/23 13:36	1
M2-8:2 FTS	81		50 - 200	07/12/23 11:15	07/13/23 13:36	1
13C3 HFPO-DA	76		25 - 160	07/12/23 11:15	07/13/23 13:36	1
d7-N-MeFOSE-M	78		10 - 150	07/12/23 11:15	07/13/23 13:36	1
d9-N-EtFOSE-M	75		10 - 150	07/12/23 11:15	07/13/23 13:36	1
d5-NEtPFOSA	67		10 - 130	07/12/23 11:15	07/13/23 13:36	1
d3-NMePFOSA	61		15 - 130	07/12/23 11:15	07/13/23 13:36	1

**Lab Sample ID: LCS 280-619208/3-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	Limits
Perfluorobutanoic acid (PFBA)	128	144		ng/L		113	58 - 148
Perfluoropentanoic acid (PFPeA)	64.0	69.6		ng/L		109	54 - 152
Perfluorohexanoic acid (PFHxA)	32.0	35.2		ng/L		110	55 - 152
Perfluoroheptanoic acid (PFHpA)	32.0	34.3		ng/L		107	54 - 154
Perfluorooctanoic acid (PFOA)	32.0	34.5		ng/L		108	52 - 161
Perfluorononanoic acid (PFNA)	32.0	35.4		ng/L		111	59 - 149
Perfluorodecanoic acid (PFDA)	32.0	34.6		ng/L		108	52 - 147
Perfluoroundecanoic acid (PFUnA)	32.0	34.8		ng/L		109	48 - 159

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LCS 280-619208/3-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorododecanoic acid (PFDoA)	32.0	34.1		ng/L		107	64 - 142
Perfluorotridecanoic acid (PFTriA)	32.0	33.4		ng/L		104	49 - 148
Perfluorotetradecanoic acid (PFTeDA)	32.0	37.6		ng/L		118	47 - 161
Perfluorobutanesulfonic acid (PFBS)	28.4	29.7		ng/L		104	62 - 144
Perfluoropentanesulfonic acid (PFPeS)	30.0	33.8		ng/L		113	59 - 151
Perfluorohexanesulfonic acid (PFHxS)	29.2	33.6		ng/L		115	57 - 146
Perfluoroheptanesulfonic acid (PFHpS)	30.5	34.2		ng/L		112	55 - 152
Perfluorooctanesulfonic acid (PFOS)	29.8	31.3		ng/L		105	58 - 149
Perfluorononanesulfonic acid (PFNS)	30.8	32.3		ng/L		105	52 - 148
Perfluorodecanesulfonic acid (PFDS)	30.8	31.6		ng/L		102	51 - 147
Perfluorododecanesulfonic acid (PFDoS)	31.0	28.7		ng/L		92	36 - 145
4:2 FTS	120	140		ng/L		117	67 - 146
6:2 FTS	121	131		ng/L		108	61 - 151
8:2 FTS	123	142		ng/L		116	63 - 152
Perfluorooctanesulfonamide (PFOSA)	32.0	36.2		ng/L		113	61 - 148
NMeFOSA	32.0	35.6		ng/L		111	63 - 145
NEtFOSA	32.0	37.0		ng/L		116	65 - 139
NMeFOSAA	32.0	36.1		ng/L		113	58 - 144
NEtFOSAA	32.0	38.2		ng/L		119	59 - 146
NMeFOSE	320	365		ng/L		114	71 - 136
NEtFOSE	320	361		ng/L		113	69 - 137
HFPO-DA (GenX)	128	144		ng/L		112	63 - 144
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	121	149		ng/L		123	68 - 146
PFMBA	64.0	68.3		ng/L		107	55 - 148
NFDHA	64.0	70.5		ng/L		110	48 - 161
PFMPA	64.0	65.1		ng/L		102	51 - 145
9Cl-PF3ONS	119	138		ng/L		116	56 - 156
11Cl-PF3OUdS	121	130		ng/L		108	46 - 156
PFEESA	57.0	59.5		ng/L		104	56 - 151
3:3 FTCA	160	171		ng/L		107	62 - 129
5:3 FTCA	800	884		ng/L		110	63 - 134
7:3 FTCA	800	823		ng/L		103	50 - 138

Isotope Dilution	LCS %Recovery	LCS Qualifier	Limits
13C4 PFBA	78		10 - 130
13C5 PFPeA	81		40 - 150
13C5 PFHxA	80		40 - 150
13C4 PFHpA	81		40 - 150
13C8 PFOA	75		30 - 140

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LCS 280-619208/3-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Isotope Dilution	LCS		Limits
	%Recovery	Qualifier	
13C9 PFNA	76		30 - 140
13C6 PFDA	79		20 - 140
13C7 PFUnA	72		20 - 140
13C2 PFDoA	75		10 - 150
13C2 PFTeDA	78		10 - 130
13C3 PFBS	79		25 - 150
13C3 PFHxS	71		25 - 150
13C8 PFOS	82		20 - 140
13C8 FOSA	71		10 - 130
d3-NMeFOSAA	83		10 - 200
d5-NEtFOSAA	82		10 - 200
M2-4:2 FTS	78		25 - 200
M2-6:2 FTS	81		25 - 200
M2-8:2 FTS	74		25 - 200
13C3 HFPO-DA	75		25 - 160
d7-N-MeFOSE-M	75		10 - 150
d9-N-EtFOSE-M	73		10 - 150
d5-NEtPFOSA	57		10 - 130
d3-NMePFOSA	57		10 - 130

**Lab Sample ID: LLCS 280-619208/2-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluoropentanoic acid (PFPeA)	6.40	6.95		ng/L		109	57 - 148
Perfluorohexanoic acid (PFHxA)	3.20	3.58		ng/L		112	62 - 149
Perfluoroheptanoic acid (PFHpA)	3.20	3.55		ng/L		111	56 - 150
Perfluorooctanoic acid (PFOA)	3.20	3.81		ng/L		119	57 - 161
Perfluorononanoic acid (PFNA)	3.20	3.47		ng/L		109	53 - 157
Perfluorodecanoic acid (PFDA)	3.20	3.42		ng/L		107	43 - 158
Perfluoroundecanoic acid (PFUnA)	3.20	3.56		ng/L		111	50 - 155
Perfluorododecanoic acid (PFDoA)	3.20	3.36		ng/L		105	60 - 141
Perfluorotridecanoic acid (PFTriA)	3.20	3.31		ng/L		103	52 - 140
Perfluorotetradecanoic acid (PFTeDA)	3.20	3.56		ng/L		111	52 - 156
Perfluorobutanesulfonic acid (PFBS)	2.84	2.67		ng/L		94	63 - 145
Perfluoropentanesulfonic acid (PFPeS)	3.00	3.38		ng/L		113	58 - 144
Perfluorohexanesulfonic acid (PFHxS)	2.92	3.22		ng/L		110	44 - 158
Perfluoroheptanesulfonic acid (PFHpS)	3.05	3.42		ng/L		112	51 - 150
Perfluorooctanesulfonic acid (PFOS)	2.98	3.24		ng/L		109	43 - 162

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LLCS 280-619208/2-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorononanesulfonic acid (PFNS)	3.08	3.38		ng/L		110	46 - 151
Perfluorodecanesulfonic acid (PFDS)	3.08	3.32		ng/L		108	50 - 144
Perfluorododecanesulfonic acid (PFDoS)	3.10	2.78		ng/L		89	30 - 138
4:2 FTS	12.0	13.0		ng/L		109	52 - 158
6:2 FTS	12.1	13.3		ng/L		110	48 - 158
8:2 FTS	12.3	15.2		ng/L		124	46 - 165
Perfluorooctanesulfonamide (PFOSA)	3.20	3.54		ng/L		111	47 - 163
NMeFOSA	3.20	4.07		ng/L		127	54 - 155
NEtFOSA	3.20	3.65		ng/L		114	49 - 156
NMeFOSAA	3.20	3.51	J	ng/L		110	32 - 160
NEtFOSAA	3.20	3.67		ng/L		115	51 - 154
NMeFOSE	32.0	36.0		ng/L		113	56 - 151
NEtFOSE	32.0	37.4		ng/L		117	60 - 147
HFPO-DA (GenX)	12.8	15.3		ng/L		119	58 - 154
4,8-Dioxa-3H-perfluorononoic acid (ADONA)	12.1	14.5		ng/L		120	61 - 148
PFMBA	6.40	7.25		ng/L		113	49 - 154
NFDHA	6.40	6.59		ng/L		103	47 - 160
PFMPA	6.40	6.89		ng/L		108	48 - 150
9Cl-PF3ONS	11.9	11.5		ng/L		96	44 - 167
11Cl-PF3OUdS	12.1	12.3		ng/L		102	36 - 158
PFEESA	5.70	5.89		ng/L		103	56 - 144
3:3 FTCA	16.0	17.9		ng/L		112	32 - 161
5:3 FTCA	80.0	96.4		ng/L		121	39 - 156
7:3 FTCA	80.0	90.4		ng/L		113	36 - 149

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
13C4 PFBA	77		10 - 130
13C5 PFPeA	78		35 - 150
13C5 PFHxA	77		55 - 150
13C4 PFHpA	76		55 - 150
13C8 PFOA	80		60 - 140
13C9 PFNA	81		55 - 140
13C6 PFDA	79		50 - 140
13C7 PFUnA	80		30 - 140
13C2 PFDoA	77		10 - 150
13C2 PFTeDA	80		10 - 130
13C3 PFBS	84		55 - 150
13C3 PFHxS	78		55 - 150
13C8 PFOS	82		45 - 140
13C8 FOSA	79		30 - 130
d3-NMeFOSAA	91		45 - 200
d5-NEtFOSAA	91		10 - 200
M2-4:2 FTS	86		60 - 200
M2-6:2 FTS	83		60 - 200
M2-8:2 FTS	85		50 - 200

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LLCS 280-619208/2-A**  
**Matrix: Water**  
**Analysis Batch: 619400**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619208**

Isotope Dilution	LLCS LLCS		Limits
	%Recovery	Qualifier	
13C3 HFPO-DA	77		25 - 160
d7-N-MeFOSE-M	83		10 - 150
d9-N-EtFOSE-M	77		10 - 150
d5-NEtPFOSA	64		10 - 130
d3-NMePFOSA	60		15 - 130

**Lab Sample ID: MB 280-619711/1-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

Analyte	MB MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Perfluorobutanoic acid (PFBA)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoropentanoic acid (PFPeA)	ND		4.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorohexanoic acid (PFHxA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoroheptanoic acid (PFHpA)	ND		2.0	0.52	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorooctanoic acid (PFOA)	ND		2.0	0.64	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorononanoic acid (PFNA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorodecanoic acid (PFDA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoroundecanoic acid (PFUnA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorododecanoic acid (PFDoA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorotridecanoic acid (PFTriA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorotetradecanoic acid (PFTeDA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorobutanesulfonic acid (PFBS)	ND		2.0	0.30	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoropentanesulfonic acid (PFPeS)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorohexanesulfonic acid (PFHxS)	ND		2.0	0.57	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluoroheptanesulfonic acid (PFHpS)	ND		2.0	0.40	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorooctanesulfonic acid (PFOS)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorononanesulfonic acid (PFNS)	ND		2.0	0.40	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorodecanesulfonic acid (PFDS)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorododecanesulfonic acid (PFDoS)	ND		2.0	0.90	ng/L		07/17/23 11:33	07/18/23 13:18	1
4:2 FTS	ND		8.0	1.7	ng/L		07/17/23 11:33	07/18/23 13:18	1
6:2 FTS	ND		8.0	2.5	ng/L		07/17/23 11:33	07/18/23 13:18	1
8:2 FTS	ND		8.0	2.6	ng/L		07/17/23 11:33	07/18/23 13:18	1
Perfluorooctanesulfonamide (PFOSA)	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
NMeFOSA	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
NEtFOSA	ND		2.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
NMeFOSAA	ND		4.0	1.2	ng/L		07/17/23 11:33	07/18/23 13:18	1
NEtFOSAA	ND		2.0	0.70	ng/L		07/17/23 11:33	07/18/23 13:18	1
NMeFOSE	ND		20	5.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
NEtFOSE	ND		20	5.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
HFPO-DA (GenX)	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	ND		8.0	1.5	ng/L		07/17/23 11:33	07/18/23 13:18	1
PFMBA	ND		4.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
NFDHA	ND		4.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
PFMPA	ND		4.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
9CI-PF3ONS	ND		8.0	1.0	ng/L		07/17/23 11:33	07/18/23 13:18	1

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: MB 280-619711/1-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
11CI-PF3OUdS	ND		8.0	2.0	ng/L		07/17/23 11:33	07/18/23 13:18	1
PFEESA	ND		4.0	0.50	ng/L		07/17/23 11:33	07/18/23 13:18	1
3:3 FTCA	ND		10	1.5	ng/L		07/17/23 11:33	07/18/23 13:18	1
5:3 FTCA	ND		50	10	ng/L		07/17/23 11:33	07/18/23 13:18	1
7:3 FTCA	ND		50	10	ng/L		07/17/23 11:33	07/18/23 13:18	1

Isotope Dilution	MB %Recovery	MB Qualifier	Limits	Prepared	Analyzed	Dil Fac
13C4 PFBA	81		10 - 130	07/17/23 11:33	07/18/23 13:18	1
13C5 PFPeA	73		35 - 150	07/17/23 11:33	07/18/23 13:18	1
13C5 PFHxA	80		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C4 PFHpA	76		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C8 PFOA	79		60 - 140	07/17/23 11:33	07/18/23 13:18	1
13C9 PFNA	78		55 - 140	07/17/23 11:33	07/18/23 13:18	1
13C6 PFDA	77		50 - 140	07/17/23 11:33	07/18/23 13:18	1
13C7 PFUnA	74		30 - 140	07/17/23 11:33	07/18/23 13:18	1
13C2 PFDoA	69		10 - 150	07/17/23 11:33	07/18/23 13:18	1
13C2 PFTeDA	67		10 - 130	07/17/23 11:33	07/18/23 13:18	1
13C3 PFBS	77		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C3 PFHxS	73		55 - 150	07/17/23 11:33	07/18/23 13:18	1
13C8 PFOS	71		45 - 140	07/17/23 11:33	07/18/23 13:18	1
13C8 FOSA	59		30 - 130	07/17/23 11:33	07/18/23 13:18	1
d3-NMeFOSAA	78		45 - 200	07/17/23 11:33	07/18/23 13:18	1
d5-NEtFOSAA	71		10 - 200	07/17/23 11:33	07/18/23 13:18	1
M2-4:2 FTS	85		60 - 200	07/17/23 11:33	07/18/23 13:18	1
M2-6:2 FTS	86		60 - 200	07/17/23 11:33	07/18/23 13:18	1
M2-8:2 FTS	91		50 - 200	07/17/23 11:33	07/18/23 13:18	1
13C3 HFPO-DA	82		25 - 160	07/17/23 11:33	07/18/23 13:18	1
d7-N-MeFOSE-M	61		10 - 150	07/17/23 11:33	07/18/23 13:18	1
d9-N-EtFOSE-M	59		10 - 150	07/17/23 11:33	07/18/23 13:18	1
d5-NEtPFOSA	46		10 - 130	07/17/23 11:33	07/18/23 13:18	1
d3-NMePFOSA	47		15 - 130	07/17/23 11:33	07/18/23 13:18	1

**Lab Sample ID: LCS 280-619711/3-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	Limits
Perfluorobutanoic acid (PFBA)	128	144		ng/L		113	58 - 148
Perfluoropentanoic acid (PFPeA)	64.0	72.8		ng/L		114	54 - 152
Perfluorohexanoic acid (PFHxA)	32.0	36.9		ng/L		115	55 - 152
Perfluoroheptanoic acid (PFHpA)	32.0	34.7		ng/L		109	54 - 154
Perfluorooctanoic acid (PFOA)	32.0	38.7		ng/L		121	52 - 161
Perfluorononanoic acid (PFNA)	32.0	36.9		ng/L		115	59 - 149
Perfluorodecanoic acid (PFDA)	32.0	36.8		ng/L		115	52 - 147
Perfluoroundecanoic acid (PFUnA)	32.0	36.9		ng/L		115	48 - 159
Perfluorododecanoic acid (PFDoA)	32.0	36.7		ng/L		115	64 - 142
Perfluorotridecanoic acid (PFTriA)	32.0	38.8		ng/L		121	49 - 148

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LCS 280-619711/3-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorotetradecanoic acid (PFTeDA)	32.0	39.3		ng/L		123	47 - 161
Perfluorobutanesulfonic acid (PFBS)	28.4	34.5		ng/L		121	62 - 144
Perfluoropentanesulfonic acid (PFPeS)	30.0	32.4		ng/L		108	59 - 151
Perfluorohexanesulfonic acid (PFHxS)	29.2	36.7		ng/L		126	57 - 146
Perfluoroheptanesulfonic acid (PFHpS)	30.5	36.3		ng/L		119	55 - 152
Perfluorooctanesulfonic acid (PFOS)	29.8	33.8		ng/L		114	58 - 149
Perfluorononanesulfonic acid (PFNS)	30.8	37.3		ng/L		121	52 - 148
Perfluorodecanesulfonic acid (PFDS)	30.8	30.9		ng/L		100	51 - 147
Perfluorododecanesulfonic acid (PFDoS)	31.0	26.9		ng/L		87	36 - 145
4:2 FTS	120	126		ng/L		105	67 - 146
6:2 FTS	121	142		ng/L		117	61 - 151
8:2 FTS	123	135		ng/L		110	63 - 152
Perfluorooctanesulfonamide (PFOSA)	32.0	35.0		ng/L		109	61 - 148
NMeFOSA	32.0	43.7		ng/L		137	63 - 145
NEtFOSA	32.0	38.2		ng/L		119	65 - 139
NMeFOSAA	32.0	36.6		ng/L		114	58 - 144
NEtFOSAA	32.0	35.5		ng/L		111	59 - 146
NMeFOSE	320	389		ng/L		122	71 - 136
NEtFOSE	320	380		ng/L		119	69 - 137
HFPO-DA (GenX)	128	145		ng/L		113	63 - 144
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	121	144		ng/L		120	68 - 146
PFMBA	64.0	78.5		ng/L		123	55 - 148
NFDHA	64.0	71.1		ng/L		111	48 - 161
PFMPA	64.0	73.5		ng/L		115	51 - 145
9Cl-PF3ONS	119	116		ng/L		97	56 - 156
11Cl-PF3OUdS	121	120		ng/L		99	46 - 156
PFEESA	57.0	59.8		ng/L		105	56 - 151
3:3 FTCA	160	170		ng/L		107	62 - 129
5:3 FTCA	800	928		ng/L		116	63 - 134
7:3 FTCA	800	903		ng/L		113	50 - 138

Isotope Dilution	LCS LCS		Limits
	%Recovery	Qualifier	
13C4 PFBA	81		10 - 130
13C5 PFPeA	73		40 - 150
13C5 PFHxA	76		40 - 150
13C4 PFHpA	77		40 - 150
13C8 PFOA	81		30 - 140
13C9 PFNA	77		30 - 140
13C6 PFDA	79		20 - 140
13C7 PFUnA	76		20 - 140

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LCS 280-619711/3-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

<i>Isotope Dilution</i>	<i>LCS %Recovery</i>	<i>LCS Qualifier</i>	<i>Limits</i>
13C2 PFDoA	73		10 - 150
13C2 PFTeDA	69		10 - 130
13C3 PFBS	75		25 - 150
13C3 PFHxS	74		25 - 150
13C8 PFOS	73		20 - 140
13C8 FOSA	66		10 - 130
d3-NMeFOSAA	84		10 - 200
d5-NEtFOSAA	83		10 - 200
M2-4:2 FTS	99		25 - 200
M2-6:2 FTS	88		25 - 200
M2-8:2 FTS	96		25 - 200
13C3 HFPO-DA	78		25 - 160
d7-N-MeFOSE-M	65		10 - 150
d9-N-EtFOSE-M	66		10 - 150
d5-NEtPFOSA	47		10 - 130
d3-NMePFOSA	45		10 - 130

**Lab Sample ID: LLCS 280-619711/2-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

<i>Analyte</i>	<i>Spike Added</i>	<i>LLCS Result</i>	<i>LLCS Qualifier</i>	<i>Unit</i>	<i>D</i>	<i>%Rec</i>	<i>%Rec Limits</i>
Perfluorobutanoic acid (PFBA)	12.8	14.5		ng/L		114	44 - 157
Perfluoropentanoic acid (PFPeA)	6.40	7.28		ng/L		114	57 - 148
Perfluorohexanoic acid (PFHxA)	3.20	3.70		ng/L		116	62 - 149
Perfluoroheptanoic acid (PFHpA)	3.20	3.48		ng/L		109	56 - 150
Perfluorooctanoic acid (PFOA)	3.20	3.99		ng/L		125	57 - 161
Perfluorononanoic acid (PFNA)	3.20	3.92		ng/L		122	53 - 157
Perfluorodecanoic acid (PFDA)	3.20	3.61		ng/L		113	43 - 158
Perfluoroundecanoic acid (PFUnA)	3.20	3.44		ng/L		108	50 - 155
Perfluorododecanoic acid (PFDoA)	3.20	3.78		ng/L		118	60 - 141
Perfluorotridecanoic acid (PFTriA)	3.20	3.55		ng/L		111	52 - 140
Perfluorotetradecanoic acid (PFTeDA)	3.20	4.41		ng/L		138	52 - 156
Perfluorobutanesulfonic acid (PFBS)	2.84	3.33		ng/L		117	63 - 145
Perfluoropentanesulfonic acid (PFPeS)	3.00	3.01		ng/L		100	58 - 144
Perfluorohexanesulfonic acid (PFHxS)	2.92	3.56		ng/L		122	44 - 158
Perfluoroheptanesulfonic acid (PFHpS)	3.05	3.29		ng/L		108	51 - 150
Perfluorooctanesulfonic acid (PFOS)	2.98	3.09		ng/L		104	43 - 162
Perfluorononanesulfonic acid (PFNS)	3.08	3.27		ng/L		106	46 - 151
Perfluorodecanesulfonic acid (PFDS)	3.08	3.02		ng/L		98	50 - 144

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

**Lab Sample ID: LLCS 280-619711/2-A**  
**Matrix: Water**  
**Analysis Batch: 619866**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619711**

Analyte	Spike Added	LLCS Result	LLCS Qualifier	Unit	D	%Rec	%Rec Limits
Perfluorododecanesulfonic acid (PFDoS)	3.10	2.38		ng/L		77	30 - 138
4:2 FTS	12.0	13.2		ng/L		111	52 - 158
6:2 FTS	12.1	13.6		ng/L		112	48 - 158
8:2 FTS	12.3	11.8		ng/L		96	46 - 165
Perfluorooctanesulfonamide (PFOSA)	3.20	3.39		ng/L		106	47 - 163
NMeFOSA	3.20	4.41		ng/L		138	54 - 155
NEtFOSA	3.20	3.36		ng/L		105	49 - 156
NMeFOSAA	3.20	3.82	J	ng/L		119	32 - 160
NEtFOSAA	3.20	4.10		ng/L		128	51 - 154
NMeFOSE	32.0	38.1		ng/L		119	56 - 151
NEtFOSE	32.0	37.6		ng/L		117	60 - 147
HFPO-DA (GenX)	12.8	14.9		ng/L		116	58 - 154
4,8-Dioxa-3H-perfluorononanoic acid (ADONA)	12.1	14.7		ng/L		122	61 - 148
PFMBA	6.40	7.71		ng/L		120	49 - 154
NFDHA	6.40	6.81		ng/L		106	47 - 160
PFMPA	6.40	7.54		ng/L		118	48 - 150
9CI-PF3ONS	11.9	11.0		ng/L		92	44 - 167
11CI-PF3OUdS	12.1	13.0		ng/L		108	36 - 158
PFEESA	5.70	6.19		ng/L		109	56 - 144
3:3 FTCA	16.0	17.3		ng/L		108	32 - 161
5:3 FTCA	80.0	89.0		ng/L		111	39 - 156
7:3 FTCA	80.0	85.6		ng/L		107	36 - 149

Isotope Dilution	LLCS		Limits
	%Recovery	Qualifier	
13C4 PFBA	82		10 - 130
13C5 PFPeA	74		35 - 150
13C5 PFHxA	80		55 - 150
13C4 PFHpA	80		55 - 150
13C8 PFOA	78		60 - 140
13C9 PFNA	77		55 - 140
13C6 PFDA	82		50 - 140
13C7 PFUnA	79		30 - 140
13C2 PFDoA	80		10 - 150
13C2 PFTeDA	73		10 - 130
13C3 PFBS	77		55 - 150
13C3 PFHxS	76		55 - 150
13C8 PFOS	79		45 - 140
13C8 FOSA	64		30 - 130
d3-NMeFOSAA	79		45 - 200
d5-NEtFOSAA	80		10 - 200
M2-4:2 FTS	94		60 - 200
M2-6:2 FTS	89		60 - 200
M2-8:2 FTS	96		50 - 200
13C3 HFPO-DA	79		25 - 160
d7-N-MeFOSE-M	66		10 - 150
d9-N-EtFOSE-M	67		10 - 150



# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS (Continued)

Lab Sample ID: LLCS 280-619711/2-A  
 Matrix: Water  
 Analysis Batch: 619866

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA  
 Prep Batch: 619711

Isotope Dilution	LLCS LLCS		Limits
	%Recovery	Qualifier	
d5-NEtPFOSA	53		10 - 130
d3-NMePFOSA	50		15 - 130

## Method: 200.8 - Metals (ICP/MS)

Lab Sample ID: MB 280-618940/1-A  
 Matrix: Water  
 Analysis Batch: 619314

Client Sample ID: Method Blank  
 Prep Type: Total/NA  
 Prep Batch: 618940

Analyte	MB MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Manganese	ND		3.0	0.51	ug/L		07/11/23 09:04	07/12/23 09:13	1

Lab Sample ID: LCS 280-618940/2-A  
 Matrix: Water  
 Analysis Batch: 619314

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA  
 Prep Batch: 618940

Analyte	Spike Added	LCS LCS		Unit	D	%Rec	%Rec Limits
		Result	Qualifier				
Manganese	40.0	41.7		ug/L		104	87 - 115

## Method: 300.0 - Anions, Ion Chromatography

Lab Sample ID: MB 280-620991/48  
 Matrix: Water  
 Analysis Batch: 620991

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Chloride	ND		3.0	1.0	mg/L			07/28/23 03:29	1
Sulfate	ND		5.0	1.0	mg/L			07/28/23 03:29	1

Lab Sample ID: MB 280-620991/6  
 Matrix: Water  
 Analysis Batch: 620991

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB MB		RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
	Result	Qualifier							
Chloride	ND		3.0	1.0	mg/L			07/27/23 15:35	1
Sulfate	ND		5.0	1.0	mg/L			07/27/23 15:35	1

Lab Sample ID: LCS 280-620991/4  
 Matrix: Water  
 Analysis Batch: 620991

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS LCS		Unit	D	%Rec	%Rec Limits
		Result	Qualifier				
Chloride	100	104		mg/L		104	90 - 110
Sulfate	100	99.6		mg/L		100	90 - 110

Lab Sample ID: LCS 280-620991/46  
 Matrix: Water  
 Analysis Batch: 620991

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS LCS		Unit	D	%Rec	%Rec Limits
		Result	Qualifier				
Chloride	100	108		mg/L		108	90 - 110

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 300.0 - Anions, Ion Chromatography (Continued)

**Lab Sample ID: LCS 280-620991/46**  
**Matrix: Water**  
**Analysis Batch: 620991**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Sulfate	100	101		mg/L		101	90 - 110

**Lab Sample ID: LCSD 280-620991/47**  
**Matrix: Water**  
**Analysis Batch: 620991**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chloride	100	108		mg/L		108	90 - 110	0	10
Sulfate	100	100		mg/L		100	90 - 110	1	10

**Lab Sample ID: LCSD 280-620991/5**  
**Matrix: Water**  
**Analysis Batch: 620991**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chloride	100	104		mg/L		104	90 - 110	0	10
Sulfate	100	99.4		mg/L		99	90 - 110	0	10

**Lab Sample ID: MRL 280-620991/3**  
**Matrix: Water**  
**Analysis Batch: 620991**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**

Analyte	Spike Added	MRL Result	MRL Qualifier	Unit	D	%Rec	%Rec Limits
Chloride	5.00	5.29		mg/L		106	50 - 150
Sulfate	5.00	4.74	J	mg/L		95	50 - 150

## Method: 350.1 - Nitrogen, Ammonia

**Lab Sample ID: MB 280-619790/64**  
**Matrix: Water**  
**Analysis Batch: 619790**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Ammonia	ND		0.10	0.029	mg/L			07/13/23 14:10	1

**Lab Sample ID: LCS 280-619790/65**  
**Matrix: Water**  
**Analysis Batch: 619790**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Ammonia	2.50	2.51		mg/L		100	90 - 110

## Method: 351.2 - Nitrogen, Total Kjeldahl

**Lab Sample ID: MB 280-621028/2-A**  
**Matrix: Water**  
**Analysis Batch: 621184**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 621028**

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrogen, Kjeldahl	ND		1.0	0.69	mg/L		07/27/23 15:27	07/28/23 15:09	1

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 351.2 - Nitrogen, Total Kjeldahl (Continued)

Lab Sample ID: LCS 280-621028/1-A  
 Matrix: Water  
 Analysis Batch: 621184

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA  
 Prep Batch: 621028

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Nitrogen, Kjeldahl	6.00	5.91		mg/L		98	90 - 110

Lab Sample ID: 280-178681-1 MS  
 Matrix: Water  
 Analysis Batch: 621184

Client Sample ID: S-1  
 Prep Type: Total/NA  
 Prep Batch: 621028

Analyte	Sample Result	Sample Qualifier	Spike Added	MS Result	MS Qualifier	Unit	D	%Rec	%Rec Limits
Nitrogen, Kjeldahl	ND	F1	3.00	2.30	F1	mg/L		77	90 - 110

Lab Sample ID: 280-178681-1 MSD  
 Matrix: Water  
 Analysis Batch: 621184

Client Sample ID: S-1  
 Prep Type: Total/NA  
 Prep Batch: 621028

Analyte	Sample Result	Sample Qualifier	Spike Added	MSD Result	MSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Nitrogen, Kjeldahl	ND	F1	3.00	2.36	F1	mg/L		79	90 - 110	3	25

## Method: 353.2 - Nitrogen, Nitrate-Nitrite

Lab Sample ID: MB 280-619143/22  
 Matrix: Water  
 Analysis Batch: 619143

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Nitrate Nitrite as N	ND		0.10	0.044	mg/L			07/11/23 10:42	1

Lab Sample ID: LCS 280-619143/21  
 Matrix: Water  
 Analysis Batch: 619143

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Nitrate Nitrite as N	5.00	5.07		mg/L		101	90 - 110

## Method: 365.1 - Phosphorus, Total

Lab Sample ID: MB 280-618759/5-A  
 Matrix: Water  
 Analysis Batch: 618823

Client Sample ID: Method Blank  
 Prep Type: Total/NA  
 Prep Batch: 618759

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Phosphorus, Total	ND		0.050	0.025	mg/L		07/07/23 10:34	07/07/23 15:20	1

Lab Sample ID: LCS 280-618759/3-A  
 Matrix: Water  
 Analysis Batch: 618823

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA  
 Prep Batch: 618759

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Phosphorus, Total	0.500	0.502		mg/L		100	90 - 110

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 365.1 - Phosphorus, Total (Continued)

Lab Sample ID: LCSD 280-618759/4-A  
 Matrix: Water  
 Analysis Batch: 618823

Client Sample ID: Lab Control Sample Dup  
 Prep Type: Total/NA  
 Prep Batch: 618759

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Phosphorus, Total	0.500	0.499		mg/L		100	90 - 110	0	10

## Method: 410.4 - COD

Lab Sample ID: MB 280-621436/5  
 Matrix: Water  
 Analysis Batch: 621436

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Chemical Oxygen Demand	9.40	J	20	8.7	mg/L			08/01/23 11:15	1

Lab Sample ID: LCS 280-621436/3  
 Matrix: Water  
 Analysis Batch: 621436

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chemical Oxygen Demand	100	103		mg/L		103	90 - 110		

Lab Sample ID: LCSD 280-621436/4  
 Matrix: Water  
 Analysis Batch: 621436

Client Sample ID: Lab Control Sample Dup  
 Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Chemical Oxygen Demand	100	104		mg/L		104	90 - 110	1	11

## Method: 9040C - pH

Lab Sample ID: LCS 280-619585/5  
 Matrix: Water  
 Analysis Batch: 619585

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
pH adj. to 25 deg C	7.00	7.1		SU		101	99 - 101		

## Method: SM 2540C - Solids, Total Dissolved (TDS)

Lab Sample ID: MB 280-619088/1  
 Matrix: Water  
 Analysis Batch: 619088

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Dissolved Solids (TDS)	ND		10	4.7	mg/L			07/11/23 11:19	1

Lab Sample ID: LCS 280-619088/2  
 Matrix: Water  
 Analysis Batch: 619088

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Total Dissolved Solids (TDS)	505	506		mg/L		100	88 - 114		

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: SM 2540C - Solids, Total Dissolved (TDS) (Continued)

Lab Sample ID: LCSD 280-619088/3  
 Matrix: Water  
 Analysis Batch: 619088

Client Sample ID: Lab Control Sample Dup  
 Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Total Dissolved Solids (TDS)	505	510		mg/L		101	88 - 114	1	20

## Method: SM 2540D - Solids, Total Suspended (TSS)

Lab Sample ID: MB 280-619138/1  
 Matrix: Water  
 Analysis Batch: 619138

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Total Suspended Solids	ND		4.0	1.1	mg/L			07/11/23 14:50	1

Lab Sample ID: LCS 280-619138/2  
 Matrix: Water  
 Analysis Batch: 619138

Client Sample ID: Lab Control Sample  
 Prep Type: Total/NA

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Total Suspended Solids	508	280	*-	mg/L		55	79 - 114

Lab Sample ID: LCSD 280-619138/3  
 Matrix: Water  
 Analysis Batch: 619138

Client Sample ID: Lab Control Sample Dup  
 Prep Type: Total/NA

Analyte	Spike Added	LCSD Result	LCSD Qualifier	Unit	D	%Rec	%Rec Limits	RPD	RPD Limit
Total Suspended Solids	508	362	*- *1	mg/L		71	79 - 114	26	20

## Method: SM5210B - BOD, 5 Day

Lab Sample ID: MB 280-618771/4  
 Matrix: Water  
 Analysis Batch: 618771

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	MB Result	MB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Biochemical Oxygen Demand	ND		2.0	0.24	mg/L			07/07/23 11:16	1

Lab Sample ID: SCB 280-618771/1  
 Matrix: Water  
 Analysis Batch: 618771

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	SCB Result	SCB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Biochemical Oxygen Demand	0.974	J	2.0	0.24	mg/L			07/07/23 11:16	1

Lab Sample ID: USB 280-618771/2  
 Matrix: Water  
 Analysis Batch: 618771

Client Sample ID: Method Blank  
 Prep Type: Total/NA

Analyte	USB Result	USB Qualifier	RL	MDL	Unit	D	Prepared	Analyzed	Dil Fac
Biochemical Oxygen Demand	1.00	J	2.0	0.24	mg/L			07/07/23 11:16	1



# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: SM5210B - BOD, 5 Day (Continued)

**Lab Sample ID: LCS 280-618771/3**  
**Matrix: Water**  
**Analysis Batch: 618771**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**

Analyte	Spike Added	LCS Result	LCS Qualifier	Unit	D	%Rec	%Rec Limits
Biochemical Oxygen Demand	198	174		mg/L		88	85 - 115

**Lab Sample ID: 280-178681-1 DU**  
**Matrix: Water**  
**Analysis Batch: 618771**

**Client Sample ID: S-1**  
**Prep Type: Total/NA**

Analyte	Sample Result	Sample Qualifier	DU Result	DU Qualifier	Unit	D	RPD	RPD Limit
Biochemical Oxygen Demand	7.1	b	11.8	J F5	mg/L		50	20

## Method: 903.0 - Radium-226 (GFPC)

**Lab Sample ID: MB 160-620038/1-A**  
**Matrix: Water**  
**Analysis Batch: 622932**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 620038**

Analyte	MB Result	MB Qualifier	Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
Radium-226	0.05258	U	0.0606	0.0608	1.00	0.0977	pCi/L	07/13/23 09:29	08/04/23 09:32	1
<b>Carrier</b>	<b>MB %Yield</b>	<b>MB Qualifier</b>	<b>Limits</b>					<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>
Ba Carrier	97.7		30 - 110					07/13/23 09:29	08/04/23 09:32	1

**Lab Sample ID: LCS 160-620038/2-A**  
**Matrix: Water**  
**Analysis Batch: 622932**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 620038**

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits
Radium-226	11.3	10.37		1.09	1.00	0.0977	pCi/L	92	75 - 125
<b>Carrier</b>	<b>LCS %Yield</b>	<b>LCS Qualifier</b>	<b>Limits</b>						
Ba Carrier	94.7		30 - 110						

**Lab Sample ID: LCSD 160-620038/3-A**  
**Matrix: Water**  
**Analysis Batch: 622932**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**  
**Prep Batch: 620038**

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	RER	RER Limit
Radium-226	11.3	10.29		1.09	1.00	0.111	pCi/L	91	75 - 125	0.04	1
<b>Carrier</b>	<b>LCSD %Yield</b>	<b>LCSD Qualifier</b>	<b>Limits</b>								
Ba Carrier	94.7		30 - 110								

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 904.0 - Radium-228 (GFPC)

**Lab Sample ID: MB 160-620040/1-A**  
**Matrix: Water**  
**Analysis Batch: 622120**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 620040**

Analyte	MB MB		Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Radium-228	-0.03188	U	0.228	0.228	1.00	0.448	pCi/L	07/13/23 09:38	07/28/23 12:40	1
Carrier	MB MB		Limits			Prepared	Analyzed	Dil Fac		
	%Yield	Qualifier								
Ba Carrier	97.7			30 - 110					07/13/23 09:38	07/28/23 12:40
Y Carrier	82.2		30 - 110		07/13/23 09:38	07/28/23 12:40	1			

**Lab Sample ID: LCS 160-620040/2-A**  
**Matrix: Water**  
**Analysis Batch: 622120**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 620040**

Analyte	Spike Added	LCS Result	LCS Qual	Total	RL	MDC	Unit	%Rec	%Rec Limits
				Uncert. (2σ+/-)					
Radium-228	8.00	7.939		1.14	1.00	0.487	pCi/L	99	75 - 125
Carrier	LCS LCS		Limits			Prepared	Analyzed	Dil Fac	
	%Yield	Qualifier							
Ba Carrier	94.7			30 - 110					07/13/23 09:38
Y Carrier	82.6		30 - 110		07/13/23 09:38	07/28/23 12:40	1		

**Lab Sample ID: LCSD 160-620040/3-A**  
**Matrix: Water**  
**Analysis Batch: 621992**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**  
**Prep Batch: 620040**

Analyte	Spike Added	LCSD Result	LCSD Qual	Total	RL	MDC	Unit	%Rec	%Rec Limits	RER	RER Limit
				Uncert. (2σ+/-)							
Radium-228	8.00	8.159		1.18	1.00	0.559	pCi/L	102	75 - 125	0.09	1
Carrier	LCSD LCSD		Limits			Prepared	Analyzed	Dil Fac			
	%Yield	Qualifier									
Ba Carrier	94.7			30 - 110					07/13/23 09:38	07/28/23 12:40	1
Y Carrier	81.5		30 - 110		07/13/23 09:38	07/28/23 12:40	1				

## Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

**Lab Sample ID: MB 160-619766/1-A**  
**Matrix: Water**  
**Analysis Batch: 620746**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619766**

Analyte	MB MB		Count	Total	RL	MDC	Unit	Prepared	Analyzed	Dil Fac
	Result	Qualifier	Uncert. (2σ+/-)	Uncert. (2σ+/-)						
Thorium-228	-0.08161	U	0.0752	0.0755	1.00	0.219	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-230	-0.03611	U	0.171	0.171	1.00	0.285	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Thorium-232	-0.009937	U	0.0244	0.0244	1.00	0.123	pCi/L	07/11/23 12:12	07/18/23 13:12	1
Tracer	MB MB		Limits			Prepared	Analyzed	Dil Fac		
	%Yield	Qualifier								
Thorium-229	76.9		30 - 110		07/11/23 12:12	07/18/23 13:12	1			

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# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: A-01-R - Isotopic Thorium (Alpha Spectrometry) (Continued)

**Lab Sample ID: LCS 160-619766/2-A**  
**Matrix: Water**  
**Analysis Batch: 620748**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619766**

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	
Thorium-230	7.97	7.662		1.05	1.00	0.266	pCi/L	96	75 - 125	
<b>Tracer</b>	<b>%Yield</b>	<b>LCS Qualifier</b>	<b>Limits</b>							
Thorium-229	83.4		30 - 110							

**Lab Sample ID: LCSD 160-619766/3-A**  
**Matrix: Water**  
**Analysis Batch: 620749**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**  
**Prep Batch: 619766**

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits		RER	RER Limit
Thorium-230	7.97	7.747		1.04	1.00	0.275	pCi/L	97	75 - 125	0.04	1	
<b>Tracer</b>	<b>%Yield</b>	<b>LCSD Qualifier</b>	<b>Limits</b>									
Thorium-229	92.2		30 - 110									

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

**Lab Sample ID: MB 160-619767/1-A**  
**Matrix: Water**  
**Analysis Batch: 620686**

**Client Sample ID: Method Blank**  
**Prep Type: Total/NA**  
**Prep Batch: 619767**

Analyte	MB MB		Count Uncert. (2σ+/-)	Total Uncert. (2σ+/-)	RL	MDC	Unit	Prepared		Analyzed		Dil Fac
	Result	Qualifier										
Uranium-233/234	0.09104	U	0.0971	0.0974	1.00	0.131	pCi/L	07/11/23 12:22	07/18/23 13:17		1	
Uranium-235/236	0.01666	U	0.0552	0.0552	1.00	0.138	pCi/L	07/11/23 12:22	07/18/23 13:17		1	
Uranium-238	0.01737	U	0.0435	0.0435	1.00	0.0973	pCi/L	07/11/23 12:22	07/18/23 13:17		1	
<b>Tracer</b>	<b>%Yield</b>	<b>MB Qualifier</b>	<b>Limits</b>					<b>Prepared</b>	<b>Analyzed</b>	<b>Dil Fac</b>		
Uranium-232	86.2		30 - 110					07/11/23 12:22	07/18/23 13:17	1		

**Lab Sample ID: LCS 160-619767/2-A**  
**Matrix: Water**  
**Analysis Batch: 620688**

**Client Sample ID: Lab Control Sample**  
**Prep Type: Total/NA**  
**Prep Batch: 619767**

Analyte	Spike Added	LCS Result	LCS Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec Limits	
Uranium-233/234	12.7	13.12		1.58	1.00	0.186	pCi/L	103	75 - 125	
Uranium-238	13.0	12.82		1.55	1.00	0.110	pCi/L	98	75 - 125	
<b>Tracer</b>	<b>%Yield</b>	<b>LCS Qualifier</b>	<b>Limits</b>							
Uranium-232	78.4		30 - 110							

# QC Sample Results

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry) (Continued)

**Lab Sample ID: LCSD 160-619767/3-A**  
**Matrix: Water**  
**Analysis Batch: 620690**

**Client Sample ID: Lab Control Sample Dup**  
**Prep Type: Total/NA**  
**Prep Batch: 619767**

Analyte	Spike Added	LCSD Result	LCSD Qual	Total Uncert. (2σ+/-)	RL	MDC	Unit	%Rec	%Rec		RER	RER Limit
									Limits	RER		
Uranium-233/234	12.7	12.85		1.52	1.00	0.100	pCi/L	101	75 - 125	0.09		1
Uranium-238	13.0	12.34		1.47	1.00	0.0659	pCi/L	95	75 - 125	0.16		1
<b>Tracer</b>		<b>LCSD %Yield</b>	<b>LCSD Qualifier</b>									<b>Limits</b>
Uranium-232		86.0										30 - 110

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# QC Association Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## GC/MS Semi VOA

### Prep Batch: 619045

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	3510C	
MB 280-619045/1-A	Method Blank	Total/NA	Water	3510C	
LCS 280-619045/2-A	Lab Control Sample	Total/NA	Water	3510C	
LCSD 280-619045/3-A	Lab Control Sample Dup	Total/NA	Water	3510C	

### Analysis Batch: 619193

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8270E	619045
MB 280-619045/1-A	Method Blank	Total/NA	Water	8270E	619045
LCS 280-619045/2-A	Lab Control Sample	Total/NA	Water	8270E	619045
LCSD 280-619045/3-A	Lab Control Sample Dup	Total/NA	Water	8270E	619045

### Prep Batch: 619212

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	D7065-11	
MB 280-619212/1-A	Method Blank	Total/NA	Water	D7065-11	
LCS 280-619212/2-A	Lab Control Sample	Total/NA	Water	D7065-11	

### Analysis Batch: 619388

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	D7065-11	619212
MB 280-619212/1-A	Method Blank	Total/NA	Water	D7065-11	619212
LCS 280-619212/2-A	Lab Control Sample	Total/NA	Water	D7065-11	619212

## GC Semi VOA

### Prep Batch: 619392

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	3510C	
MB 280-619392/1-A	Method Blank	Total/NA	Water	3510C	
LCS 280-619392/2-A	Lab Control Sample	Total/NA	Water	3510C	
LCSD 280-619392/3-A	Lab Control Sample Dup	Total/NA	Water	3510C	

### Analysis Batch: 619741

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8081B	619392
MB 280-619392/1-A	Method Blank	Total/NA	Water	8081B	619392
LCS 280-619392/2-A	Lab Control Sample	Total/NA	Water	8081B	619392
LCSD 280-619392/3-A	Lab Control Sample Dup	Total/NA	Water	8081B	619392

## HPLC/IC

### Prep Batch: 395283

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8315A Prep	
MB 410-395283/1-A	Method Blank	Total/NA	Water	8315A Prep	
LCS 410-395283/2-A	Lab Control Sample	Total/NA	Water	8315A Prep	
LCSD 410-395283/3-A	Lab Control Sample Dup	Total/NA	Water	8315A Prep	

### Analysis Batch: 395541

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	8315A	395283

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# QC Association Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## HPLC/IC (Continued)

### Analysis Batch: 395541 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
MB 410-395283/1-A	Method Blank	Total/NA	Water	8315A	395283
LCS 410-395283/2-A	Lab Control Sample	Total/NA	Water	8315A	395283
LCSD 410-395283/3-A	Lab Control Sample Dup	Total/NA	Water	8315A	395283

## LCMS

### Prep Batch: 619039

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	1633	
MB 280-619039/1-A	Method Blank	Total/NA	Water	1633	
LCS 280-619039/3-A	Lab Control Sample	Total/NA	Water	1633	
LLCS 280-619039/2-A	Lab Control Sample	Total/NA	Water	1633	

### Prep Batch: 619208

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2	FRB	Total/NA	Water	1633	
MB 280-619208/1-A	Method Blank	Total/NA	Water	1633	
LCS 280-619208/3-A	Lab Control Sample	Total/NA	Water	1633	
LLCS 280-619208/2-A	Lab Control Sample	Total/NA	Water	1633	

### Analysis Batch: 619263

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	Draft 1633	619039
MB 280-619039/1-A	Method Blank	Total/NA	Water	Draft 1633	619039
LCS 280-619039/3-A	Lab Control Sample	Total/NA	Water	Draft 1633	619039
LLCS 280-619039/2-A	Lab Control Sample	Total/NA	Water	Draft 1633	619039

### Analysis Batch: 619400

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2	FRB	Total/NA	Water	Draft 1633	619208
MB 280-619208/1-A	Method Blank	Total/NA	Water	Draft 1633	619208
LCS 280-619208/3-A	Lab Control Sample	Total/NA	Water	Draft 1633	619208
LLCS 280-619208/2-A	Lab Control Sample	Total/NA	Water	Draft 1633	619208

### Prep Batch: 619711

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2 - RE	FRB	Total/NA	Water	1633	
MB 280-619711/1-A	Method Blank	Total/NA	Water	1633	
LCS 280-619711/3-A	Lab Control Sample	Total/NA	Water	1633	
LLCS 280-619711/2-A	Lab Control Sample	Total/NA	Water	1633	

### Analysis Batch: 619866

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-2 - RE	FRB	Total/NA	Water	Draft 1633	619711
MB 280-619711/1-A	Method Blank	Total/NA	Water	Draft 1633	619711
LCS 280-619711/3-A	Lab Control Sample	Total/NA	Water	Draft 1633	619711
LLCS 280-619711/2-A	Lab Control Sample	Total/NA	Water	Draft 1633	619711

# QC Association Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Metals

### Prep Batch: 618940

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	200.8	
MB 280-618940/1-A	Method Blank	Total/NA	Water	200.8	
LCS 280-618940/2-A	Lab Control Sample	Total/NA	Water	200.8	

### Analysis Batch: 619314

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	200.8	618940
MB 280-618940/1-A	Method Blank	Total/NA	Water	200.8	618940
LCS 280-618940/2-A	Lab Control Sample	Total/NA	Water	200.8	618940

## General Chemistry

### Prep Batch: 618759

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	365.2/365.3/365	
MB 280-618759/5-A	Method Blank	Total/NA	Water	365.2/365.3/365	
LCS 280-618759/3-A	Lab Control Sample	Total/NA	Water	365.2/365.3/365	
LCSD 280-618759/4-A	Lab Control Sample Dup	Total/NA	Water	365.2/365.3/365	

### Analysis Batch: 618771

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	SM5210B	
MB 280-618771/4	Method Blank	Total/NA	Water	SM5210B	
SCB 280-618771/1	Method Blank	Total/NA	Water	SM5210B	
USB 280-618771/2	Method Blank	Total/NA	Water	SM5210B	
LCS 280-618771/3	Lab Control Sample	Total/NA	Water	SM5210B	
280-178681-1 DU	S-1	Total/NA	Water	SM5210B	

### Analysis Batch: 618823

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	365.1	618759
MB 280-618759/5-A	Method Blank	Total/NA	Water	365.1	618759
LCS 280-618759/3-A	Lab Control Sample	Total/NA	Water	365.1	618759
LCSD 280-618759/4-A	Lab Control Sample Dup	Total/NA	Water	365.1	618759

### Analysis Batch: 619088

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	SM 2540C	
MB 280-619088/1	Method Blank	Total/NA	Water	SM 2540C	
LCS 280-619088/2	Lab Control Sample	Total/NA	Water	SM 2540C	
LCSD 280-619088/3	Lab Control Sample Dup	Total/NA	Water	SM 2540C	

### Analysis Batch: 619138

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	SM 2540D	
MB 280-619138/1	Method Blank	Total/NA	Water	SM 2540D	
LCS 280-619138/2	Lab Control Sample	Total/NA	Water	SM 2540D	
LCSD 280-619138/3	Lab Control Sample Dup	Total/NA	Water	SM 2540D	

# QC Association Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## General Chemistry

### Analysis Batch: 619143

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	353.2	
MB 280-619143/22	Method Blank	Total/NA	Water	353.2	
LCS 280-619143/21	Lab Control Sample	Total/NA	Water	353.2	

### Analysis Batch: 619585

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	9040C	
LCS 280-619585/5	Lab Control Sample	Total/NA	Water	9040C	

### Analysis Batch: 619790

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	350.1	
MB 280-619790/64	Method Blank	Total/NA	Water	350.1	
LCS 280-619790/65	Lab Control Sample	Total/NA	Water	350.1	

### Analysis Batch: 620181

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	Inorganic N	

### Analysis Batch: 620991

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	300.0	
280-178681-1	S-1	Total/NA	Water	300.0	
MB 280-620991/48	Method Blank	Total/NA	Water	300.0	
MB 280-620991/6	Method Blank	Total/NA	Water	300.0	
LCS 280-620991/4	Lab Control Sample	Total/NA	Water	300.0	
LCS 280-620991/46	Lab Control Sample	Total/NA	Water	300.0	
LCSD 280-620991/47	Lab Control Sample Dup	Total/NA	Water	300.0	
LCSD 280-620991/5	Lab Control Sample Dup	Total/NA	Water	300.0	
MRL 280-620991/3	Lab Control Sample	Total/NA	Water	300.0	

### Prep Batch: 621028

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	351.2	
MB 280-621028/2-A	Method Blank	Total/NA	Water	351.2	
LCS 280-621028/1-A	Lab Control Sample	Total/NA	Water	351.2	
280-178681-1 MS	S-1	Total/NA	Water	351.2	
280-178681-1 MSD	S-1	Total/NA	Water	351.2	

### Analysis Batch: 621184

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	351.2	621028
MB 280-621028/2-A	Method Blank	Total/NA	Water	351.2	621028
LCS 280-621028/1-A	Lab Control Sample	Total/NA	Water	351.2	621028
280-178681-1 MS	S-1	Total/NA	Water	351.2	621028
280-178681-1 MSD	S-1	Total/NA	Water	351.2	621028

### Analysis Batch: 621436

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	410.4	
MB 280-621436/5	Method Blank	Total/NA	Water	410.4	

Eurofins Denver

# QC Association Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## General Chemistry (Continued)

### Analysis Batch: 621436 (Continued)

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
LCS 280-621436/3	Lab Control Sample	Total/NA	Water	410.4	
LCSD 280-621436/4	Lab Control Sample Dup	Total/NA	Water	410.4	

## Rad

### Prep Batch: 619766

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	ExtChrom	
MB 160-619766/1-A	Method Blank	Total/NA	Water	ExtChrom	
LCS 160-619766/2-A	Lab Control Sample	Total/NA	Water	ExtChrom	
LCSD 160-619766/3-A	Lab Control Sample Dup	Total/NA	Water	ExtChrom	

### Prep Batch: 619767

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	ExtChrom	
MB 160-619767/1-A	Method Blank	Total/NA	Water	ExtChrom	
LCS 160-619767/2-A	Lab Control Sample	Total/NA	Water	ExtChrom	
LCSD 160-619767/3-A	Lab Control Sample Dup	Total/NA	Water	ExtChrom	

### Prep Batch: 620038

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	PrecSep-21	
MB 160-620038/1-A	Method Blank	Total/NA	Water	PrecSep-21	
LCS 160-620038/2-A	Lab Control Sample	Total/NA	Water	PrecSep-21	
LCSD 160-620038/3-A	Lab Control Sample Dup	Total/NA	Water	PrecSep-21	

### Prep Batch: 620040

Lab Sample ID	Client Sample ID	Prep Type	Matrix	Method	Prep Batch
280-178681-1	S-1	Total/NA	Water	PrecSep_0	
MB 160-620040/1-A	Method Blank	Total/NA	Water	PrecSep_0	
LCS 160-620040/2-A	Lab Control Sample	Total/NA	Water	PrecSep_0	
LCSD 160-620040/3-A	Lab Control Sample Dup	Total/NA	Water	PrecSep_0	

# Lab Chronicle

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

**Client Sample ID: S-1**

**Lab Sample ID: 280-178681-1**

**Date Collected: 07/06/23 10:55**

**Matrix: Water**

**Date Received: 07/06/23 11:21**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	3510C			131.8 mL	1 mL	619045	07/11/23 09:25	KAS	EET DEN
Total/NA	Analysis	8270E		1	1 mL	1 mL	619193	07/12/23 12:56	MRS	EET DEN
Total/NA	Prep	D7065-11			964.4 mL	1 mL	619212	07/12/23 10:53	KAS	EET DEN
Total/NA	Analysis	D7065-11		5	200 uL	200 uL	619388	07/13/23 14:47	MRS	EET DEN
Total/NA	Prep	3510C			244.9 mL	5 mL	619392	07/13/23 12:16	KAS	EET DEN
Total/NA	Analysis	8081B		1	1 mL	1 mL	619741	07/17/23 21:03	SMQ	EET DEN
Total/NA	Prep	8315A Prep			50 mL	10 mL	395283	07/10/23 17:06	A2VL	ELLE
Total/NA	Analysis	8315A		1			395541	07/11/23 10:21	GM5C	ELLE
Total/NA	Prep	1633			25.2 mL	5 mL	619039	07/11/23 10:52	MSJ	EET DEN
Total/NA	Analysis	Draft 1633		1	1 mL	1 mL	619263	07/12/23 16:12	SCS	EET DEN
Total/NA	Prep	200.8			50 mL	50 mL	618940	07/11/23 09:04	MSM	EET DEN
Total/NA	Analysis	200.8		1			619314	07/12/23 03:34	LMT	EET DEN
Total/NA	Analysis	300.0		1	10 mL	10 mL	620991	07/28/23 03:46	EJS	EET DEN
Total/NA	Analysis	300.0		10	10 mL	10 mL	620991	07/28/23 04:03	EJS	EET DEN
Total/NA	Analysis	350.1		1	10 mL	10 mL	619790	07/13/23 15:52	MMP	EET DEN
Total/NA	Prep	351.2			25 mL	25 mL	621028	07/27/23 15:27	BCR	EET DEN
Total/NA	Analysis	351.2		1			621184	07/28/23 15:10	BCR	EET DEN
Total/NA	Analysis	353.2		1	100 mL	100 mL	619143	07/11/23 11:50	LRB	EET DEN
Total/NA	Prep	365.2/365.3/365			50 mL	50 mL	618759	07/07/23 10:34	LBR	EET DEN
Total/NA	Analysis	365.1		1	2 mL	2 mL	618823	07/07/23 15:21	LBR	EET DEN
Total/NA	Analysis	410.4		1	2 mL	2 mL	621436	08/01/23 11:15	BCR	EET DEN
Total/NA	Analysis	9040C		1			619585	07/13/23 14:56	KEG	EET DEN
Total/NA	Analysis	Inorganic N		1			620181	07/20/23 12:08	ZPM	EET DEN
Total/NA	Analysis	SM 2540C		1	100 mL	100 mL	619088	07/11/23 11:19	LRB	EET DEN
Total/NA	Analysis	SM 2540D		1	25 mL	250 mL	619138	07/11/23 14:50	LRB	EET DEN
Total/NA	Analysis	SM5210B		1	120 mL	300 mL	618771	07/07/23 11:16	BCR	EET DEN
Total/NA	Prep	PrecSep-21			243.00 mL	1.0 g	620038	07/13/23 09:29	KAC	EET SL
Total/NA	Analysis	903.0		1			622954	08/04/23 09:40	SCB	EET SL
Total/NA	Prep	PrecSep_0			243.00 mL	1.0 g	620040	07/13/23 09:38	KAC	EET SL
Total/NA	Analysis	904.0		1			621992	07/28/23 12:44	FLC	EET SL
Total/NA	Prep	ExtChrom			48.42 mL	1.0 mL	619766	07/11/23 12:12	IAG	EET SL
Total/NA	Analysis	A-01-R		1			620752	07/18/23 13:12	FLC	EET SL
Total/NA	Prep	ExtChrom			48.42 mL	1.0 mL	619767	07/11/23 12:22	IAG	EET SL
Total/NA	Analysis	A-01-R		1			620691	07/18/23 13:17	FLC	EET SL

**Client Sample ID: FRB**

**Lab Sample ID: 280-178681-2**

**Date Collected: 07/06/23 09:44**

**Matrix: Water**

**Date Received: 07/06/23 11:21**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	1633	RE		125.2 mL	5 mL	619711	07/17/23 11:33	FBD	EET DEN
Total/NA	Analysis	Draft 1633	RE	1	1 mL	1 mL	619866	07/18/23 18:21	CM	EET DEN



# Lab Chronicle

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

**Client Sample ID: FRB**

**Lab Sample ID: 280-178681-2**

**Date Collected: 07/06/23 09:44**

**Matrix: Water**

**Date Received: 07/06/23 11:21**

Prep Type	Batch Type	Batch Method	Run	Dil Factor	Initial Amount	Final Amount	Batch Number	Prepared or Analyzed	Analyst	Lab
Total/NA	Prep	1633			250.9 mL	5 mL	619208	07/12/23 11:15	MAC	EET DEN
Total/NA	Analysis	Draft 1633		1	1 mL	1 mL	619400	07/13/23 18:07	SCS	EET DEN

**Laboratory References:**

EET DEN = Eurofins Denver, 4955 Yarrow Street, Arvada, CO 80002, TEL (303)736-0100

EET SL = Eurofins St. Louis, 13715 Rider Trail North, Earth City, MO 63045, TEL (314)298-8566

ELLE = Eurofins Lancaster Laboratories Environment Testing, LLC, 2425 New Holland Pike, Lancaster, PA 17601, TEL (717)656-2300



# Accreditation/Certification Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Laboratory: Eurofins Denver

Unless otherwise noted, all analytes for this laboratory were covered under each accreditation/certification below.

Authority	Program	Identification Number	Expiration Date												
Oregon	NELAP	4025-019	01-08-24												
<p>The following analytes are included in this report, but the laboratory is not certified by the governing authority. This list may include analytes for which the agency does not offer certification.</p> <table style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="text-align: left;">Analysis Method</th> <th style="text-align: left;">Prep Method</th> <th style="text-align: left;">Matrix</th> <th style="text-align: left;">Analyte</th> </tr> </thead> <tbody> <tr> <td>9040C</td> <td></td> <td>Water</td> <td>Temperature</td> </tr> <tr> <td>Inorganic N</td> <td></td> <td>Water</td> <td>Total Inorganic Nitrogen</td> </tr> </tbody> </table>				Analysis Method	Prep Method	Matrix	Analyte	9040C		Water	Temperature	Inorganic N		Water	Total Inorganic Nitrogen
Analysis Method	Prep Method	Matrix	Analyte												
9040C		Water	Temperature												
Inorganic N		Water	Total Inorganic Nitrogen												

## Laboratory: Eurofins Lancaster Laboratories Environment Testing, LLC

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
A2LA	Dept. of Defense ELAP	0001.01	11-30-24
A2LA	ISO/IEC 17025	0001.01	11-30-24
Alabama	State	43200	01-31-24
Alaska	State	PA00009	06-30-24
Alaska (UST)	State	17-027	02-28-24
Arizona	State	AZ0780	03-12-24
Arkansas DEQ	State	88-00660	08-08-23
California	State	2792	11-30-23
Colorado	State	PA00009	06-30-24
Connecticut	State	PH-0746	06-30-25
DE Haz. Subst. Cleanup Act (HSCA)	State	019-006 (PA cert)	01-31-24
Delaware (DW)	State	N/A	01-31-24
Florida	NELAP	E87997	07-23-23
Georgia (DW)	State	C048	01-31-24
Hawaii	State	N/A	01-31-24
Illinois	NELAP	200027	01-31-24
Iowa	State	361	03-01-24
Kansas	NELAP	E-10151	10-31-23
Kentucky (DW)	State	KY90088	12-31-23
Kentucky (UST)	State	0001.01	11-30-24
Kentucky (WW)	State	KY90088	12-31-23
Louisiana (All)	NELAP	02055	06-30-24
Maine	State	2019012	03-12-25
Maryland	State	100	06-30-24
Massachusetts	State	M-PA009	06-30-24
Michigan	State	9930	01-31-24
Minnesota	NELAP	042-999-487	12-31-23
Mississippi	State	023	01-31-24
Missouri	State	450	01-31-25
Montana (DW)	State	0098	01-01-24
Nebraska	State	NE-OS-32-17	01-31-24
New Hampshire	NELAP	2730	08-01-23
New Jersey	NELAP	PA011	07-27-23
New York	NELAP	10670	04-01-24
North Carolina (DW)	State	42705	07-31-24
North Carolina (WW/SW)	State	521	12-31-23
North Dakota	State	R-205	01-31-24
Oklahoma	NELAP	9804	08-31-23
Oregon	NELAP	PA200001	09-11-23

# Accreditation/Certification Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Laboratory: Eurofins Lancaster Laboratories Environment Testing, LLC (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
PALA	Canada	1978	09-16-24
Pennsylvania	NELAP	36-00037	07-20-23
Rhode Island	State	LAO00338	12-31-23
South Carolina	State	89002	01-31-24
Tennessee	State	02838	01-31-24
Texas	NELAP	T104704194-23-46	08-31-23
USDA	US Federal Programs	525-22-298-19481	10-25-25
Vermont	State	VT - 36037	10-28-23
Virginia	NELAP	460182	07-14-23
Washington	State	C457	07-17-23
West Virginia (DW)	State	9906 C	12-31-23
West Virginia DEP	State	055	07-31-24
Wyoming	State	8TMS-L	01-31-24
Wyoming (UST)	A2LA	0001.01	11-30-24

## Laboratory: Eurofins St. Louis

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Alaska (UST)	State	20-001	05-06-25
ANAB	Dept. of Defense ELAP	L2305	04-06-25
ANAB	Dept. of Energy	L2305.01	04-06-25
ANAB	ISO/IEC 17025	L2305	04-06-25
Arizona	State	AZ0813	12-08-23
California	Los Angeles County Sanitation Districts	10259	06-30-22 *
California	State	2886	06-30-23 *
Connecticut	State	PH-0241	03-31-25
Florida	NELAP	E87689	06-30-24
HI - RadChem Recognition	State	n/a	06-30-24
Illinois	NELAP	200023	11-30-23
Iowa	State	373	12-01-24
Kansas	NELAP	E-10236	10-31-23
Kentucky (DW)	State	KY90125	12-31-23
Kentucky (WW)	State	KY90125 (Permit KY0004049)	12-31-23
Louisiana	NELAP	04080	06-30-22 *
Louisiana (All)	NELAP	04080	06-30-24
Louisiana (DW)	State	LA011	12-31-23
Maryland	State	310	08-08-23
Massachusetts	State	M-MO054	06-30-24
MI - RadChem Recognition	State	9005	06-30-24
Missouri	State	780	06-30-25
Nevada	State	MO000542020-1	08-31-23
New Jersey	NELAP	MO002	06-30-24
New Mexico	State	MO00054	06-30-24
New York	NELAP	11616	03-31-24
North Carolina (DW)	State	29700	07-31-24
North Dakota	State	R-207	06-30-23 *
Oklahoma	NELAP	9997	08-31-23
Oregon	NELAP	4157	09-01-23

\* Accreditation/Certification renewal pending - accreditation/certification considered valid.

Eurofins Denver

# Accreditation/Certification Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Laboratory: Eurofins St. Louis (Continued)

All accreditations/certifications held by this laboratory are listed. Not all accreditations/certifications are applicable to this report.

Authority	Program	Identification Number	Expiration Date
Pennsylvania	NELAP	68-00540	02-28-24
South Carolina	State	85002001	06-30-23 *
Texas	NELAP	T104704193	07-31-24
US Fish & Wildlife	US Federal Programs	058448	07-31-24
USDA	US Federal Programs	P330-17-00028	05-18-26
Utah	NELAP	MO000542021-14	07-31-23 *
Virginia	NELAP	10310	06-15-25
Washington	State	C592	08-30-23
West Virginia DEP	State	381	10-31-23

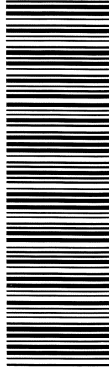
\* Accreditation/Certification renewal pending - accreditation/certification considered valid.







# Chain of Custody Record



280-178681 Chain of Custody

<b>Client Information</b>		Lab PM: Stone, Natalie B		COC No: 280-131050-36287.1	
Client Contact: Erica Wirski		E-Mail: Natalie.Stone@et.eurofins.com		Page: 1 of 1	
Company: Kennedy/Jenks Consultants		Address: 143 Union Blvd City: Lakewood State, Zip: CO, 80228 Phone:		Job #:	
Due Date Requested:		TAT Requested (days):		Analysis Requested	
Compliance Project: <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No		Purchase Order Requested		Field Filtered Sample (Yes or No)	
PO #:		Project #: 28024970		Perform MS/MSD (Yes or No)	
WO #:		SSOW#:		903.0 - Radium-226 (Sub to St. Louis)	
Email: ericawirski@kennedyjenks.com		Project Name: Arvada NTS Metro Water Quality Analysis		904.0 - Radium-228 (Sub to St. Louis)	
Address: 143 Union Blvd		City: Lakewood		8081B - Pesticides	
State, Zip: CO, 80228		Phone:		200.8 - Total Metals	
Project #: 28024970		SSOW#:		Ammonia/TKN/COD/Total Phos/Nitrate-Nitrite	
Site: Colorado		Sample Date		TDS/TS/PH/Chloride and Sulfate	
Sample Identification		Sample Type (C=Comp, G=Grab)		SM5210B_BODcalc - BOD	
500 mL UP (61) - 11 - 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54		Sample Time		1633_B24 - PFAS	
21 LUP 5-5-16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54		Preservation Code:		N 8270E - SVOCs	
21 Nitrate 45%, 5-7, 5-8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54		Matrix (W=water, S=solid, O=water/soil, BT=Tissue, A=Air)		N 8315A - Formaldehyde (Sub to Lancaster)	
125 mL UP 5-13		Water		N A01R_Th - Thorium (Sub to St. Louis)	
250 mL Nitric Acid, 5-14		Water		N A01R_U - Uranium (Sub to St. Louis)	
11 Glass Sulfuric Acid, 5-15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54		Water		Special Instructions/Note:	
500 mL Glass UP 5-2 to 5-22		Water		MIS3 FAB for 51-54	
250 mL Glass UP 5-21 to 5-26		Water		MIS3 FAB for 51-54	
125 mL Glass UP 5-27 to 5-32		Water		MIS3 FAB for 51-54	
250 mL Glass UP 5-2 to 5-22		Water		MIS3 FAB for 51-54	
250 mL Glass UP 5-21 to 5-26		Water		MIS3 FAB for 51-54	
125 mL Glass UP 5-27 to 5-32		Water		MIS3 FAB for 51-54	

# Chain of Custody Record



Environment Testing



<b>Client Information (Sub Contract Lab)</b>		Sampler	Lab PM	Carrier Tracking No(s)	COC No
Client Contact: Shipping/Receiving		Stone, Natalie B	Stone, Natalie B	State of Origin Colorado	280-663264.1
Company TestAmerica Laboratories, Inc.		E-Mail: Natalie.Stone@et.eurofinsus.com	Accreditations Required (See note): NELAP - Oregon	Page # 1 of 1	
Address 13715 Rider Trail North,		Due Date Requested: 8/9/2023	Job # 280-178681-1		
City Earth City	TAT Requested (days):	Analysis Requested			
State/Zip MO, 63045	PO #:	903.0/Pf/Secp_21 Standard Target List	904.0/Pf/Secp_0 Standard Target List	A01R_U/ExtChrom_Actin Standard Target List	A01R_Th/ExtChrom_Actin Standard Target List
Phone: 314-298-8566(Tel) 314-298-8757(Fax)	WO #:	Perform MS/MSD (Yes or No)	Field Filtered Sample (Yes or No)	Preservation Codes: M - Hexane N - None O - AshNaO2 P - Na2O4S Q - Na2SO3 R - Na2S2O3 S - H2SO4 G - Amchlor H - Ascorbic Acid I - Ice J - DI Water K - EDTA L - EDA Z - other (specify) Other:	Special Instructions/Note:
Project Name Arvada NTS Metro Water Quality Analysis	Project #: 28024970	Sample Date	Sample Time	Sample Type (C=Comp, G=grab)	Matrix (Water, Solid, Sewer/Wastewater, etc.)
Site Arvada NTS Metro Water Quality Analysis	SSOW#	7/6/23	10:55 Mountain	Water	
<b>Sample Identification - Client ID (Lab ID)</b>		Total Number of Containers			
S-1 (280-178681-1)					4
<p>Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte &amp; accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/test/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins TestAmerica</p>					
<b>Possible Hazard Identification</b>					
Unconfirmed					
Deliverable Requested: I, II, III, IV, Other (specify)					
Primary Deliverable Rank: 2					
Time: _____					
Special Instructions/QC Requirements:					
<input type="checkbox"/> Return To Client <input type="checkbox"/> Disposal By Lab <input type="checkbox"/> Archive For _____ Months <input checked="" type="checkbox"/> Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)					
Relinquished by: _____		Date/Time: 7/7/23 1445	Received by: FE		
Relinquished by: _____		Date/Time: _____	Received by: MICHA KENNEDY 7/10/23 09:25		
Relinquished by: _____		Date/Time: _____	Received by: _____		
Custody Seals Intact: _____		Custody Seal No.:	Cooler Temperature(s) °C and Other Remarks		
Δ Yes Δ No					



**Eurofins Denver**

4955 Yarrow Street  
 Arvada, CO 80002  
 Phone: 303-736-0100 Fax: 303-431-7171

**Chain of Custody Record**



Environment Testing

<b>Client Information (Sub Contract Lab)</b>		Sampler: Stone, Natalie B		Lab PM: Stone, Natalie B		Carrier Tracking No(s):		COC No: 280-663255.1			
Client Contact: Shipping/Receiving		Phone:		E-Mail: Natalie.Stone@et.eurofinsus.com		State of Origin: Colorado		Page: Page 1 of 1			
Company: Eurofins Lancaster Laboratories Environm				Accreditations Required (See note): NELAP - Oregon				Job #: 280-178681-1			
Address: 2425 New Holland Pike, City: Lancaster		Due Date Requested: 8/9/2023		<b>Analysis Requested</b>						<b>Preservation Codes:</b> A - HCL                    M - Hexane B - NaOH                N - None C - Zn Acetate        O - AsNaO2 D - Nitric Acid        P - Na2O4S E - NaHSO4            Q - Na2SO3 F - MeOH               R - Na2S2O3 G - Amchlor            S - H2SO4 H - Ascorbic Acid    T - TSP Dodecahydrate I - Ica                    U - Acetone J - DI Water            V - MCAA K - EDTA                W - pH 4-5 L - EDA                 Y - Trizma Z - other (specify)	
State, Zip: PA, 17601		TAT Requested (days):									
Phone: 717-656-2300(Tel)		PO #:		Field Filtered Sample (Yes or No) Perform MS/MSD (Yes or No) B315A/B315A_W_Prep Formaldehyde		Total Number of containers		Other:			
Email:		WO #:						Project #: 28024970			
Project Name: Arvada NTS Metro Water Quality Analysis		SSOW#:		Site:		Sample Identification - Client ID (Lab ID)		Sample Date			
						Sample Time		Sample Type (C=comp, G=grab)			
						Matrix (Water, Solid, Organic, Tissue, AAM)		Preservation Code			
								Special Instructions/Note:			
								S-1 (280-178681-1)			
								7/6/23			
								10:55 Mountain			
								Water			
								X			
								2			

Note: Since laboratory accreditations are subject to change, Eurofins TestAmerica places the ownership of method, analyte & accreditation compliance upon our subcontract laboratories. This sample shipment is forwarded under chain-of-custody. If the laboratory does not currently maintain accreditation in the State of Origin listed above for analysis/tests/matrix being analyzed, the samples must be shipped back to the Eurofins TestAmerica laboratory or other instructions will be provided. Any changes to accreditation status should be brought to Eurofins TestAmerica attention immediately. If all requested accreditations are current to date, return the signed Chain of Custody attesting to said compliance to Eurofins TestAmerica.

<b>Possible Hazard Identification</b>		<b>Sample Disposal ( A fee may be assessed if samples are retained longer than 1 month)</b>	
Unconfirmed		<input type="checkbox"/> Return To Client <input type="checkbox"/> Disposal By Lab <input type="checkbox"/> Archive For _____ Months	
Deliverable Requested: I, II, III, IV, Other (specify)		Special Instructions/QC Requirements:	
Primary Deliverable Rank: 2			
Empty Kit Relinquished by:		Date:	
Date/Time:		Time:	
Method of Shipment:			
Relinquished by: <i>[Signature]</i>		Date/Time: 7/5/23 1510	
Company: ETADEN		Received by:	
Date/Time:		Date/Time:	
Company:		Company:	
Relinquished by:		Received by: <i>[Signature]</i>	
Date/Time:		Date/Time: 7/8/23 10:00	
Company:		Company: EUET	
Custody Seals Intact: <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No		Custody Seal No.:	
Cooler Temperature(s) °C and Other Remarks:		RAW: 0.8    COR: 0.8	

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## Login Sample Receipt Checklist

Client: Kennedy/Jenks Consultants

Job Number: 280-178681-1

**Login Number: 178681**

**List Number: 1**

**Creator: Rystrom, Joshua R**

**List Source: Eurofins Denver**

Question	Answer	Comment
Radioactivity wasn't checked or is <math>\leq</math> background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	N/A	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable.	True	Received same day of collection; chilling process has begun.
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	False	Refer to Job Narrative for details.
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	N/A	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <math><6\text{mm}</math> (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

# Login Sample Receipt Checklist

Client: Kennedy/Jenks Consultants

Job Number: 280-178681-1

**Login Number: 178681**

**List Source: Eurofins Lancaster Laboratories Environment Testing, LLC**

**List Number: 2**

**List Creation: 07/08/23 10:24 AM**

**Creator: McBeth, Jessica**

Question	Answer	Comment
The cooler's custody seal is intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	True	
Cooler Temperature is acceptable (<math>\leq 6^{\circ}\text{C}</math>, not frozen).	True	
Cooler Temperature is recorded.	True	
WV: Container Temperature is acceptable (<math>\leq 6^{\circ}\text{C}</math>, not frozen).	N/A	
WV: Container Temperature is recorded.	N/A	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
There are no discrepancies between the containers received and the COC.	False	Refer to Job Narrative for details.
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
There is sufficient vol. for all requested analyses.	True	
Is the Field Sampler's name present on COC?	False	Received project as a subcontract.
Sample custody seals are intact.	N/A	
VOA sample vials do not have headspace >6mm in diameter (none, if from WV)?	N/A	



## Login Sample Receipt Checklist

Client: Kennedy/Jenks Consultants

Job Number: 280-178681-1

**Login Number: 178681**

**List Number: 3**

**Creator: Korrinhizer, Micha L**

**List Source: Eurofins St. Louis**

**List Creation: 07/10/23 11:27 AM**

Question	Answer	Comment
Radioactivity wasn't checked or is </= background as measured by a survey meter.	True	
The cooler's custody seal, if present, is intact.	True	
Sample custody seals, if present, are intact.	True	
The cooler or samples do not appear to have been compromised or tampered with.	True	
Samples were received on ice.	N/A	
Cooler Temperature is acceptable.	True	
Cooler Temperature is recorded.	True	
COC is present.	True	
COC is filled out in ink and legible.	True	
COC is filled out with all pertinent information.	True	
Is the Field Sampler's name present on COC?	True	
There are no discrepancies between the containers received and the COC.	True	
Samples are received within Holding Time (excluding tests with immediate HTs)	True	
Sample containers have legible labels.	True	
Containers are not broken or leaking.	True	
Sample collection date/times are provided.	True	
Appropriate sample containers are used.	True	
Sample bottles are completely filled.	True	
Sample Preservation Verified.	True	
There is sufficient vol. for all requested analyses, incl. any requested MS/MSDs	True	
Containers requiring zero headspace have no headspace or bubble is <6mm (1/4").	True	
Multiphasic samples are not present.	True	
Samples do not require splitting or compositing.	True	
Residual Chlorine Checked.	N/A	

# Isotope Dilution Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Matrix: Water

Prep Type: Total/NA

### Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFBA (10-130)	PFPeA (35-150)	13C5PHA (55-150)	C4PFHA (55-150)	C8PFOA (60-140)	C9PFNA (55-140)	C6PFDA (50-140)	13C7PUA (30-140)
280-178681-1	S-1	72	71	71	68	70	66	67	66
280-178681-2	FRB	68	70	70	71	66	71	64	50
280-178681-2 - RE	FRB								
LLCS 280-619039/2-A	Lab Control Sample	70	73	71	70	68	66	70	66
LLCS 280-619208/2-A	Lab Control Sample	77	78	77	76	80	81	79	80
LLCS 280-619711/2-A	Lab Control Sample	82	74	80	80	78	77	82	79
MB 280-619039/1-A	Method Blank	69	69	70	65	65	68	67	69
MB 280-619208/1-A	Method Blank	79	79	78	74	81	80	74	77
MB 280-619711/1-A	Method Blank	81	73	80	76	79	78	77	74

### Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFDaA (10-150)	PFTDA (10-130)	C3PFBS (55-150)	C3PFHS (55-150)	C8PFOS (45-140)	PFOSA (30-130)	d3NMFOS (45-200)	d5NEFOS (10-200)
280-178681-1	S-1	58	34	66	58	63	86	93	83
280-178681-2	FRB	37	21	65			57	66	58
280-178681-2 - RE	FRB				67	66			
LLCS 280-619039/2-A	Lab Control Sample	62	66	72	68	66	68	70	69
LLCS 280-619208/2-A	Lab Control Sample	77	80	84	78	82	79	91	91
LLCS 280-619711/2-A	Lab Control Sample	80	73	77	76	79	64	79	80
MB 280-619039/1-A	Method Blank	67	60	66	63	67	73	79	81
MB 280-619208/1-A	Method Blank	76	80	78	76	79	69	84	85
MB 280-619711/1-A	Method Blank	69	67	77	73	71	59	78	71

### Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	M242FTS (60-200)	M262FTS (60-200)	M282FTS (50-200)	HFPODA (25-160)	NMFm (10-150)	NEFM (10-150)	d5NPFSA (10-130)	d3NMFSA (15-130)
280-178681-1	S-1	85	91	120	71	57	48	41	45
280-178681-2	FRB	131	98	70	72	28	19	29	35
280-178681-2 - RE	FRB								
LLCS 280-619039/2-A	Lab Control Sample	74	77	82	73	64	60	51	50
LLCS 280-619208/2-A	Lab Control Sample	86	83	85	77	83	77	64	60
LLCS 280-619711/2-A	Lab Control Sample	94	89	96	79	66	67	53	50
MB 280-619039/1-A	Method Blank	76	84	94	66	64	59	53	51
MB 280-619208/1-A	Method Blank	83	79	81	76	78	75	67	61
MB 280-619711/1-A	Method Blank	85	86	91	82	61	59	46	47

#### Surrogate Legend

- PFBA = 13C4 PFBA
- PFPeA = 13C5 PFPeA
- 13C5PHA = 13C5 PFHxA
- C4PFHA = 13C4 PFHpA
- C8PFOA = 13C8 PFOA
- C9PFNA = 13C9 PFNA
- C6PFDA = 13C6 PFDA
- 13C7PUA = 13C7 PFUnA
- PFDaA = 13C2 PFDaA
- PFTDA = 13C2 PFTeDA
- C3PFBS = 13C3 PFBS
- C3PFHS = 13C3 PFHxS
- C8PFOS = 13C8 PFOS
- PFOSA = 13C8 FOSA

Eurofins Denver

# Isotope Dilution Summary

Client: Kennedy/Jenks Consultants  
 Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

d3NMFOS = d3-NMeFOSAA  
 d5NEFOS = d5-NEtFOSAA  
 M242FTS = M2-4:2 FTS  
 M262FTS = M2-6:2 FTS  
 M282FTS = M2-8:2 FTS  
 HFPODA = 13C3 HFPO-DA  
 NMFM = d7-N-MeFOSE-M  
 NEFM = d9-N-EtFOSE-M  
 d5NPFSA = d5-NEtPFOSA  
 d3NMFSA = d3-NMePFOSA

## Method: Draft 1633 - Per- and Polyfluoroalkyl Substances by LC/MS/MS

Matrix: Water

Prep Type: Total/NA

### Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFBA (10-130)	PFPeA (40-150)	13C5PHA (40-150)	C4PFHA (40-150)	C8PFOA (30-140)	C9PFNA (30-140)	C6PFDA (20-140)	13C7PUA (20-140)
LCS 280-619039/3-A	Lab Control Sample	71	70	69	69	71	71	74	80
LCS 280-619208/3-A	Lab Control Sample	78	81	80	81	75	76	79	72
LCS 280-619711/3-A	Lab Control Sample	81	73	76	77	81	77	79	76

### Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	PFDaA (10-150)	PFTDA (10-130)	C3PFBS (25-150)	C3PFHS (25-150)	C8PFOS (20-140)	PFOSA (10-130)	d3NMFOS (10-200)	d5NEFOS (10-200)
LCS 280-619039/3-A	Lab Control Sample	76	68	70	65	69	83	97	100
LCS 280-619208/3-A	Lab Control Sample	75	78	79	71	82	71	83	82
LCS 280-619711/3-A	Lab Control Sample	73	69	75	74	73	66	84	83

### Percent Isotope Dilution Recovery (Acceptance Limits)

Lab Sample ID	Client Sample ID	M242FTS (25-200)	M262FTS (25-200)	M282FTS (25-200)	HFPODA (25-160)	NMFM (10-150)	NEFM (10-150)	d5NPFSA (10-130)	d3NMFSA (10-130)
LCS 280-619039/3-A	Lab Control Sample	74	87	104	72	70	66	54	53
LCS 280-619208/3-A	Lab Control Sample	78	81	74	75	75	73	57	57
LCS 280-619711/3-A	Lab Control Sample	99	88	96	78	65	66	47	45

### Surrogate Legend

PFBA = 13C4 PFBA  
 PFPeA = 13C5 PFPeA  
 13C5PHA = 13C5 PFHxA  
 C4PFHA = 13C4 PFHpA  
 C8PFOA = 13C8 PFOA  
 C9PFNA = 13C9 PFNA  
 C6PFDA = 13C6 PFDA  
 13C7PUA = 13C7 PFUnA  
 PFDaA = 13C2 PFDaA  
 PFTDA = 13C2 PFTeDA  
 C3PFBS = 13C3 PFBS  
 C3PFHS = 13C3 PFHxS  
 C8PFOS = 13C8 PFOS  
 PFOSA = 13C8 FOSA  
 d3NMFOS = d3-NMeFOSAA  
 d5NEFOS = d5-NEtFOSAA  
 M242FTS = M2-4:2 FTS  
 M262FTS = M2-6:2 FTS  
 M282FTS = M2-8:2 FTS  
 HFPODA = 13C3 HFPO-DA  
 NMFM = d7-N-MeFOSE-M  
 NEFM = d9-N-EtFOSE-M

# Isotope Dilution Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis  
d5NPFSA = d5-NEtPFOSA  
d3NMFSa = d3-NMePFOSA

Job ID: 280-178681-1

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# Tracer/Carrier Summary

Client: Kennedy/Jenks Consultants  
Project/Site: Arvada NTS Metro Water Quality Analysis

Job ID: 280-178681-1

## Method: 903.0 - Radium-226 (GFPC)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Ba (30-110)	
280-178681-1	S-1	62.3	
LCS 160-620038/2-A	Lab Control Sample	94.7	
LCSD 160-620038/3-A	Lab Control Sample Dup	94.7	
MB 160-620038/1-A	Method Blank	97.7	
<b>Tracer/Carrier Legend</b>			
Ba = Ba Carrier			

## Method: 904.0 - Radium-228 (GFPC)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Ba (30-110)	Y (30-110)
280-178681-1	S-1	62.3	82.2
LCS 160-620040/2-A	Lab Control Sample	94.7	82.6
LCSD 160-620040/3-A	Lab Control Sample Dup	94.7	81.5
MB 160-620040/1-A	Method Blank	97.7	82.2
<b>Tracer/Carrier Legend</b>			
Ba = Ba Carrier			
Y = Y Carrier			

## Method: A-01-R - Isotopic Thorium (Alpha Spectrometry)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	Th-229 (30-110)	
280-178681-1	S-1	80.7	
LCS 160-619766/2-A	Lab Control Sample	83.4	
LCSD 160-619766/3-A	Lab Control Sample Dup	92.2	
MB 160-619766/1-A	Method Blank	76.9	
<b>Tracer/Carrier Legend</b>			
Th-229 = Thorium-229			

## Method: A-01-R - Isotopic Uranium (Alpha Spectrometry)

Matrix: Water

Prep Type: Total/NA

		Percent Yield (Acceptance Limits)	
Lab Sample ID	Client Sample ID	U-232 (30-110)	
280-178681-1	S-1	78.6	
LCS 160-619767/2-A	Lab Control Sample	78.4	
LCSD 160-619767/3-A	Lab Control Sample Dup	86.0	
MB 160-619767/1-A	Method Blank	86.2	
<b>Tracer/Carrier Legend</b>			
U-232 = Uranium-232			



**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<i>Dissolved</i>						
Chromium - Hexavalent	ND	SM 3500-Cr B	0.01 mg/L	3/2/23	QC63291	MAT
Manganese	0.7831 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Iron	0.015 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN
<i>Potentially Dissolved</i>						
Chromium - Trivalent	0.01 mg/L	Calculation	0.01 mg/L	3/1/23	-	MBN
Arsenic	0.0032 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0009 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0153 mg/L	EPA 200.8	0.0015 mg/L	2/28/23	QC63218	MBN
Copper	0.0644 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0534 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Manganese	1.49 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Nickel	0.0158 mg/L	EPA 200.8	0.0009 mg/L	2/28/23	QC63218	MBN
Selenium	0.0086 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	ND	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	ND	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0305 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.138 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
<i>Total</i>						
Mercury	0.0002 mg/L	EPA 245.7	0.0002 mg/L	2/28/23	QC63211	MLT
<i>Total Recoverable</i>						
Chromium - Trivalent	0.08 mg/L	Calculation	0.01 mg/L	3/1/23	-	MBN
Aluminum	41.9 mg/L	EPA 200.8	0.010 mg/L	2/28/23	QC63218	MBN

**Abbreviations/ References:**

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Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit

**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Total Recoverable</u>						
Antimony	ND	EPA 200.8	0.0012 mg/L	2/28/23	QC63218	MBN
Arsenic	0.0085 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Barium	0.7867 mg/L	EPA 200.8	0.0007 mg/L	2/28/23	QC63218	MBN
Beryllium	0.0021 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0011 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0877 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.1621 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0969 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Molybdenum	0.0061 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Nickel	0.0656 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0088 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	0.0007 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	0.0010 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0420 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.351 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
Iron	59.5 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN

Abbreviations/ References:

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mpn/100 mls = Most Probable Number Index/ 100 mls  
Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Dissolved</u>						
Chromium - Hexavalent	ND	SM 3500-Cr B	0.01 mg/L	3/2/23	QC63291	MAT
Manganese	8.46 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Iron	0.030 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN
<u>Potentially Dissolved</u>						
Chromium - Trivalent	ND	Calculation	0.01 mg/L	3/2/23	-	MBN
Arsenic	0.0056 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0028 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0458 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.1060 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0856 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Manganese	11.3 mg/L	EPA 200.8	0.0080 mg/L	2/28/23	QC63218	MBN
Nickel	0.0480 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0053 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	ND	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	ND	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0182 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.216 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
<u>Total</u>						
Mercury	0.0003 mg/L	EPA 245.7	0.0002 mg/L	2/28/23	QC63211	MLT
<u>Total Recoverable</u>						
Chromium - Trivalent	ND	Calculation	0.01 mg/L	3/2/23	-	MBN
Aluminum	68.7 mg/L	EPA 200.8	0.010 mg/L	2/28/23	QC63218	MBN

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Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit

**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<i>Total Recoverable</i>						
Antimony	ND	EPA 200.8	0.0012 mg/L	2/28/23	QC63218	MBN
Arsenic	0.0153 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Barium	1.58 mg/L	EPA 200.8	0.0007 mg/L	2/28/23	QC63218	MBN
Beryllium	0.0030 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0033 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.1397 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.2837 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.1382 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Molybdenum	0.0107 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Nickel	0.1071 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0086 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	0.0023 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	0.0015 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0218 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.602 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
Iron	112 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN

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Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

Report To: James Carroll  
Company: Lithos Engineering

Receive Date: 2/24/23  
Project Name: Dewatering Application

Test	QC Batch ID	QC Type	Result	Method
Chromium - Hexavalent	QC63291	Blank	ND	SM 3500-Cr B
Mercury	QC63211	Method Blank	ND	EPA 245.7
Aluminum	QC63218	Method Blank	ND	EPA 200.8
Antimony	QC63218	Method Blank	ND	EPA 200.8
Arsenic	QC63218	Method Blank	ND	EPA 200.8
Barium	QC63218	Method Blank	ND	EPA 200.8
Beryllium	QC63218	Method Blank	ND	EPA 200.8
Cadmium	QC63218	Method Blank	ND	EPA 200.8
Chromium	QC63218	Method Blank	ND	EPA 200.8
Copper	QC63218	Method Blank	ND	EPA 200.8
Lead	QC63218	Method Blank	ND	EPA 200.8
Manganese	QC63218	Method Blank	ND	EPA 200.8
Molybdenum	QC63218	Method Blank	ND	EPA 200.8
Nickel	QC63218	Method Blank	ND	EPA 200.8
Selenium	QC63218	Method Blank	ND	EPA 200.8
Silver	QC63218	Method Blank	ND	EPA 200.8
Thallium	QC63218	Method Blank	ND	EPA 200.8
Uranium	QC63218	Method Blank	ND	EPA 200.8
Zinc	QC63218	Method Blank	ND	EPA 200.8
Iron	QC63200	Method Blank	ND	EPA 200.7

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
Chromium - Hexavalent	QC63291	Duplicate	0 - 20	-	1.7	SM 3500-Cr B
		LCS	90 - 110	103.5	-	
Mercury	QC63211	Duplicate	0 - 20	-	0.0	EPA 245.7
		LCS	90 - 110	105.8	-	
		MS	80 - 120	92.0	-	
Aluminum	QC63218	LCS	90 - 110	102.1	-	EPA 200.8
		MS	70 - 130	99.5	-	
		MSD	0 - 10	-	3.1	
Antimony	QC63218	LCS	90 - 110	99.9	-	EPA 200.8
		MS	70 - 130	103.3	-	
		MSD	0 - 10	-	1.3	
Arsenic	QC63218	LCS	90 - 110	100.6	-	EPA 200.8
		MS	70 - 130	113.8	-	
		MSD	0 - 10	-	3.7	
Barium	QC63218	LCS	90 - 110	96.1	-	EPA 200.8
		MS	70 - 130	91.6	-	
		MSD	0 - 10	-	0.7	
Beryllium	QC63218	LCS	90 - 110	99.4	-	EPA 200.8
		MS	70 - 130	97.5	-	

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 (s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.



Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		MSD	0 - 10	-	4.9	
Cadmium	QC63218	LCS	90 - 110	94.0	-	EPA 200.8
		MS	70 - 130	104.5	-	
		MSD	0 - 10	-	2.8	
Chromium	QC63218	LCS	90 - 110	100.7	-	EPA 200.8
		MS	70 - 130	104.4	-	
		MSD	0 - 10	-	0.2	
Copper	QC63218	LCS	90 - 110	96.6	-	EPA 200.8
		MS	70 - 130	86.2	-	
		MSD	0 - 10	-	0.4	
Lead	QC63218	LCS	90 - 110	98.1	-	EPA 200.8
		MS	70 - 130	94.8	-	
		MSD	0 - 10	-	6.8	
Manganese	QC63218	LCS	90 - 110	99.4	-	EPA 200.8
		MS	70 - 130	105.2	-	
		MSD	0 - 10	-	0.6	
Molybdenum	QC63218	LCS	90 - 110	95.3	-	EPA 200.8
		MS	70 - 130	97.4	-	
		MSD	0 - 10	-	0.5	
Nickel	QC63218	LCS	90 - 110	101.7	-	EPA 200.8
		MS	70 - 130	100.0	-	
		MSD	0 - 10	-	1.9	
Selenium	QC63218	LCS	90 - 110	94.4	-	EPA 200.8
		MS	70 - 130	110.0	-	
		MSD	0 - 10	-	2.1	
Silver	QC63218	LCS	90 - 110	94.9	-	EPA 200.8
		MS	70 - 130	93.8	-	
		MSD	0 - 10	-	1.0	
Thallium	QC63218	LCS	90 - 110	102.6	-	EPA 200.8
		MS	70 - 130	102.3	-	
		MSD	0 - 10	-	5.5	
Uranium	QC63218	LCS	90 - 110	100.1	-	EPA 200.8
		MS	70 - 130	94.5	-	
		MSD	0 - 10	-	7.1	
Zinc	QC63218	LCS	90 - 110	98.0	-	EPA 200.8
		MS	70 - 130	91.7	-	
		MSD	0 - 10	-	0.3	
Iron	QC63200	Duplicate	0 - 20	-	0.0	EPA 200.7
		LCS	90 - 110	98.4	-	
		MS	75 - 125	102.9	-	

All analyses were performed in accordance with approved methods under the latest revision to 40 CFR Part 136 unless otherwise identified. Based on my inquiry of the person or persons directly responsible for analyzing the wastewater samples and generating the report (s), the analyses, report, and information submitted are, to the best of my knowledge and belief, true, accurate, and complete.



DATA APPROVED FOR RELEASE BY

**Abbreviations/ References:**

RL = Reporting Limit = Minimum Level  
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 mpn/100 mls = Most Probable Number Index/ 100 mls  
 Date Analyzed = Date Test Completed

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 (s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
 Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507





CAL Task

230224063

NAB

**Bottle Order  
Test Detail**

Order ID: QBO22090006

Date Created: 9/2/22

**Ship To:** Kennedy/Jenks Consultants  
143 Union Blvd  
Suite 600  
Lakewood CO 80228  
303-985-3636  
**Attention:** Emily Hudish

**Shipping Options:**

Ship Via: Customer Pickup Cooler: Yes

Chain of Custody Drinking Water:  
Standard: 2

**Customer Needs By: 1/23/23  
Ships From: Lakewood**

**Project:**

Dewatering Application

**\*\*Verify All Shipping Addresses\*\***

**Qty. Bottle / Preservative / Test**  
2 3- VOA HCl / 3-VOA None  
624 VOCs - Water - Ground

2 500 ml Amber Unpreserved  
625 SOC's - Water - Ground

2 500 ml Cylinder - HNO3  
Ag - PD - Water - Ground  
Ag - TR - Water - Ground  
Al - TR - Water - Ground  
As - PD - Water - Ground  
As - TR - Water - Ground  
Ba - TR - Water - Ground  
Be - TR - Water - Ground  
Cd - PD - Water - Ground  
Cd - TR - Water - Ground  
Cr - PD - Water - Ground  
Cr - TR - Water - Ground  
Cr - Tri - Water - Ground  
Cu - PD - Water - Ground  
Cu - TR - Water - Ground  
Fe - TR - Water - Ground  
Hg - Water - Ground

**\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\***

**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

**Ship To:** Kennedy/Jenks Consultants  
143 Union Blvd  
Suite 600  
Lakewood CO 80228  
303-985-3636

**Attention:** Emily Hudish

**CAL Task**  
230224063

NAB

**Shipping Options:**

Ship Via: Customer Pickup Cooler: Yes

Chain of Custody Drinking Water:  
Standard: 2

**Customer Needs By: 1/23/23**  
**Ships From: Lakewood**

**Project:**

Dewatering Application

**\*\*Verify All Shipping Addresses\*\***

**Qty. Bottle / Preservative / Test**

- Mn - PD - Water - Ground
- Mo - TR - Water - Ground
- Ni - PD - Water - Ground
- Ni - TR - Water - Ground
- Pb - PD - Water - Ground
- Pb - TR - Water - Ground
- Sb - TR - Water - Ground
- Se - PD - Water - Ground
- Se - TR - Water - Ground
- Tl - PD - Water - Ground
- Tl - TR - Water - Ground
- U - PD - Water - Ground
- U - TR - Water - Ground
- Zn - PD - Water - Ground
- Zn - TR - Water - Ground

**2 500 ml Cylinder - Unpreserved**

- Cr - Hex - Water - Ground
- Fe - Dis - Water - Ground
- Mn - Dis - Water - Ground

**\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\***

**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
1,2,4-Trichlorobenzene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
1,2-Dichlorobenzene	ND	EPA 625	2.5 ug/L	3/1/23	QC63199	MBS
1,2-diphenylhydrazine (as Azobenzene)	ND	EPA 625	5.0 ug/L	3/1/23	QC63199	MBS
1,3-Dichlorobenzene	ND	EPA 625	2.5 ug/L	3/1/23	QC63199	MBS
1,4-Dichlorobenzene	ND	EPA 625	2.5 ug/L	3/1/23	QC63199	MBS
2,4,6-Trichlorophenol	ND	EPA 625	20.0 ug/L	3/1/23	QC63199	MBS
2,4-Dichlorophenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2,4-Dimethylphenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2,4-Dinitrophenol	ND	EPA 625	60.0 ug/L	3/1/23	QC63199	MBS
2,4-Dinitrotoluene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2,6-Dinitrotoluene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2-Chloronaphthalene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2-Chlorophenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2-Nitrophenol	ND	EPA 625	20.0 ug/L	3/1/23	QC63199	MBS
3,3'-Dichlorobenzidine	ND	EPA 625	18.0 ug/L	3/1/23	QC63199	MBS
4,6-Dinitro-2-methylphenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Bromophenyl phenyl ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Chloro-3-methylphenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Chlorophenyl phenyl ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Nitrophenol	ND	EPA 625	25.0 ug/L	3/1/23	QC63199	MBS
Acenaphthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Acenaphthylene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Anthracene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS

**Abbreviations/ References:**

RL = Reporting Limit = Minimum Level  
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ug/L = Micrograms Per Liter or PPB  
mpn/100 mls = Most Probable Number Index/ 100 mls  
Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.



## Analytical Results

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Benzidine	ND	EPA 625	150.0 ug/L	3/1/23	QC63199	MBS
Benzo(a)anthracene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(a)pyrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(b)fluoranthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(g,h,i)perylene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(k)fluoranthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-chloroethoxy) methane	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-chloroethyl) ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-chloroisopropyl) ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-ethylhexyl) phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Butylbenzylphthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Chrysene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Dibenzo(a,h)anthracene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Diethyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Dimethyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Di-n-butyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Di-n-octyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Fluoranthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Fluorene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Hexachlorobenzene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Hexachlorobutadiene	ND	EPA 625	9.0 ug/L	3/1/23	QC63199	MBS
Hexachlorocyclopentadiene	ND	EPA 625	50.0 ug/L	3/1/23	QC63199	MBS
Hexachloroethane	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Indeno(1,2,3-cd)pyrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS

**Abbreviations/ References:**

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Date Analyzed = Date Test Completed

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Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Isophorone	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Naphthalene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Nitrobenzene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
n-Nitrosodimethylamine	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
n-Nitroso-di-n-propylamine	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
n-Nitrosodiphenylamine (as Diphenylamine)	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Pentachlorophenol	ND	EPA 625	36.0 ug/L	3/1/23	QC63199	MBS
Phenanthrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Phenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Pyrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS

Surrogate	PercentRecovery	Acceptance Limits
2,4,6-Tribromophenol	85.5	16 - 145
2-Fluorobiphenyl	81.2	60 - 140
2-Fluorophenol	81.4	60 - 140
Nitrobenzene-d5	74.9	15 - 314
Phenol-d5	76.2	8 - 424
p-Terphenyl-d14	105.2	37 - 163

**Abbreviations/ References:**

RL = Reporting Limit = Minimum Level  
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Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
1,2,4-Trichlorobenzene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
1,2-Dichlorobenzene	ND	EPA 625	2.5 ug/L	3/1/23	QC63199	MBS
1,2-diphenylhydrazine (as Azobenzene)	ND	EPA 625	5.0 ug/L	3/1/23	QC63199	MBS
1,3-Dichlorobenzene	ND	EPA 625	2.5 ug/L	3/1/23	QC63199	MBS
1,4-Dichlorobenzene	ND	EPA 625	2.5 ug/L	3/1/23	QC63199	MBS
2,4,6-Trichlorophenol	ND	EPA 625	20.0 ug/L	3/1/23	QC63199	MBS
2,4-Dichlorophenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2,4-Dimethylphenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2,4-Dinitrophenol	ND	EPA 625	60.0 ug/L	3/1/23	QC63199	MBS
2,4-Dinitrotoluene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2,6-Dinitrotoluene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2-Chloronaphthalene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2-Chlorophenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
2-Nitrophenol	ND	EPA 625	20.0 ug/L	3/1/23	QC63199	MBS
3,3'-Dichlorobenzidine	ND	EPA 625	18.0 ug/L	3/1/23	QC63199	MBS
4,6-Dinitro-2-methylphenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Bromophenyl phenyl ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Chloro-3-methylphenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Chlorophenyl phenyl ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
4-Nitrophenol	ND	EPA 625	25.0 ug/L	3/1/23	QC63199	MBS
Acenaphthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Acenaphthylene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Anthracene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS

**Abbreviations/ References:**

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Date Analyzed = Date Test Completed

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ND = Not Detected at Reporting Limit.

## Analytical Results

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**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
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**Bill To:** James Carroll  
**Company:** Lithos Engineering  
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Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Benzidine	ND	EPA 625	150.0 ug/L	3/1/23	QC63199	MBS
Benzo(a)anthracene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(a)pyrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(b)fluoranthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(g,h,i)perylene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Benzo(k)fluoranthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-chloroethoxy) methane	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-chloroethyl) ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-chloroisopropyl) ether	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Bis(2-ethylhexyl) phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Butylbenzylphthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Chrysene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Dibenzo(a,h)anthracene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Diethyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Dimethyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Di-n-butyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Di-n-octyl phthalate	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Fluoranthene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Fluorene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Hexachlorobenzene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Hexachlorobutadiene	ND	EPA 625	9.0 ug/L	3/1/23	QC63199	MBS
Hexachlorocyclopentadiene	ND	EPA 625	50.0 ug/L	3/1/23	QC63199	MBS
Hexachloroethane	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Indeno(1,2,3-cd)pyrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS

**Abbreviations/ References:**

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**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Isophorone	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Naphthalene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Nitrobenzene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
n-Nitrosodimethylamine	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
n-Nitroso-di-n-propylamine	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
n-Nitrosodiphenylamine (as Diphenylamine)	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Pentachlorophenol	ND	EPA 625	36.0 ug/L	3/1/23	QC63199	MBS
Phenanthrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Phenol	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS
Pyrene	ND	EPA 625	10.0 ug/L	3/1/23	QC63199	MBS

Surrogate	Percent Recovery	Acceptance Limits
2,4,6-Tribromophenol	76.3	16 - 145
2-Fluorobiphenyl	84.6	60 - 140
2-Fluorophenol	82.2	60 - 140
Nitrobenzene-d5	77.2	15 - 314
Phenol-d5	75.3	8 - 424
p-Terphenyl-d14	113.5	37 - 163

**Abbreviations/ References:**

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**Report To:** James Carroll  
**Company:** Lithos Engineering

**Receive Date:** 2/24/23  
**Project Name:** Dewatering Application

Test	QC Batch ID	QC Type	Result	Method
1,2,4-Trichlorobenzene	QC63199	Method Blank	ND	EPA 625
1,2-Dichlorobenzene	QC63199	Method Blank	ND	EPA 625
1,2-diphenylhydrazine (as Azobenzene)	QC63199	Method Blank	ND	EPA 625
1,3-Dichlorobenzene	QC63199	Method Blank	ND	EPA 625
1,4-Dichlorobenzene	QC63199	Method Blank	ND	EPA 625
2,4,6-Trichlorophenol	QC63199	Method Blank	ND	EPA 625
2,4-Dichlorophenol	QC63199	Method Blank	ND	EPA 625
2,4-Dimethylphenol	QC63199	Method Blank	ND	EPA 625
2,4-Dinitrophenol	QC63199	Method Blank	ND	EPA 625
2,4-Dinitrotoluene	QC63199	Method Blank	ND	EPA 625
2,6-Dinitrotoluene	QC63199	Method Blank	ND	EPA 625
2-Chloronaphthalene	QC63199	Method Blank	ND	EPA 625
2-Chlorophenol	QC63199	Method Blank	ND	EPA 625
2-Nitrophenol	QC63199	Method Blank	ND	EPA 625
3,3'-Dichlorobenzidine	QC63199	Method Blank	ND	EPA 625
4,6-Dinitro-2-methylphenol	QC63199	Method Blank	ND	EPA 625
4-Bromophenyl phenyl ether	QC63199	Method Blank	ND	EPA 625
4-Chloro-3-methylphenol	QC63199	Method Blank	ND	EPA 625
4-Chlorophenyl phenyl ether	QC63199	Method Blank	ND	EPA 625
4-Nitrophenol	QC63199	Method Blank	ND	EPA 625
Acenaphthene	QC63199	Method Blank	ND	EPA 625
Acenaphthylene	QC63199	Method Blank	ND	EPA 625
Anthracene	QC63199	Method Blank	ND	EPA 625
Benzdine	QC63199	Method Blank	ND	EPA 625
Benzo(a)anthracene	QC63199	Method Blank	ND	EPA 625
Benzo(a)pyrene	QC63199	Method Blank	ND	EPA 625
Benzo(b)fluoranthene	QC63199	Method Blank	ND	EPA 625
Benzo(g,h,i)perylene	QC63199	Method Blank	ND	EPA 625
Benzo(k)fluoranthene	QC63199	Method Blank	ND	EPA 625
Bis(2-chloroethoxy) methane	QC63199	Method Blank	ND	EPA 625
Bis(2-chloroethyl) ether	QC63199	Method Blank	ND	EPA 625
Bis(2-chloroisopropyl) ether	QC63199	Method Blank	ND	EPA 625
Bis(2-ethylhexyl) phthalate	QC63199	Method Blank	ND	EPA 625
Butylbenzylphthalate	QC63199	Method Blank	ND	EPA 625
Chrysene	QC63199	Method Blank	ND	EPA 625
Dibenzo(a,h)anthracene	QC63199	Method Blank	ND	EPA 625
Diethyl phthalate	QC63199	Method Blank	ND	EPA 625
Dimethyl phthalate	QC63199	Method Blank	ND	EPA 625
Di-n-butyl phthalate	QC63199	Method Blank	ND	EPA 625
Di-n-octyl phthalate	QC63199	Method Blank	ND	EPA 625
Fluoranthene	QC63199	Method Blank	ND	EPA 625

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Fluorene	QC63199	Method Blank	ND	EPA 625
Hexachlorobenzene	QC63199	Method Blank	ND	EPA 625
Hexachlorobutadiene	QC63199	Method Blank	ND	EPA 625
Hexachlorocyclopentadiene	QC63199	Method Blank	ND	EPA 625
Hexachloroethane	QC63199	Method Blank	ND	EPA 625
Indeno(1,2,3-cd)pyrene	QC63199	Method Blank	ND	EPA 625
Isophorone	QC63199	Method Blank	ND	EPA 625
Naphthalene	QC63199	Method Blank	ND	EPA 625
Nitrobenzene	QC63199	Method Blank	ND	EPA 625
n-Nitrosodimethylamine	QC63199	Method Blank	ND	EPA 625
n-Nitroso-di-n-propylamine	QC63199	Method Blank	ND	EPA 625
n-Nitrosodiphenylamine (as Diphenyla	QC63199	Method Blank	ND	EPA 625
Pentachlorophenol	QC63199	Method Blank	ND	EPA 625
Phenanthrene	QC63199	Method Blank	ND	EPA 625
Phenol	QC63199	Method Blank	ND	EPA 625
Pyrene	QC63199	Method Blank	ND	EPA 625

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method	
1,2,4-Trichlorobenzene	QC63199	LCS	61 - 130	79.9	-	EPA 625	
		LCS Dup	-	77.8	-		
		MS	44 - 142	69.8	-		
		MSD	0 - 50	-	1.8		
1,2-Dichlorobenzene	QC63199	LCS	65 - 135	76.1	-	EPA 625	
		LCS Dup	-	74.0	-		
		MS	18 - 190	66.7	-		
		MSD	0 - 57	-	3.3		
1,2-diphenylhydrazine (as Azobenzene)	QC63199	LCS	67 - 114	64.6	-	EPA 625	
		Analyte is below the QC criteria in the LCS and LCS Dup; may be subject to low bias. MBS 3/2/2023					
		LCS Dup	-	63.8	-		
		Analyte is below the QC criteria in the LCS and LCS Dup; may be subject to low bias. MBS 3/2/2023					
		MS	60 - 121	61.6	-		
1,3-Dichlorobenzene	QC63199	MSD	0 - 21	-	1.0		
		LCS	70 - 130	72.6	-	EPA 625	
		LCS Dup	-	70.2	-		
		MS	59 - 156	64.1	-		
MSD	0 - 43	-	3.6				
1,4-Dichlorobenzene	QC63199	LCS	56 - 135	74.6	-	EPA 625	
		LCS Dup	-	71.6	-		
		MS	18 - 190	64.1	-		
		MSD	0 - 57	-	4.3		
2,4,6-Trichlorophenol	QC63199	LCS	69 - 130	90.7	-	EPA 625	
		LCS Dup	-	77.5	-		
		MS	37 - 144	118.1	-		
		MSD	0 - 58	-	1.7		
2,4-Dichlorophenol	QC63199	LCS	64 - 130	87.8	-	EPA 625	
		LCS Dup	-	76.8	-		
		MS	39 - 135	93.6	-		
		MSD	0 - 50	-	1.2		
2,4-Dimethylphenol	QC63199	LCS	58 - 130	100.6	-	EPA 625	
		LCS Dup	-	106.5	-		
		MS	32 - 120	106.6	-		
		MSD	0 - 58	-	1.5		
2,4-Dinitrophenol	QC63199	LCS	39 - 173	49.5	-	EPA 625	

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 Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
 (s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		LCS Dup	-	2.5	-	
		Analyte is below the QC criteria in the LCS Dup; meets QC criteria in the LCS. MBS 3/2/2023				
		MS	1 - 191	124.9	-	
		MSD	0 - 132	-	2.6	
2,4-Dinitrotoluene	QC63199	LCS	53 - 130	101.9	-	EPA 625
		LCS Dup	-	100.4	-	
		MS	39 - 139	105.0	-	
		MSD	0 - 42	-	2.1	
2,6-Dinitrotoluene	QC63199	LCS	68 - 137	100.7	-	EPA 625
		LCS Dup	-	101.2	-	
		MS	50 - 158	107.7	-	
		MSD	0 - 48	-	3.6	
2-Chloronaphthalene	QC63199	LCS	70 - 130	80.5	-	EPA 625
		LCS Dup	-	77.5	-	
		MS	60 - 120	73.1	-	
		MSD	0 - 24	-	3.7	
2-Chlorophenol	QC63199	LCS	55 - 130	84.7	-	EPA 625
		LCS Dup	-	82.2	-	
		MS	23 - 134	83.6	-	
		MSD	0 - 61	-	1.8	
2-Nitrophenol	QC63199	LCS	61 - 163	108.4	-	EPA 625
		LCS Dup	-	101.4	-	
		MS	29 - 182	123.7	-	
		MSD	0 - 55	-	2.3	
3,3'-Dichlorobenzidine	QC63199	LCS	18 - 213	55.9	-	EPA 625
		LCS Dup	-	64.1	-	
		MS	1 - 262	29.5	-	
		MSD	0 - 108	-	11.7	
4,6-Dinitro-2-methylphenol	QC63199	LCS	56 - 130	112.0	-	EPA 625
		LCS Dup	-	92.1	-	
		MS	1 - 181	147.0	-	
		MSD	0 - 203	-	1.1	
4-Bromophenyl phenyl ether	QC63199	LCS	70 - 130	88.8	-	EPA 625
		LCS Dup	-	88.0	-	
		MS	53 - 127	86.3	-	
		MSD	0 - 43	-	0.3	
4-Chloro-3-methylphenol	QC63199	LCS	68 - 130	91.1	-	EPA 625
		LCS Dup	-	87.5	-	
		MS	22 - 147	100.2	-	
		MSD	0 - 73	-	0.5	
4-Chlorophenyl phenyl ether	QC63199	LCS	57 - 145	86.2	-	EPA 625
		LCS Dup	-	84.2	-	
		MS	25 - 158	79.6	-	
		MSD	0 - 61	-	2.2	
4-Nitrophenol	QC63199	LCS	35 - 130	53.2	-	EPA 625
		LCS Dup	-	42.2	-	
		MS	1 - 132	77.6	-	
		MSD	0 - 131	-	2.7	
Acenaphthene	QC63199	LCS	70 - 130	82.5	-	EPA 625
		LCS Dup	-	81.3	-	
		MS	47 - 145	75.0	-	

**Abbreviations/ References:**

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 (s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		MSD	0 - 48	-	2.6	
Acenaphthylene	QC63199	LCS	60 - 130	75.0	-	EPA 625
		LCS Dup	-	72.6	-	
		MS	33 - 145	73.0	-	
		MSD	0 - 74	-	1.3	
Anthracene	QC63199	LCS	58 - 130	84.4	-	EPA 625
		LCS Dup	-	83.2	-	
		MS	27 - 133	83.4	-	
		MSD	0 - 81	-	1.5	
Benzidine	QC63199	LCS	1 - 231	10.3	-	EPA 625
		LCS Dup	-	15.5	-	
		MS	1 - 318	0.0	-	
		MSD	0 - 218	-	0.0	
		Analyte is below the QC criteria in the LCS and LCS Dup; meets QC criteria in the LCS. Most likely due to sample matrix effects. MBS 3/2/2023				
		Analyte is below the QC criteria in the LCS and LCS Dup; meets QC criteria in the LCS. Most likely due to sample matrix effects. MBS 3/2/2023				
Benzo(a)anthracene	QC63199	LCS	42 - 133	77.1	-	EPA 625
		LCS Dup	-	81.9	-	
		MS	33 - 143	70.7	-	
		MSD	0 - 53	-	1.1	
Benzo(a)pyrene	QC63199	LCS	32 - 148	89.5	-	EPA 625
		LCS Dup	-	89.9	-	
		MS	17 - 163	86.1	-	
		MSD	0 - 72	-	1.6	
Benzo(b)fluoranthene	QC63199	LCS	42 - 140	92.5	-	EPA 625
		LCS Dup	-	93.9	-	
		MS	24 - 159	86.6	-	
		MSD	0 - 71	-	1.3	
Benzo(g,h,i)perylene	QC63199	LCS	13 - 195	91.7	-	EPA 625
		LCS Dup	-	69.8	-	
		MS	1 - 219	83.7	-	
		MSD	0 - 97	-	1.0	
Benzo(k)fluoranthene	QC63199	LCS	25 - 146	91.1	-	EPA 625
		LCS Dup	-	92.1	-	
		MS	11 - 162	84.8	-	
		MSD	0 - 63	-	1.5	
Bis(2-chloroethoxy) methane	QC63199	LCS	52 - 164	74.8	-	EPA 625
		LCS Dup	-	73.5	-	
		MS	33 - 184	71.3	-	
		MSD	0 - 54	-	2.8	
Bis(2-chloroethyl) ether	QC63199	LCS	52 - 130	72.4	-	EPA 625
		LCS Dup	-	69.9	-	
		MS	12 - 158	59.1	-	
		MSD	0 - 108	-	3.1	
Bis(2-chloroisopropyl) ether	QC63199	LCS	63 - 139	52.0	-	EPA 625
		Analyte is below the QC criteria in the LCS and LCS Dup; may be subject to low bias. MBS 3/2/2023				
		LCS Dup	-	50.1	-	
		Analyte is below the QC criteria in the LCS and LCS Dup; may be subject to low bias. MBS 3/2/2023				
		MS	36 - 166	47.7	-	
		MSD	0 - 76	-	3.3	
Bis(2-ethylhexyl) phthalate	QC63199	LCS	43 - 137	85.8	-	EPA 625

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(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		LCS Dup	-	89.6	-	
		MS	8 - 158	92.4	-	
		MSD	0 - 82	-	1.6	
Butylbenzylphthalate	QC63199	LCS	43 - 140	88.1	-	EPA 625
		LCS Dup	-	96.7	-	
		MS	1 - 152	98.5	-	
		MSD	0 - 60	-	1.7	
Chrysene	QC63199	LCS	44 - 140	78.7	-	EPA 625
		LCS Dup	-	83.6	-	
		MS	17 - 168	72.2	-	
		MSD	0 - 87	-	0.2	
Dibenzo(a,h)anthracene	QC63199	LCS	13 - 200	91.3	-	EPA 625
		LCS Dup	-	69.1	-	
		MS	1 - 227	85.4	-	
		MSD	0 - 126	-	0.2	
Diethyl phthalate	QC63199	LCS	47 - 130	91.5	-	EPA 625
		LCS Dup	-	91.1	-	
		MS	1 - 120	90.7	-	
		MSD	0 - 100	-	2.4	
Dimethyl phthalate	QC63199	LCS	50 - 130	92.6	-	EPA 625
		LCS Dup	-	91.4	-	
		MS	1 - 120	91.7	-	
		MSD	0 - 183	-	1.6	
Di-n-butyl phthalate	QC63199	LCS	52 - 130	96.4	-	EPA 625
		LCS Dup	-	97.7	-	
		MS	1 - 120	99.2	-	
		MSD	0 - 47	-	1.6	
Di-n-octyl phthalate	QC63199	LCS	21 - 132	92.3	-	EPA 625
		LCS Dup	-	85.5	-	
		MS	4 - 146	103.6	-	
		MSD	0 - 69	-	1.9	
Fluoranthene	QC63199	LCS	47 - 130	95.6	-	EPA 625
		LCS Dup	-	94.5	-	
		MS	26 - 137	94.2	-	
		MSD	0 - 66	-	0.0	
Fluorene	QC63199	LCS	70 - 130	83.6	-	EPA 625
		LCS Dup	-	82.6	-	
		MS	59 - 121	75.0	-	
		MSD	0 - 38	-	1.7	
Hexachlorobenzene	QC63199	LCS	38 - 142	98.0	-	EPA 625
		LCS Dup	-	94.1	-	
		MS	1 - 152	91.2	-	
		MSD	0 - 55	-	1.5	
Hexachlorobutadiene	QC63199	LCS	68 - 130	83.5	-	EPA 625
		LCS Dup	-	80.0	-	
		MS	24 - 120	74.7	-	
		MSD	0 - 62	-	3.8	
Hexachlorocyclopentadiene	QC63199	LCS	8 - 106	35.7	-	EPA 625
		LCS Dup	-	0.9	-	
		MS	1 - 111	7.0	-	

Analyte is below the QC criteria in the LCS Dup; meets QC criteria in the LCS. MBS 3/2/2023

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Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method	
		MSD	0 - 41	-	75.9		
%RPD is above QC criteria most likely due to sample matrix effects. MBS 3/2/2023							
Hexachloroethane	QC63199	LCS	55 - 130	69.5	-	EPA 625	
		LCS Dup	-	66.6	-		
		MS	40 - 120	63.0	-		
		MSD	0 - 52	-	1.0		
Indeno(1,2,3-cd)pyrene	QC63199	LCS	13 - 151	91.2	-	EPA 625	
		LCS Dup	-	72.3	-		
		MS	1 - 171	86.9	-		
		MSD	0 - 99	-	1.3		
Isophorone	QC63199	LCS	52 - 180	77.0	-	EPA 625	
		LCS Dup	-	74.5	-		
		MS	21 - 196	77.8	-		
		MSD	0 - 93	-	4.1		
Naphthalene	QC63199	LCS	70 - 130	81.5	-	EPA 625	
		LCS Dup	-	79.1	-		
		MS	21 - 133	72.1	-		
		MSD	0 - 65	-	2.4		
Nitrobenzene	QC63199	LCS	54 - 158	70.8	-	EPA 625	
		LCS Dup	-	68.7	-		
		MS	35 - 180	68.0	-		
		MSD	0 - 62	-	2.9		
n-Nitrosodimethylamine	QC63199	LCS	57 - 141	59.5	-	EPA 625	
		LCS Dup	-	53.5	-		
		Analyte is below the QC criteria in the LCS Dup; meets QC criteria in the LCS. MBS 3/2/2023					
		MS	30 - 168	0.0	-		
		Analyte below QC criteria due to sample matrix interferent at the analyte RT. MBS 3/2/2023					
n-Nitroso-di-n-propylamine	QC63199	LCS	59 - 170	71.1	-	EPA 625	
		LCS Dup	-	69.2	-		
		MS	1 - 230	41.4	-		
		MSD	0 - 87	-	3.1		
		Analyte above QC %RPD criteria due to sample matrix interferent at the analyte RT. MBS 3/2/2023					
n-Nitrosodiphenylamine (as Diphenylamine)	QC63199	LCS	70 - 130	106.2	-	EPA 625	
		LCS Dup	-	104.1	-		
		MS	65 - 135	105.1	-		
		MSD	0 - 20	-	2.3		
Pentachlorophenol	QC63199	LCS	42 - 152	61.3	-	EPA 625	
		LCS Dup	-	32.6	-		
		Analyte is below the QC criteria in the LCS Dup; meets QC criteria in the LCS. MBS 3/2/2023					
		MS	14 - 176	125.9	-		
Phenanthrene	QC63199	LCS	67 - 130	83.6	-	EPA 625	
		LCS Dup	-	82.6	-		
		MS	54 - 120	81.4	-		
		MSD	0 - 39	-	1.6		
Phenol	QC63199	LCS	48 - 130	69.4	-	EPA 625	
		LCS Dup	-	67.7	-		
		MS	5 - 120	5.5	-		
		Analyte is extrapolated above the calibration curve; may be subject to bias. MBS 3/2/2023					
		MSD	0 - 64	-	99.6		
Analyte is extrapolated above the calibration curve; may be subject to bias. MBS 3/2/2023							

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Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
Pyrene	QC63199	LCS	70 - 130	95.3	-	EPA 625
		LCS Dup	-	95.2	-	
		MS	52 - 120	94.1	-	
		MSD	0 - 49	-	0.4	

All analyses were performed in accordance with approved methods under the latest revision to 40 CFR Part 136 unless otherwise identified. Based on my inquiry of the person or persons directly responsible for analyzing the wastewater samples and generating the report (s), the analyses, report, and information submitted are, to the best of my knowledge and belief, true, accurate, and complete.



DATA APPROVED FOR RELEASE BY

**Abbreviations/ References:**

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 mprn/100 mls = Most Probable Number Index/ 100 mls  
 Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
 (s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit





CAL Task

230224063

NAB

# Bottle Order Test Detail

Order ID: QBO22090006

Date Created: 9/2/22

**Ship To:** Kennedy/Jenks Consultants  
143 Union Blvd  
Suite 600  
Lakewood CO 80228  
303-985-3636

**Attention:** Emily Hudish

**Shipping Options:**

Ship Via: Customer Pickup Cooler: Yes

Chain of Custody Drinking Water:  
Standard: 2

**Customer Needs By: 1/23/23**  
**Ships From: Lakewood**

**Project:**  
Dewatering Application

**\*\*Verify All Shipping Addresses\*\***

**Qty. Bottle / Preservative / Test**  
2 3- VOA HCl / 3-VOA None  
624 VOCs - Water - Ground

2 500 ml Amber Unpreserved  
625 SOC's - Water - Ground

2 500 ml Cylinder - HNO3  
Ag - PD - Water - Ground  
Ag - TR - Water - Ground  
Al - TR - Water - Ground  
As - PD - Water - Ground  
As - TR - Water - Ground  
Ba - TR - Water - Ground  
Be - TR - Water - Ground  
Cd - PD - Water - Ground  
Cd - TR - Water - Ground  
Cr - PD - Water - Ground  
Cr - TR - Water - Ground  
Cr - Tri - Water - Ground  
Cu - PD - Water - Ground  
Cu - TR - Water - Ground  
Fe - TR - Water - Ground  
Hg - Water - Ground

**\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\***

**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

<b>Ship To:</b> Kennedy/Jenks Consultants 143 Union Blvd Suite 600 Lakewood CO 80228 303-985-3636	<b>CAL Task</b> 230224063	<b>Shipping Options:</b> Ship Via: Customer Pickup    Cooler: Yes
<b>Attention:</b> Emily Hudish	NAB	Chain of Custody    Drinking Water: Standard: 2
<b>**Verify All Shipping Addresses**</b>		<b>Customer Needs By: 1/23/23</b> <b>Ships From: Lakewood</b>
		<b>Project:</b> Dewatering Application

Qty.	Bottle / Preservative / Test
	Mn - PD - Water - Ground
	Mo - TR - Water - Ground
	Ni - PD - Water - Ground
	Ni - TR - Water - Ground
	Pb - PD - Water - Ground
	Pb - TR - Water - Ground
	Sb - TR - Water - Ground
	Se - PD - Water - Ground
	Se - TR - Water - Ground
	Tl - PD - Water - Ground
	Tl - TR - Water - Ground
	U - PD - Water - Ground
	U - TR - Water - Ground
	Zn - PD - Water - Ground
	Zn - TR - Water - Ground
<hr/>	
2	<b>500 ml Cylinder - Unpreserved</b>
	Cr - Hex - Water - Ground
	Fe - Dis - Water - Ground
	Mn - Dis - Water - Ground

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**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507



**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
1,1,1,2-Tetrachloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1,1-Trichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1,2,2-Tetrachloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1,2-Trichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1-Dichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1-Dichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1-Dichloropropene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2,3-Trichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dibromoethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dichlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,3-Dichlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,3-Dichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,3-dichloropropene - Total	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,4-Dichlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,4-Dioxane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
2,2-Dichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
2-Chloroethylvinyl Ether	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
2-Chlorotoluene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
4-Chlorotoluene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Acrolein	ND	EPA 624.1	10.0 ug/L	3/8/23	QC63325	LEH
Acrylonitrile	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Benzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Bromobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH

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Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

## Analytical Results

TASK NO: 230224063

**Report To:** James Carroll

**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll

**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Bromodichloromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Bromoform	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Bromomethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Carbon Tetrachloride	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chloroform	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chloromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
cis-1,2-Dichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
cis-1,3-Dichloropropene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Dibromochloromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Dibromomethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Ethylbenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
m,p-Xylenes	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Methylene Chloride	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
o-Xylenes	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Styrene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Tetrachloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Toluene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
trans-1,2-dichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
trans-1,3-Dichloropropene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Trichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Trichlorofluoromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Vinyl Chloride	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Xylenes (total)	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH

**Abbreviations/ References:**

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(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
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Surrogate	PercentRecovery	Acceptance Limits
4-Bromofluorobenzene	100.1	60 - 140
Fluorobenzene	92.2	60 - 140
Pentafluorobenzene	97.9	60 - 140

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## Analytical Results

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Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
1,1,1,2-Tetrachloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1,1-Trichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1,2,2-Tetrachloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1,2-Trichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1-Dichloroethane	2.1 ug/L	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1-Dichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,1-Dichloropropene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2,3-Trichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dibromoethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dichlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dichloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,2-Dichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,3-Dichlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,3-Dichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,3-dichloropropene - Total	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,4-Dichlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
1,4-Dioxane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
2,2-Dichloropropane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
2-Chloroethylvinyl Ether	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
2-Chlorotoluene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
4-Chlorotoluene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Acrolein	ND	EPA 624.1	10.0 ug/L	3/8/23	QC63325	LEH
Acrylonitrile	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Benzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Bromobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH

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Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
Bromodichloromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Bromoform	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Bromomethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Carbon Tetrachloride	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chlorobenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chloroethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chloroform	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Chloromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
cis-1,2-Dichloroethene	1.1 ug/L	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
cis-1,3-Dichloropropene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Dibromochloromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Dibromomethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Ethylbenzene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
m,p-Xylenes	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Methylene Chloride	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
o-Xylenes	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Styrene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Tetrachloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Toluene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
trans-1,2-dichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
trans-1,3-Dichloropropene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Trichloroethene	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Trichlorofluoromethane	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Vinyl Chloride	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH
Xylenes (total)	ND	EPA 624.1	1.0 ug/L	3/8/23	QC63325	LEH

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**Analytical Results**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
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Surrogate	Percent Recovery	Acceptance Limits
4-Bromofluorobenzene	101.8	60 - 140
Fluorobenzene	93.6	60 - 140
Pentafluorobenzene	97.8	60 - 140

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**Report To:** James Carroll  
**Company:** Lithos Engineering

**Receive Date:** 2/24/23  
**Project Name:** Dewatering Application

Test	QC Batch ID	QC Type	Result	Method
1,1,1,2-Tetrachloroethane	QC63325	Method Blank	ND	EPA 624.1
1,1,1-Trichloroethane	QC63325	Method Blank	ND	EPA 624.1
1,1,2,2-Tetrachloroethane	QC63325	Method Blank	ND	EPA 624.1
1,1,2-Trichloroethane	QC63325	Method Blank	ND	EPA 624.1
1,1-Dichloroethane	QC63325	Method Blank	ND	EPA 624.1
1,1-Dichloroethene	QC63325	Method Blank	ND	EPA 624.1
1,1-Dichloropropene	QC63325	Method Blank	ND	EPA 624.1
1,2,3-Trichloropropane	QC63325	Method Blank	ND	EPA 624.1
1,2-Dibromoethane	QC63325	Method Blank	ND	EPA 624.1
1,2-Dichlorobenzene	QC63325	Method Blank	ND	EPA 624.1
1,2-Dichloroethane	QC63325	Method Blank	ND	EPA 624.1
1,2-Dichloropropane	QC63325	Method Blank	ND	EPA 624.1
1,3-Dichlorobenzene	QC63325	Method Blank	ND	EPA 624.1
1,3-Dichloropropane	QC63325	Method Blank	ND	EPA 624.1
1,3-dichloropropene - Total	QC63325	Method Blank	ND	EPA 624.1
1,4-Dichlorobenzene	QC63325	Method Blank	ND	EPA 624.1
1,4-Dioxane	QC63325	Method Blank	ND	EPA 624.1
2,2-Dichloropropane	QC63325	Method Blank	ND	EPA 624.1
2-Chloroethylvinyl Ether	QC63325	Method Blank	ND	EPA 624.1
2-Chlorotoluene	QC63325	Method Blank	ND	EPA 624.1
4-Chlorotoluene	QC63325	Method Blank	ND	EPA 624.1
Acrolein	QC63325	Method Blank	ND	EPA 624.1
Acrylonitrile	QC63325	Method Blank	ND	EPA 624.1
Benzene	QC63325	Method Blank	ND	EPA 624.1
Bromobenzene	QC63325	Method Blank	ND	EPA 624.1
Bromodichloromethane	QC63325	Method Blank	ND	EPA 624.1
Bromoform	QC63325	Method Blank	ND	EPA 624.1
Bromomethane	QC63325	Method Blank	ND	EPA 624.1
Carbon Tetrachloride	QC63325	Method Blank	ND	EPA 624.1
Chlorobenzene	QC63325	Method Blank	ND	EPA 624.1
Chloroethane	QC63325	Method Blank	ND	EPA 624.1
Chloroform	QC63325	Method Blank	ND	EPA 624.1
Chloromethane	QC63325	Method Blank	ND	EPA 624.1
cis-1,2-Dichloroethene	QC63325	Method Blank	ND	EPA 624.1
cis-1,3-Dichloropropene	QC63325	Method Blank	ND	EPA 624.1
Dibromochloromethane	QC63325	Method Blank	ND	EPA 624.1
Dibromomethane	QC63325	Method Blank	ND	EPA 624.1
Ethylbenzene	QC63325	Method Blank	ND	EPA 624.1
m,p-Xylenes	QC63325	Method Blank	ND	EPA 624.1
Methylene Chloride	QC63325	Method Blank	ND	EPA 624.1
o-Xylenes	QC63325	Method Blank	ND	EPA 624.1

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Styrene	QC63325	Method Blank	ND	EPA 624.1
Tetrachloroethene	QC63325	Method Blank	ND	EPA 624.1
Toluene	QC63325	Method Blank	ND	EPA 624.1
trans-1,2-dichloroethene	QC63325	Method Blank	ND	EPA 624.1
trans-1,3-Dichloropropene	QC63325	Method Blank	ND	EPA 624.1
Trichloroethene	QC63325	Method Blank	ND	EPA 624.1
Trichlorofluoromethane	QC63325	Method Blank	ND	EPA 624.1
Vinyl Chloride	QC63325	Method Blank	ND	EPA 624.1
Xylenes (total)	QC63325	Method Blank	ND	EPA 624.1

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
1,1,1,2-Tetrachloroethane	QC63325	LCS	70 - 130	101.4	-	EPA 624.1
		MS	45 - 155	110.8	-	
		MSD	0 - 45	-	1.2	
1,1,1-Trichloroethane	QC63325	LCS	70 - 130	116.0	-	EPA 624.1
		MS	52 - 162	127.5	-	
		MSD	0 - 36	-	0.2	
1,1,2,2-Tetrachloroethane	QC63325	LCS	60 - 140	90.6	-	EPA 624.1
		MS	46 - 157	95.0	-	
		MSD	0 - 61	-	1.1	
1,1,2-Trichloroethane	QC63325	LCS	70 - 130	96.0	-	EPA 624.1
		MS	52 - 150	103.0	-	
		MSD	0 - 45	-	0.6	
1,1-Dichloroethane	QC63325	LCS	70 - 130	118.9	-	EPA 624.1
		MS	59 - 155	127.7	-	
		MSD	0 - 49	-	0.8	
1,1-Dichloroethene	QC63325	LCS	50 - 150	113.1	-	EPA 624.1
		MS	1 - 234	122.0	-	
		MSD	0 - 32	-	0.7	
1,1-Dichloropropene	QC63325	LCS	70 - 130	113.6	-	EPA 624.1
		MS	35 - 165	124.9	-	
		MSD	0 - 50	-	0.1	
1,2,3-Trichloropropane	QC63325	LCS	70 - 130	83.3	-	EPA 624.1
		MS	70 - 130	88.9	-	
		MSD	0 - 30	-	1.8	
1,2-Dibromoethane	QC63325	LCS	70 - 130	95.3	-	EPA 624.1
		MS	65 - 135	100.9	-	
		MSD	0 - 30	-	2.7	
1,2-Dichlorobenzene	QC63325	LCS	65 - 135	94.7	-	EPA 624.1
		MS	18 - 190	102.1	-	
		MSD	0 - 57	-	0.3	
1,2-Dichloroethane	QC63325	LCS	70 - 130	96.5	-	EPA 624.1
		MS	49 - 155	104.2	-	
		MSD	0 - 49	-	0.1	
1,2-Dichloropropane	QC63325	LCS	35 - 165	99.2	-	EPA 624.1
		MS	1 - 210	107.2	-	
		MSD	0 - 55	-	0.6	
1,3-Dichlorobenzene	QC63325	LCS	70 - 130	98.4	-	EPA 624.1
		MS	59 - 159	103.4	-	
		MSD	0 - 43	-	0.1	
1,3-Dichloropropane	QC63325	LCS	70 - 130	94.9	-	EPA 624.1
		MS	65 - 135	99.2	-	

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Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		MSD	0 - 30	-	2.4	
1,4-Dichlorobenzene	QC63325	LCS	65 - 135	95.9	-	EPA 624.1
		MS	18 - 190	101.0	-	
		MSD	0 - 57	-	0.3	
1,4-Dioxane	QC63325	LCS	65 - 135	81.4	-	EPA 624.1
		MS	70 - 130	87.2	-	
		MSD	0 - 30	-	2.3	
2,2-Dichloropropane	QC63325	LCS	70 - 130	115.4	-	EPA 624.1
		MS	40 - 160	125.4	-	
		MSD	0 - 45	-	2.7	
2-Chloroethylvinyl Ether	QC63325	LCS	1 - 225	118.0	-	EPA 624.1
		MS	1 - 305	45.1	-	
		MSD	0 - 71	-	11.9	
2-Chlorotoluene	QC63325	LCS	70 - 130	99.5	-	EPA 624.1
		MS	35 - 165	106.6	-	
		MSD	0 - 50	-	0.3	
4-Chlorotoluene	QC63325	LCS	70 - 130	102.1	-	EPA 624.1
		MS	35 - 165	106.6	-	
		MSD	0 - 50	-	0.4	
Acrolein	QC63325	LCS	60 - 140	130.6	-	EPA 624.1
		MS	40 - 160	134.3	-	
		MSD	0 - 60	-	3.2	
Acrylonitrile	QC63325	LCS	60 - 140	97.4	-	EPA 624.1
		MS	40 - 160	104.0	-	
		MSD	0 - 60	-	0.5	
Benzene	QC63325	LCS	65 - 135	106.1	-	EPA 624.1
		MS	37 - 151	115.2	-	
		MSD	0 - 61	-	0.4	
Bromobenzene	QC63325	LCS	70 - 130	98.6	-	EPA 624.1
		MS	50 - 150	102.0	-	
		MSD	0 - 40	-	1.4	
Bromodichloromethane	QC63325	LCS	65 - 135	103.8	-	EPA 624.1
		MS	35 - 155	111.9	-	
		MSD	0 - 56	-	0.4	
Bromoform	QC63325	LCS	70 - 130	85.9	-	EPA 624.1
		MS	45 - 169	88.0	-	
		MSD	0 - 42	-	1.9	
Bromomethane	QC63325	LCS	15 - 185	128.4	-	EPA 624.1
		MS	1 - 242	124.4	-	
		MSD	0 - 61	-	2.4	
Carbon Tetrachloride	QC63325	LCS	70 - 130	109.6	-	EPA 624.1
		MS	70 - 140	119.5	-	
		MSD	0 - 41	-	2.0	
Chlorobenzene	QC63325	LCS	65 - 135	100.0	-	EPA 624.1
		MS	37 - 160	107.9	-	
		MSD	0 - 53	-	0.3	
Chloroethane	QC63325	LCS	40 - 160	102.6	-	EPA 624.1
		MS	14 - 230	109.5	-	
		MSD	0 - 78	-	0.5	
Chloroform	QC63325	LCS	70 - 135	111.8	-	EPA 624.1

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Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		MS	51 - 138	121.8	-	
		MSD	0 - 54	-	0.7	
Chloromethane	QC63325	LCS	1 - 205	98.5	-	EPA 624.1
		MS	1 - 273	106.8	-	
		MSD	0 - 60	-	3.5	
cis-1,2-Dichloroethene	QC63325	LCS	70 - 130	112.9	-	EPA 624.1
		MS	54 - 156	120.9	-	
		MSD	0 - 60	-	0.9	
cis-1,3-Dichloropropene	QC63325	LCS	25 - 175	108.3	-	EPA 624.1
		MS	1 - 227	115.5	-	
		MSD	0 - 58	-	0.9	
Dibromochloromethane	QC63325	LCS	70 - 135	102.6	-	EPA 624.1
		MS	53 - 149	109.8	-	
		MSD	0 - 50	-	1.1	
Dibromomethane	QC63325	LCS	70 - 130	94.9	-	EPA 624.1
		MS	65 - 135	100.2	-	
		MSD	0 - 30	-	1.1	
Ethylbenzene	QC63325	LCS	60 - 140	99.8	-	EPA 624.1
		MS	37 - 162	110.2	-	
		MSD	0 - 63	-	1.2	
m,p-Xylenes	QC63325	LCS	70 - 130	99.8	-	EPA 624.1
		MS	30 - 170	109.1	-	
		MSD	0 - 55	-	0.4	
Methylene Chloride	QC63325	LCS	60 - 140	109.6	-	EPA 624.1
		MS	1 - 221	116.2	-	
		MSD	0 - 28	-	0.1	
o-Xylenes	QC63325	LCS	70 - 130	106.2	-	EPA 624.1
		MS	40 - 160	112.8	-	
		MSD	0 - 50	-	0.4	
Styrene	QC63325	LCS	70 - 130	101.6	-	EPA 624.1
		MS	45 - 165	105.8	-	
		MSD	0 - 45	-	0.9	
Tetrachloroethene	QC63325	LCS	70 - 130	95.7	-	EPA 624.1
		MS	64 - 148	104.7	-	
		MSD	0 - 39	-	0.1	
Toluene	QC63325	LCS	70 - 130	99.5	-	EPA 624.1
		MS	47 - 150	107.9	-	
		MSD	0 - 41	-	0.2	
trans-1,2-dichloroethene	QC63325	LCS	70 - 130	110.6	-	EPA 624.1
		MS	54 - 156	118.8	-	
		MSD	0 - 45	-	1.9	
trans-1,3-Dichloropropene	QC63325	LCS	50 - 150	114.3	-	EPA 624.1
		MS	17 - 183	120.9	-	
		MSD	0 - 86	-	1.2	
Trichloroethene	QC63325	LCS	65 - 135	94.6	-	EPA 624.1
		MS	70 - 157	103.6	-	
		MSD	0 - 48	-	1.0	
Trichlorofluoromethane	QC63325	LCS	50 - 150	102.4	-	EPA 624.1
		MS	17 - 181	112.0	-	
		MSD	0 - 84	-	0.7	

**Abbreviations/ References:**

RL = Reporting Limit = Minimum Level  
mg/L = Milligrams Per Liter or PPM  
ug/L = Micrograms Per Liter or PPB  
mpn/100 mls = Most Probable Number Index/ 100 mls  
Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.



Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
Vinyl Chloride	QC63325	LCS	5 - 195	97.2	-	EPA 624.1
		MS	1 - 251	107.5	-	
		MSD	0 - 66	-	0.7	

All analyses were performed in accordance with approved methods under the latest revision to 40 CFR Part 136 unless otherwise identified. Based on my inquiry of the person or persons directly responsible for analyzing the wastewater samples and generating the report (s), the analyses, report, and information submitted are, to the best of my knowledge and belief, true, accurate, and complete.



DATA APPROVED FOR RELEASE BY

**Abbreviations/ References:**

RL = Reporting Limit = Minimum Level  
 mg/L = Milligrams Per Liter or PPM  
 ug/L = Micrograms Per Liter or PPB  
 mpn/100 mls = Most Probable Number Index/ 100 mls  
 Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
 (s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.





CAL Task

230224063

NAB

**Bottle Order  
Test Detail**

Order ID: QBO22090006

Date Created: 9/2/22

**Ship To:** Kennedy/Jenks Consultants  
143 Union Blvd  
Suite 600  
Lakewood CO 80228  
303-985-3636  
**Attention:** Emily Hudish

**Shipping Options:**

Ship Via: Customer Pickup Cooler: Yes

Chain of Custody Drinking Water:  
Standard: 2

**Customer Needs By: 1/23/23**

**Ships From: Lakewood**

**Project:**

Dewatering Application

**\*\*Verify All Shipping Addresses\*\***

**Qty. Bottle / Preservative / Test**  
2 3- VOA HCl / 3-VOA None  
624 VOCs - Water - Ground

2 500 ml Amber Unpreserved  
625 SOC's - Water - Ground

2 500 ml Cylinder - HNO3  
Ag - PD - Water - Ground  
Ag - TR - Water - Ground  
Al - TR - Water - Ground  
As - PD - Water - Ground  
As - TR - Water - Ground  
Ba - TR - Water - Ground  
Be - TR - Water - Ground  
Cd - PD - Water - Ground  
Cd - TR - Water - Ground  
Cr - PD - Water - Ground  
Cr - TR - Water - Ground  
Cr - Tri - Water - Ground  
Cu - PD - Water - Ground  
Cu - TR - Water - Ground  
Fe - TR - Water - Ground  
Hg - Water - Ground

**\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\***

**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

**Ship To:** Kennedy/Jenks Consultants  
143 Union Blvd  
Suite 600  
Lakewood CO 80228  
303-985-3636

**Attention:** Emily Hudish

**CAL Task**  
230224063

NAB

**Shipping Options:**

Ship Via: Customer Pickup Cooler: Yes

Chain of Custody Drinking Water:  
Standard: 2

**Customer Needs By: 1/23/23**

**Ships From: Lakewood**

**Project:**

Dewatering Application

**\*\*Verify All Shipping Addresses\*\***

**Qty. Bottle / Preservative / Test**

- Mn - PD - Water - Ground
- Mo - TR - Water - Ground
- Ni - PD - Water - Ground
- Ni - TR - Water - Ground
- Pb - PD - Water - Ground
- Pb - TR - Water - Ground
- Sb - TR - Water - Ground
- Se - PD - Water - Ground
- Se - TR - Water - Ground
- Tl - PD - Water - Ground
- Tl - TR - Water - Ground
- U - PD - Water - Ground
- U - TR - Water - Ground
- Zn - PD - Water - Ground
- Zn - TR - Water - Ground

**2 500 ml Cylinder - Unpreserved**

- Cr - Hex - Water - Ground
- Fe - Dis - Water - Ground
- Mn - Dis - Water - Ground

**\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\***

**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507





# LITHOS

## ENGINEERING

### GEOTECHNICAL BASELINE REPORT

NORTH TRUNK SEWER IMPROVEMENTS – TENNYSON AND 58<sup>TH</sup>

ARVADA, COLORADO

NOVEMBER 30, 2023



Engineering

from the ground down

November 30, 2023  
Project No. 22134



Kennedy Jenks Consultants, Inc.  
165 South Union Boulevard  
Suite 570, Lakewood, CO 80228-1828

Attention: Jerry Pena, PE  
Client Director

Regarding: Geotechnical Baseline Report - DRAFT  
North Trunk Sewer Improvements – Tennyson and 58th  
Arvada, CO

Mr. Pena,

Submitted herewith is the Geotechnical Baseline Report for the North Trunk Sewer Improvements – Tennyson and 58th. This report was prepared in general accordance with the Agreement between Lithos Engineering and Kennedy Jenks Consultants, Inc. dated October 3<sup>rd</sup>, 2023. The Geotechnical Baseline Report includes discussions of the geotechnical data, geotechnical baselines, and construction considerations in support of the subject project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,  
**Lithos Engineering**

Adam Malsam, EIT  
Staff Engineer

James Carroll, PE  
Project Manager

Robin Dornfest, PG  
Principle-in-Charge

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A	Tunnelman’s Ground Classification Chart

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## REPORT ORGANIZATION

The Geotechnical Baseline Report (GBR) is organized as follows:

### **Section 1: Introduction**

Describes the project background and discusses the purpose and intended usage of the GBR.

### **Section 2: Geology and Subsurface Investigation**

Provides background on the regional geology and describes the investigation undertaken to evaluate ground conditions at the site.

### **Section 3: Baseline Geologic Units and Ground Behavior**

Describes the materials found onsite and provides baselines for the materials' index properties and tunneling behavior. Additional baselines are provided for groundwater.

### **Section 4: Construction Considerations**

Discusses shaft excavation and support, as well as the required tunneling and initial support methods. Additional considerations are given for typical construction scenarios that may arise during shaft or tunnel construction, which the Contractor should account for in their bid, consideration of means and methods, and performance. Third party impacts and considerations are also discussed.

### **Sections 5 and 6: Limitations and References**

Describes limitations of the GBR and provides references for citations within the report.

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# 1 INTRODUCTION

## 1.1 Project Description

Kennedy Jenks (KJ) retained Lithos Engineering (Lithos) for evaluation and tunnel design of the North Trunk Sewer Improvements – Tennyson and 58<sup>th</sup> project (Project) for the City of Arvada (Arvada). The Project includes a tunnel crossing constructed within Tennyson Street which crosses under five railroad tracks including one owned by Burlington Northern Santa Fe (BNSF), two owned by Union Pacific (UPRR), and two owned by the Regional Transportation District (RTD). The proposed crossing is approximately 210 feet of 48-inch fiberglass reinforced pipe (FRP) at a 0.29% slope downwards from north to south, as part of a sewer line. Initial support will include a 60-inch steel jacked casing pipe with a minimum thickness of 1.0-inch. The location of the project is shown in Figure 1. Tunnel construction has been chosen because it is not feasible to construct trenches for open cut installation of the pipe across the railroad lines.

## 1.2 Description and Purpose of GBR

The main purpose of this GBR is to establish contractual baselines for anticipated ground conditions and behavior that will be encountered during shaft and tunnel construction. Subsurface conditions observed through geotechnical field explorations and through laboratory analyses of collected samples for purposes of preparing the Contract Documents, including preparation of this GBR, are presented in the Geotechnical Data Report (GDR) (Lithos Engineering, 2023). GBR preparation was performed in general accordance with the ASCE document entitled: “Geotechnical Baseline Reports, Suggested Guidelines,” dated 2022.

The baselines established in this GBR for the anticipated subsurface conditions shall be used as the basis for developing bids and to help the Contractor evaluate allowed means and methods. The baselines will be used to evaluate potential differing site conditions (DSC) during construction. This GBR also summarizes geotechnical and construction considerations that form the basis of the tunnel portion of the Project design and Contract Documents. The GBR is prepared in tandem with the applicable Contract Documents, particularly the Tunnel Excavation and Initial Support specification. In the event of a conflict, the Contract Drawings and Specifications take contractual precedence over the GBR, and the GBR takes precedence over the GDR.

The baselines for anticipated subsurface conditions presented in this GBR reflect the design team’s and Construction Manager’s/General Contractor’s (CMGC) judgment of anticipated subsurface conditions and ground behavior based on assumed construction means and methods expected to be employed in the work. The baselines were established by considering available geologic and geotechnical data, and previous construction experience in similar subsurface conditions. Development of the Project design required interpretation, extrapolation, and interpolation between data obtained for the Project including aerial imagery, geotechnical test boreholes (i.e. borings), groundwater monitoring, and laboratory tests. While actual conditions encountered during tunnel construction are expected to be in accordance with the conditions baselined herein, specific locations where encountered subsurface conditions vary from those described in this GBR may exist. The Contractor should familiarize themselves with the DSC process to judge whether variances justify pursuit of a DSC claim.

## 2 GEOLOGY AND SUBSURFACE INVESTIGATION

### 2.1 Regional Geology

The geologic conditions in the area are characterized by surficial materials consisting of alluvial deposits within the historic floodplain of Clear Creek, mapped by Lindvall (1979) as Post Piney Creek Alluvium. These soils overlie interbedded sandstone, siltstone, and claystone bedrock of the Denver Formation (Lindvall, 1979). The project site is located within the Colorado Piedmont section of the Great Plains Physiographic Province. The piedmont, being an erosional inlier, consists of arid plains that are lower than the foothills to the west and slightly lower than the Great Plains to the east. During periods of uplift of the Rocky Mountains, younger sedimentary rock units were eroded and transported by streams and rivers to the piedmont. As rivers have historically meandered, alluvium was deposited in a broad swath across the plain.

Groundwater in the region is heavily influenced by the Rocky Mountains to the west and the local rivers, creeks, and drainages. Groundwater generally flows west to east from the foothills with more localized flow towards and along waterbodies. The Arvada area has semi-confined, unconfined, and perched aquifers within surficial sediments and confined and semi-confined aquifers in bedrock. The historically meandering and braided easterly-flowing rivers have significant influence on the local groundwater levels and hydrogeology. The unconfined aquifer groundwater levels are generally greater in the immediate vicinity of waterbodies such as rivers, creeks, and irrigation ditches and decreases with distance away from waterbodies.

### 2.2 Subsurface Investigation

Vine Laboratories performed the geotechnical drilling for the Project tunnel with observation by a Lithos representative on January 27, 2023. The field investigation consisted of two borings performed along the alignment and as near to the anticipated shaft locations as access allowed. Both borings were converted to temporary monitoring wells upon completion. In general, Vine Laboratories collected split spoon and Modified California samples. A geotechnical laboratory testing program was performed by Martinez Associates on selected samples and the results assisted in classification and assessment of applicable engineering properties for encountered subsurface materials.

Details of the procedures used for conducting the field work and laboratory testing, and the factual results of the subsurface investigation and laboratory testing performed for this project are summarized in the GDR. Summaries of geotechnical data encountered during the investigation or provided by laboratory testing are embedded within this report.

### 2.3 Literature Review

In addition to the field investigation, Lithos performed a review of available literature, including aerial imagery for the tunnel location and subsurface data from the United States Geological Survey (USGS), and other public entities. Specific documents reviewed for pertinent data include:

- Aerial imagery through Google Earth and Historic Aerials ([historicaerials.com](http://historicaerials.com)). Images dating from the 1950s through present were reviewed. These images indicate the project site consisted of farmland and gravel pits/ponds where gravel aggregate was mined. The 1960s saw an increase in residential housing construction on the north side of the railroad tracks. The 1970's saw an increase in gravel mining operations with additional gravel pits/ponds being formed. In the 1980's

and 1990's the gravel pits/ponds began to be reclaimed, with the land being used for industrial purposes. This process continues to the present-day. Railroad lines have been present at this site throughout the time period analyzed with the RTD having been recently constructed between 2015 and 2017.

- USGS Geologic Maps available for the tunnel crossing to identify the mapped deposits and bedrock formations. This aided in identifying the geologic processes that shaped the present-day subsurface conditions for the tunnel.
- Project geotechnical data for the relevant historic tunnel projects.

Relevant observations or construction considerations are noted in the GBR text for the tunnel where findings were applicable, and baselines were developed accordingly.

### 3 BASELINE GEOLOGIC UNITS AND GROUND BEHAVIOR

The soil characteristics and ground conditions described in this section of the GBR constitute the baseline geotechnical conditions to be anticipated during construction of the tunnel. Geotechnical baselines described herein include percent of volume of encountered material, Tunnelman's Ground Classification, abrasivity, potential for obstructions, clogging factor, and material sizes. Baseline values and discussion pertinent to the geologic conditions from which the baselines are derived are provided below.

The shafts and tunnel excavations will encounter cohesive soil and non-cohesive soil. These materials will exhibit different ground behavior. Baselines included in this report are derived based on the Tunnelman's classification system, which is included for reference in Appendix A at the end of this report.

Borings LE-01 and LE-02 were used to baseline geologic unit material parameters and create the Geologic Profile shown on Figure 2. The sections below discuss the geologic and geotechnical characteristics of these units.

#### 3.1 Cohesive Soil

Cohesive soil to be encountered in shaft and tunnel excavations consists of lean clay (CL) with some sand and trace gravel. Cohesive soil generally consists of native materials and artificial fill with greater than 30% fines (clay and silt passing a No. 200 sieve) and exhibits a cohesive (plastic) behavior. Cohesive soil will be encountered above and below groundwater. The table below provides the baseline conditions of cohesive soil.

**Table 3.1 – Baseline Conditions of Cohesive Soil**

Tunnelman's Classification		Grain Size Distribution (% Composition)	Stickiness (% of excavation)			Soil Abrasivity	Blow Counts (Blow/Foot; ASTM D3550)
Above Groundwater	Below Groundwater		High	Medium	Low		
Slow Raveling	Fast Raveling	Fines Avg: 66 (Range: 54-71)	30	60	10	Low	Avg: 10 Range: 2-13

Cohesive soil has a low to high potential (as defined by Hollman and Thewes, 2012) to create problems with adhesion and/or clogging equipment with the in-situ moisture content. Precipitation, nuisance

water, or added moisture from construction (e.g. lubrication fluids) have the potential to create higher stickiness conditions. Hollman and Thewes suggest that the stickiness of fines, if present, can be correlated based on the consistency index and plasticity index of the clay. The consistency index is a function of the natural moisture content, the liquid limit, and the plasticity index.

Cohesive soil has a medium potential for excessive steel wear. Soil abrasivity is known to affect the wear and replacement rate of steel excavating components. Soil abrasivity is a function of the nature of the soil (e.g. mineralogy, quartz content, abrasiveness, rounding, compaction, and grain size distribution), soil moisture content, soil conditioning during excavation, and rate of excavation (Jakobsen, et al, 2013). Soil abrasivity was estimated based on mineral percentages of quartz-rich sand. Soil abrasivity is defined by Jakobsen, et al, 2013 as having NTNU/SINTEF Soil Abrasion Test (SAT) values less than 7 for low, greater than 7 and less than 22 for medium, and greater than 22 for high.

Cobbles in cohesive soil are anticipated based on the GDR and regional geology at the tunnel location. For bidding and baseline purposes, the Contractor shall assume:

- A maximum cobble volume ratio of 5%;
- 100% of cobbles will have a maximum dimension of 6 inches;
- Cobbles will have a maximum unconfined compressive strength (UCS) of 15,000 psi and maximum Cerchar Abrasivity Index (CAI) of 4.0;
- Cobbles will be sub-angular to sub-rounded;
- Cobbles will be isolated.

### 3.2 Non-Cohesive Soil

Non-cohesive soil to be encountered in shaft and tunnel excavation consists of silty gravel (GM), silty sand (SM), poorly graded sand with few silt (SP-SM), and poorly graded gravel (GP). Non-cohesive soil generally consists of native materials with less than 30% fines (clay and silt passing a No. 200 sieve) and exhibits a non-cohesive (non-plastic) behavior. Non-cohesive soil will be encountered above and below groundwater. The table below provides the baseline conditions of the non-cohesive soil.

**Table 3.2 – Baseline Conditions of Non-Cohesive Soil**

Tunnelman's Classification		Grain Size Distribution (% Composition)	Stickiness (% of excavation)			Soil Abrasivity	Blow Counts (Blow/Foot; ASTM D3550)
Above Groundwater	Below Groundwater		High	Medium	Low		
Fast Raveling	Flowing	Gravel Avg: 47 (Range: 27-64) Sand Avg: 43 (Range: 26-65) Fines Avg: 10 (Range: 5-18)	0	0	100	High	Avg: 80 Range: 9- 50/1"

Non-cohesive soil has a low potential to create problems with adhesion and/or clogging equipment with the in-situ moisture content and a high potential for excessive steel wear.

Cobbles in non-cohesive soil are anticipated based on the GDR and regional geology at the tunnel location. For bidding and baseline purposes, the Contractor shall assume:

- A maximum cobble volume ratio of 20%;
- 100% of cobbles will have a maximum dimension of 10 inches;
- Cobbles will have a maximum unconfined compressive strength (UCS) of 15,000 psi and maximum Cerchar Abrasivity Index (CAI) of 4.0;
- Cobbles will be sub-angular to sub-rounded;
- Cobbles will be isolated.

Other obstructions, including natural or artificial singular features greater than 12 inches will not be encountered.

### 3.3 Groundwater

Groundwater was encountered in both borings during the subsurface investigation. Both LE-01 and LE-02 were converted to temporary monitoring wells to characterize long term groundwater levels and collect groundwater samples to test for contaminants. Groundwater testing for contaminants was completed by others and is available to the contractor within the Contract Documents. The baseline groundwater elevation for the shafts and tunnel is shown on Figure 2.

The Contractor should anticipate local variations in permeability and aquifer characteristics will be encountered. With respect to construction dewatering design, cohesive soil is problematic in that frequent layers of lower permeability material with a high percentage of fines can hinder dewatering and are difficult to precisely model in traditional drawdown analysis.

The permeability of the geologic units varies with fines content, void ratio, and particle size. The Contractor should be aware that horizontal permeability in these deposits is significantly greater (from 5x to 10x) than vertical permeability. For baseline purposes, the permeability of the materials found onsite is as follows in the table below:

**Table 3.3 – Baseline Permeability of Materials**

Geologic Unit	Horizontal Permeability (cm/s)	
	Baseline	Range
Cohesive Soil	$1 \times 10^{-5}$	$1 \times 10^{-4}$ to $1 \times 10^{-8}$
Non-cohesive Soil	$1 \times 10^{-1}$	$1 \times 10^{-1}$ to $1 \times 10^{-3}$

## 4 CONSTRUCTION CONSIDERATIONS

The following sections discuss the methods Lithos anticipates will be used by the Contractor during construction of the shafts and tunnel crossing. Discussed methods are not intended to dictate construction alternatives, but rather to provide Lithos' opinion of various challenges to reasonable construction methods based on our experience and general practice. Within the limitations provided in the Contract Documents, the Contractor is ultimately responsible for selecting shaft and tunnel excavation methods, shaft and tunnel support systems, and ground and surface water control plans. Of primary importance are the railroad lines, as there is limited shallow cover between their base and the crown of the casing pipe (between 6.5 and 8.0 feet) and have strict settlement requirements. Existing utilities as



shown on the Contract Drawings must be crossed without impacts, per the Contract Documents. The Contractor's means and methods must be designed to protect critical infrastructure and meet Project requirements.

The Contractor should notify and coordinate with all Project stakeholders and third parties in advance of shaft and tunnel construction per the Contract Documents. Third party reviews of the Contractor's construction plans and submittals may be required by the City of Arvada, UPRR, BNSF, RTD, or others, and the Contractor should allow time to address third party concerns and requirements.

#### 4.1 Shafts

Two construction shafts (a launch and receiving shaft) will be required for tunnel construction. Due to the location of a 60-inch diameter FRP storm drain immediately below the tunnel alignment and in close proximity to the northern shaft, and discussions with the CMGC, the anticipated direction of tunnel excavation is downhill from north to south. In this configuration the tunnel will proceed from the launch shaft on the north side of the railroad tracks to the receiving shaft on the south side. The optimal sizing and layout of each shaft will be at the Contractor's discretion and may be limited by the location of existing utilities; however, it is assumed the launch shaft will have approximate dimensions of 40 feet long (parallel to alignment) by 20 feet wide (perpendicular to alignment) with a depth extending to two feet below the tunnel invert. This assumes the Contractor will use 20-foot-long steel jacking pipe segments. It is assumed the receiving shaft will be used to recover mining equipment. The receiving shaft is assumed to have approximate dimensions of 20 feet long by 20 feet wide with a depth extending to two feet below the tunnel invert. If alternate sizing is used by the Contractor, the contractor shall notify the engineer for the relevant scaled baseline percentages.

The shafts will be excavated in cohesive soil and non-cohesive soil. See the individual geologic unit discussion in Section 3 for baselines regarding ground behavior. Table 4.1 below presents the relative baseline excavation volumes of each geologic unit that will be encountered during shaft excavation. For purposes of the baselines, shafts are assumed to extend two feet below the invert of the initial support.

**Table 4.1 – Baseline Shaft Excavation Volumes by Geologic Unit**

Geologic Unit	Shaft Excavation Volume (%)	
	Launch	Receiving
Cohesive Soil	90	90
Non-Cohesive Soil	10	10

Excavation is typically completed by hydraulic excavator for shaft depths up to approximately 20 feet. All excavated materials are anticipated to be rippable with conventional equipment. Blasting, hydraulic breakers, hoe rams, or other auxiliary equipment are not anticipated for the shafts on this project; however, the Contractor is advised to consider need based on the available geotechnical data and engineering properties baselined in Section 3. Shaft construction will need to resist loads from the soil such that movements of railroad tracks, ground surface, roads, and existing utilities are kept within specified tolerances. Additional loading conditions/requirements are presented by live rail (i.e. E-80 loading). When considering handling of excavated materials, or "muck," the Contractor needs to account for potential shrinkage and bulking which are defined as the change in volume of the soil from its in-situ condition following excavation, moisture conditioning, placement or compaction.

Unless watertight shafts are used, dewatering will be necessary for successful construction and use of the shafts. Dewatering internal to the shafts may be sufficient to keep groundwater levels manageable for construction. The Contractor is also encouraged to plan for a means of handling precipitation, internal nuisance or construction water as necessary, such as sump pumps in a gravel cutout.

A variety of ground support methods can be successful in this ground. Best practice in a shallow semi-urban environment will be to provide support as soon as practical after excavation in stages or concurrent with excavation. Possible methods include trench boxes, sheet piles, slide rail, soldier piles and lagging, or erected support. In the absence of groundwater, neither a concrete mud mat nor structural shaft invert plug are anticipated.

Shaft entry/exit eyes are often zones susceptible to over-excavation and running ground, particularly as a pipe or machine is jacked or rammed through the eye transition between shafts/tunnels. Over excavation at these points is often controlled by contact grouting of surficial materials immediately outside the shafts or incorporating a bulkhead which exposes no more ground than is necessary for excavation equipment to pass. The Contractor should assume entry/exit eyes may be accomplished with conventional means, such as torch-cutting a hole with an appropriate overcut to facilitate launch or retrieval of tunnel machinery or casing for excavations above the groundwater table. Lifting/raising plates/piles, or other support members at the excavation face for tunnels below groundwater will not be permitted unless they are sealed prior to lifting with a cast-in-place entry or exit wall. Other means, such as dewatering, portal stabilization, or gasketed concrete eyes, are not anticipated to be required in the absence of groundwater.

## 4.2 Tunnel

There are several different tunneling methods available for the excavation installation of the casing pipe on this crossing, however working with the design team and the CMGC contractor this GBR focuses the contractor preference for using a Tunnel Boring Machine (TBM). Should an alternative method be identified this GBR should be updated for that approach. Due to the regulatory reequipments from the railroads the Initial Support must employ a jacked steel casing. FRP carrier pipe will be installed in a second pass, followed by backfill grouting of the annulus and contact grouting of the overcut.

The tunnel will be driven downhill from north to south on a 0.29% grade. This alignment is to reduce the risk that the tunnel does not intersect the existing 60-inch diameter FRP storm drain located immediately below the tunnel alignment and in close proximity to the northern launch shaft. The contractor shall make the necessary adjustments to facilitate a downhill drive.

The tunnel will be excavated within cohesive soil and non-cohesive soil. Mixed face conditions are expected to be encountered with harder/denser non-cohesive soil below the relatively softer cohesive soil. These mixed face conditions may cause the tunnel to deflect upwards into the cohesive soil. The Contractor should anticipate minor changes of material content within the ranges portrayed by the GDR and unlikely to affect baseline parameters and ensure a means of controlling the excavation face such that sinkholes or adverse settlement of the railroad and utilities does not occur.

The table below presents baseline excavation volumes of each geologic unit that will be encountered during tunnel excavation. The baselines specific to subsurface characteristics and ground behavior are included in Section 3.

**Table 4.2 – Baseline Tunnel Excavation Volumes by Geologic Unit**

Geologic Unit	Tunnel Excavation Volume (%)
Cohesive Soil	95
Non-Cohesive Soil	5

Based on drilling observations and regional geology, cobbles are expected to be encountered during tunnel excavation. For bidding and baseline purposes, the Contractor shall assume:

- A maximum cobble volume ratio of 10%;
- 100% of cobbles will have a maximum dimension of 10 inches;
- Cobbles will have a maximum unconfined compressive strength (UCS) of 15,000 psi and maximum Cerchar Abrasivity Index (CAI) of 4.0;
- Cobbles will be sub-angular to sub-rounded;
- Cobbles will be isolated.

With pipe jacking a TBM a properly selected jacking frame shall be sufficient to install the casing pipe under tolerable jacking loads in the baselined ground conditions and for the length and diameter of the proposed tunnel using construction best-practices. While the Contractor is responsible for selecting means and methods appropriate to the ground conditions and tunnel layout within the limitations set by the contract documents, use of an Intermediate Jacking Station (IJS) is not anticipated for this tunnel. The cutterhead of the TBM shall have the ability to close the face to limit overexcavation, settlement, and the inflow of groundwater if encountered.

It is important the Contractor closely monitors tunnel excavation out of the launch shaft and into the receiving shaft. These locations are often where ground loss into the shaft and over-excavation of ground occurs due to disturbance from shaft construction, which can create surface settlement and/or sinkholes. If not controlled, the settlement trough can follow the path of excavation and extend beyond the immediate vicinity of the shaft and into areas where settlement control is critical, such as the railroad tracks.

### 4.3 Pre-Excavation Grouting

Pre-excavation grouting is a form of ground improvement that increases the strength and improves the behavior of the soil, making it more conducive to excavation. It is commonly used to reduce settlement, particularly in granular soils. For this project, pre-excavation grouting is not recommended as the ground conditions are not suitable. The soils contain between 50% to 70% fines, making them ill suited to grouting. Additionally, the use of pre-excavation grouting within this soil has a high risk of causing subsequent ground heave at the surface and displacement of the railroad tracks and or roadway.

### 4.4 Environmental Considerations

Measurement of subsurface gas was not completed or noted during the subsurface investigation. For baseline purposes, material encountered during shaft and tunnel excavation shall be considered “Potentially Gassy” per OSHA 3115-06R (2003).

Contaminated ground water was noted during environmental site assessments within the groundwater in the crossing vicinity. For baseline purposes, extra precautions or measures will be required to handle,

treat, or dispose of contaminated ground. The Contractor shall review the Contract Documents for information regarding the recorded contaminants and disposal requirements.

## 5 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings and geotechnical laboratory testing performed by others, information provided by the client, engineering judgement, and our experience with similar subsurface conditions and projects.

This report has been prepared exclusively for our client for design, bidding, and construction purposes for the subject project. Lithos is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects.

The baseline values presented in this report are only intended for the proposed design and construction as understood by Lithos at the time of issuing this report. If the proposed design and construction changes, Lithos should be notified immediately and given the opportunity to review the proposed changes and if necessary, modify our baseline values presented herein.

An environmental assessment was not included in Lithos' scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

## 6 REFERENCES

References listed herein are included as information only. The Contractor may not rely upon the provided references as baseline statements in any phase of the project.

- American Society of Civil Engineers, 2022, *Geotechnical Baseline Reports, Suggested Guidelines*, prepared by the Task Committee on Geotechnical Baseline Reports, edited by Randall Essex.
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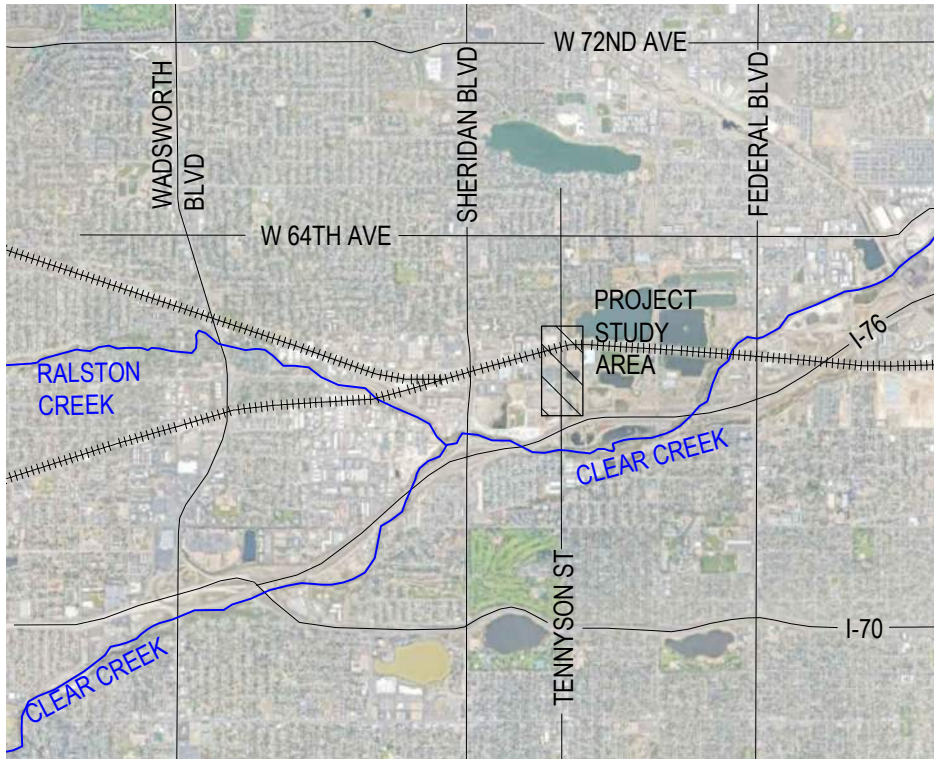
Lithos Engineering, 2023, *Geotechnical Data Report - North Trunk Sewer Improvements – Tennyson and 58th*

Occupational Safety and Health Administration, 2003, *Underground Construction (Tunneling)*, United States Department of Labor, OSHA 3115-06R.

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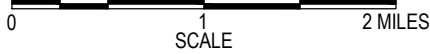


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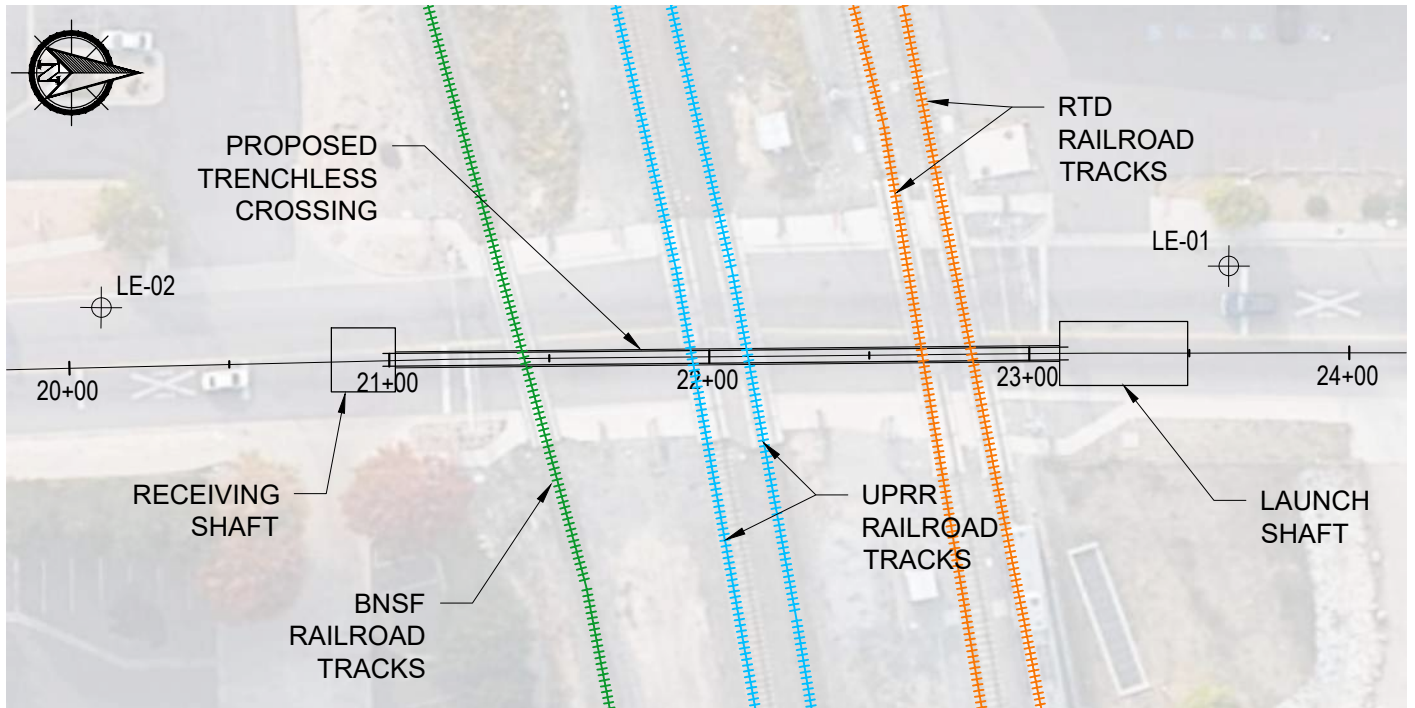


LEGEND:

- BORING LOCATION
- ROADWAYS
- RIVERS AND CREEKS
- RAILROAD TRACKS



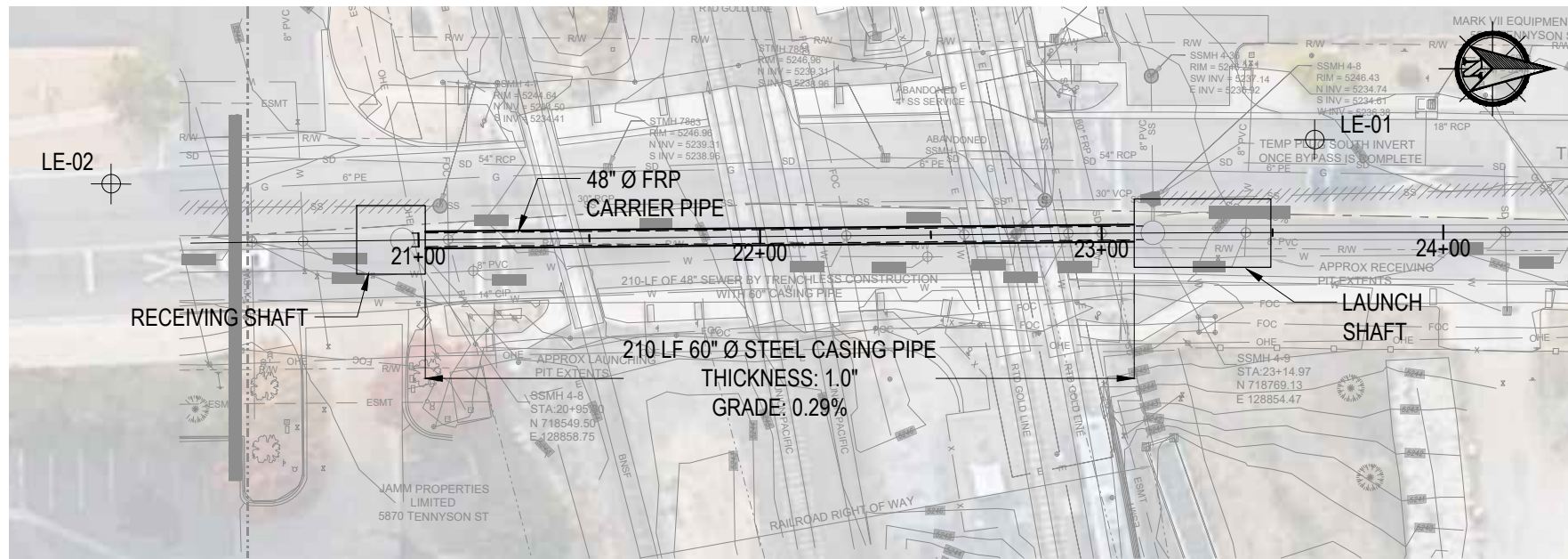
REGIONAL OVERVIEW MAP



SITE VICINITY MAP

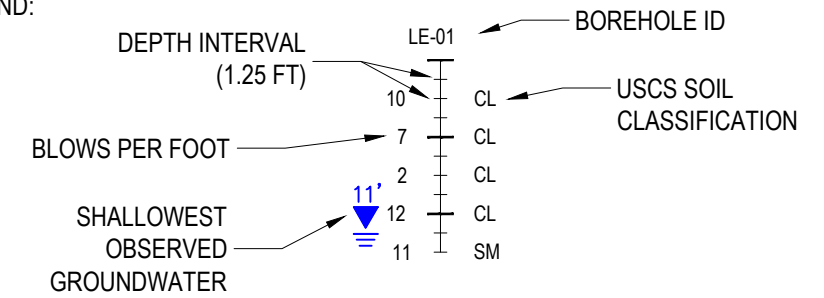
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NOT FOR  
CONSTRUCTION

 5205 S. COLLEGE AVENUE, SUITE B FORT COLLINS, COLORADO 80525 970.373.3195	PROJECT TITLE	NORTH TRUNK SEWER IMPROVEMENTS - TENNYSON AND 58TH	OWNER	 CITY OF ARVADA	CLIENT	 Kennedy Jenks	FIGURE NUMBER	1					
	DRAWING TITLE	SITE VICINITY MAP	PROJECT NO.:	20088	DRAWN BY:	AM	LOCATION:	ARVADA, CO	DESIGNED BY:	JC	DATE:	11/13/2023	CHECKED BY:



TENNYSON AND 58TH PLAN

**BORHOLE LEGEND:**

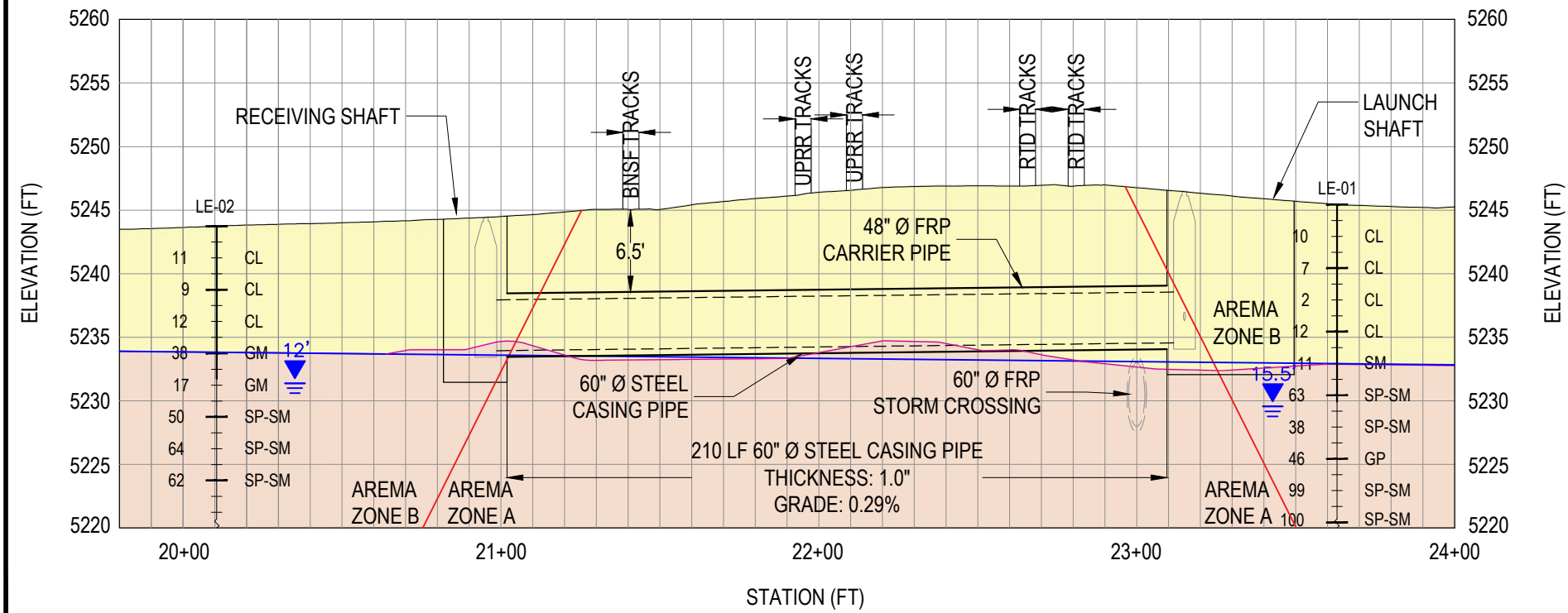


**BASELINE GEOLOGIC UNITS:**

- COHESIVE SOIL
- NON-COHESIVE SOIL

**LINE TYPES AND SYMBOLS LEGEND:**

- CASING PIPE
- CARRIER PIPE
- INTERPRETED GEOLOGIC CONTACT
- BASELINE GROUNDWATER ELEVATION
- AREMA TEMPORARY SHORING ZONE DIVIDING LINE
- APPROXIMATE BORING LOCATION



TENNYSON AND 58TH GEOLOGIC PROFILE  
 HORIZONTAL 1" = 50'  
 VERTICAL 1" = 12.5'

**NOTES:**

1. 4:1 VERTICAL EXAGGERATION
2. ALIGNMENT AND INFRASTRUCTURE ARE AS SHOWN IN CONTRACT DOCUMENTS AND ARE PROVIDED HEREIN FOR INFORMATIONAL PURPOSES ONLY.
3. BOREHOLES ARE AS SHOWN IN THE PROJECT GEOTECHNICAL DATA REPORT (GDR) AND PROVIDED HEREIN FOR INFORMATIONAL PURPOSES ONLY.
4. BASELINE GROUNDWATER TABLE IS LOCATED APPROXIMATELY AT THE CONTACT OF THE COHESIVE AND NON-COHESIVE SOILS.

DRAFT:  
NOT FOR  
CONSTRUCTION

 5205 S. COLLEGE AVENUE, SUITE B FORT COLLINS, COLORADO 80525 970.373.3195	PROJECT TITLE	NORTH TRUNK SEWER IMPROVEMENTS TENNYSON AND 58TH		OWNER	CLIENT	FIGURE NUMBER
	DRAWING TITLE	GEOLOGIC PROFILE - RAILROAD CROSSING		PROJECT NO.:	DRAWN BY:	
DATE:	LOCATION:	DESIGNED BY:	CHECKED BY:	ARVADA, CO	AM	
11/15/23	ARVADA, CO	JC	RD	22134	RD	

DRAFT

### Tunnelman's Ground Classification Chart (Soil)

Classification	Behavior	Typical Soil Types
<b>Firm</b>	Material at the face is stable and holds a vertical face unsupported.	Hard clay, cemented sand
<b>Slow Raveling</b>	Material ravel from the face within hours after the ground has been exposed.	Sands with fines, fine sands above water table
<b>Fast Raveling</b>	Material ravel from the face within minutes after the ground has been exposed.	Sands with fines, fine sands below water table
<b>Squeezing</b>	Soil slowly advances into tunnel without signs of fracturing	Soft to stiff clays where the overburden pressure is higher than the soil shear strength
<b>Swelling</b>	Soil moves slowly into tunnel, associated with a considerable volume increase in the ground surrounding the tunnel	Highly overconsolidated high plasticity clays
<b>Cohesive Running</b>	Preceded by brief period of raveling, soil will then "run" like a granulated sugar until the slope angle reaches its angle of repose	Clean, fine, moist sand
<b>Running</b>	Immediately upon exposure, the soil will "run" like a granulated sugar until the slope angle reaches its angle of repose	Clean, coarse or medium sand above water table
<b>Flowing</b>	Flows as a mixture of soil and water into the heading.	Silt, sand, and gravel beneath the water table without fines





## **GEOTECHNICAL DATA REPORT**

***NORTH TRUNK SEWER IMPROVEMENTS – TENNYSON AND 58<sup>TH</sup>***  
**ARVADA, COLORADO**

**November 2023**



November 30, 2023  
22134



Kennedy Jenks Consultants, Inc.  
165 South Union Boulevard  
Arvada, CO 80003

Attention: Jerry Pena, PE  
Client Director

Regarding: Geotechnical Data Report  
North Trunk Sewer Improvements – Tennyson and 58<sup>th</sup>  
Arvada, Colorado

Mr. Pena,

Submitted herewith is the Geotechnical Engineering Investigation for the North Trunk Sewer Improvements – Tennyson and 58th project. This study was conducted in accordance with our contract between Lithos Engineering and Kennedy Jenks Consultants, Inc. (KJ) dated October 3rd, 2022. This report contains the results of our findings, an engineering interpretation with respect to the available project characteristics, and recommendations to aid design and construction of earth-related phases of this project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,  
**Lithos Engineering**

Adam Malsam, EIT  
Staff Engineer

James Carroll, PE  
Project Manager

Robin Dornfest, PG  
President

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<u>Figure Number</u>	<u>Title</u>
1	Site Vicinity and Boring Location Map

## APPENDICES

<u>Appendix</u>	<u>Title</u>
A	Standard Geotechnical Drilling Keys and Boring Logs
B	Geotechnical Laboratory Testing Results
C	Water Quality Testing Results

## 1 INTRODUCTION

The North Trunk Sewer Improvements – Tennyson and 58th (Project) includes the installation of approximately 3,600 feet of new sanitary sewer main to meet the demand for increased capacity. The Owner of the Project is The City of Arvada (Arvada) and the lead engineer for the project is Kennedy Jenks (KJ). KJ retained Lithos to function as the Project's geotechnical and tunnel design engineer. The purpose of this report is to provide data collected during the Geotechnical Investigation at the Project site. The following sections generally describe the site and proposed construction.

### 1.1 Site Description

The Project site is located in Adams County, Colorado along Tennyson Street approximately between the intersection with W 61<sup>st</sup> Place and the underpass of Interstate 76 (Figure 1). This stretch of Tennyson Street consists of a mixture of residential and industrial uses and parks. Historically, this area served as a source of aggregate, and many gravel ponds were created as aggregates were extracted. Today, many of these gravel pits have been reclaimed and used for other purposes, though several remain.

### 1.2 Proposed Construction

A new gravity sanitary sewer main is needed to meet expected increases in required capacity. The proposed sewer will tie into an existing 30-inch sanitary sewer at the intersection of N. 61<sup>st</sup> Place and Tennyson St and will continue south beneath Tennyson St to a vault just north of the I-76 underpass. This alignment will necessitate crossing beneath five railroad tracks belonging to the Regional Transportation District (RTD), Union Pacific (UP) and Burlington Northern and Santa Fe (BNSF) along the way. Open cut trenches will be used to install most of this alignment, but trenchless techniques will be required to install the new sewer main beneath the railroad tracks without disrupting railroad operations. The proposed tunnel crossing beneath the railroad tracks includes the following properties:

- 48-inch FRP carrier pipe
- 0.24% grade
- Minimum depth of cover: 6 feet
- 60-inch steel casing pipe
- Approximately 210-feet long

Tunnel properties are based upon the 60% submittal drawings by KJ and may be adjusted as the design moves forward.

## 2 GEOLOGIC SETTING

### 2.1 Regional Geology

Geologically, the site is located within the historic floodplain of Clear Creek. The position of Clear Creek has changed several times over many years within this floodplain with gravel, sand, silt, and clay having been deposited as the creek has meandered. Lindvall (1979) mapped these deposits as Post Piney Creek Alluvium, which is described as being predominately composed of sands and silts within the floodplains of Clear Creek and the South Platte River. Below this alluvium, Lindvall (1979) has mapped the Denver Formation, which outcrops along the south bank of Clear Creek and near the intersection of W 64<sup>th</sup> St and Tennyson St. The Denver Formation is described as containing interbedded claystone, sandstone, and siltstone with the claystone being prone to swelling when wet. Lindvall (1979) also notes the presence of



artificial fill along Tennyson St. associated with the construction of the railroad tracks discussed in section 1.1.

### 3 GEOTECHNICAL INVESTIGATION

Lithos conducted a geotechnical investigation for the Project consisting of a subsurface investigation and a geotechnical laboratory testing program. The subsurface investigation included two borings for the proposed tunnel crossing and two borings for the open-cut sections of the pipeline. Borings were drilled on January 27<sup>th</sup>, 2023. Boring locations are included in Figure 1. Results from the subsurface investigation and the laboratory testing program are presented in Section 4.

#### 3.1 Subsurface Investigation

Geotechnical borings LE-01 and LE-02 are associated with the proposed tunnel crossing and were drilled to depths of 31.5 feet below the existing ground surface (BGS). Geotechnical borings LE-03 and LE-04 are associated with the open cut portion of the new pipeline and were advanced to depths of 16.5 feet BGS. Lithos subcontracted geotechnical drilling to a qualified local subcontractor who utilized a truck-mounted CME-75 rig. Drilling and sampling procedures were conducted in general accordance with the ASTM standards identified in the following table:

Subsurface Investigation ASTM Standards	
Procedure	ASTM Standard
<i>Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils</i>	D 1586
<i>Standard Practice for Thick Wall, Ring-Line, Split Barrel, Drive Sampling of Soils</i>	D 3550

Continuous-flight, hollow-stem augers were used to advance borings LE-01 and LE-02 below the existing ground surface and through surficial soil deposits. Hollow stem augers were used in this instance as the borings were converted to temporary groundwater monitoring wells upon completion so that repeat water level measurements could be taken and water samples could be collected for testing. Continuous-flight solid stem augers, meanwhile, were used to advance borings LE-03 and LE-04. During boring advancement, Modified California (2.0-inch inner diameter) or split-spoon (1.5-inch inner diameter) samples were obtained in 2.5-foot intervals. The modified California barrel sampler was utilized to obtain relatively undisturbed samples of cohesive materials. The split-spoon sampler was used to obtain disturbed samples of non-cohesive materials. The number of blows by a 140-pound hammer falling 30 inches required for 12 inches of sampler penetration (recorded in 6-inch increments) are presented on the boring logs (Appendix A). Blow counts with less than 6 inches of penetration are presented showing the number of blows for the resulting depth of penetration ( $50/2'' = 50$  blows to drive the sampler 2 inches).

#### 3.2 Geotechnical Laboratory Testing

A geotechnical laboratory testing program was developed by Lithos on representative samples collected during the subsurface investigation. A laboratory summary table and graphical testing results are provided in Appendix B. Laboratory tests conducted in general accordance with associated ASTM standards are presented in the table below.

Geotechnical Laboratory Testing	
Test	Standard
Grain Size Distribution	ASTM D422
#200 Sieve Wash	ASTM D1140
Swell / Consolidation	ASTM D4546
Atterberg Limits	ASTM D4318
Moisture Content & Dry Density	ASTM D2216 & D2937

If field characterized soil and bedrock descriptions differed from results indicated by laboratory classification testing, the boring logs presented in Appendix A were amended to reflect laboratory testing results.

### 3.3 Groundwater Testing

Groundwater samples were collected from the temporary wells installed at LE-01 and LE-02 on February 24<sup>th</sup>, 2023. Laboratory testing was conducted on these water samples to determine the concentration of trace elements and evaluate contaminants. Tests conducted are presented in the table below. Results of groundwater laboratory testing are presented in Appendix C.

Water Quality Laboratory Testing	
Test	Standard
Determination of Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry	EPA 245.7
Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Atomic Emission Spectrometry	EPA 200.7
Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry	EPA 200.8
Determination of Hexavalent Chromium by Colorimetric Method	SM 3500-CR B

## 4 SUBSURFACE CONDITIONS

Subsurface conditions were assessed based on the findings of the geotechnical investigation described in the previous section. Soil descriptions noted on the boring logs and below are in general accordance with ASTM D 2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and D 2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

### 4.1 Subsurface Materials

Primary materials encountered during the subsurface investigation include fill, fine alluvium, and coarse alluvium. Bedrock was not encountered in any of the four borings. Boring logs, including a supplementary boring log key explaining boring log details and additional details regarding sampled materials, are provided in Appendix A.

#### 4.1.1 Fill

Fill was encountered beneath the pavement section (4.5" asphalt, 6" base coarse) in LE-01 and LE-02. Fill extended from the bottom of this pavement section to 2.0 to 2.5 feet BGS. Fill was classified as the following in accordance with USCS:

- Clayey Sand (SC)
- Poorly Graded Sand with Clay (SP-SC)

Fill contained few to mostly fine to coarse sand, little fine to coarse gravel, and few to little clay. Based on recorded blow-counts, fill density is medium dense.

#### 4.1.2 Fine Alluvium

Fine alluvium was encountered in all borings and ranged in depth from the surface or base of fill to 7.5 to 13.3 feet BGS. Fine alluvium was classified as the following in accordance with USCS:

- Lean clay (CL)
- Silt (ML)

In addition to the fine soil grains, fine alluvium also contained few to some fine to coarse sand and occasional trace to few fine to coarse gravel (maximum 2.0-inch diameter). Based on recorded blow-counts, fine alluvium density may generally be described as being medium stiff to stiff, though two samples (out of 15) returned relative densities of very soft to soft. Interbedded layers of sandy silt ranging in thickness from approximately 0.5 to 2.0 feet were documented within the fine alluvium in LE-04 on the southern edge of the project area.

#### 4.1.3 Coarse Alluvium

Coarse alluvium was encountered in all borings and ranged in depth from the base of fine alluvium to the end of exploration between 16.5 and 31.5 feet bgs. Coarse alluvium was classified as the following in accordance with USCS:

- Silty Sand (SM)
- Poorly Graded Sand with Silt (SP-SM)
- Poorly Graded Gravel (GP)
- Silty Gravel (GM)
- Poorly Graded Sand (SP)
- Poorly Graded Sand with Clay (SP-SC)
- Clayey Sand (SC)

Generally, coarse alluvium was some combination of sand and gravel with few to some fines (either clay or silt) present. Flowing behavior was noted at times within the coarse alluvium based on the drilling behavior. Based on recorded blow-counts, the density of coarse alluvium ranges from medium stiff to very dense. Interbedded layers of lean clay approximately six-inches thick were documented within the coarse alluvium in LE-01.

## 4.2 Groundwater

Groundwater was encountered during the subsurface investigation in all borings at depths ranging from 8 to 17 feet bgs. Temporary monitoring wells were installed in borings LE-1 and LE-02 to measure seasonal changes in the groundwater table elevation, collect groundwater readings through design and prior to construction, and collect water samples for testing. The table below presents initial groundwater levels in the borings at the time of drilling.

Groundwater Depth							
Boring	Depth BGS (ft)						
	01/27/23	03/02/23	04/10/23	05/03/23	06/06/23	07/06/23	08/10/23
LE-01	17.0	19.2	18.2	18.0	15.75	15.45	16.15
LE-02	13.8	15.0	15.1	14.7	12.45	12.0	12.8
LE-03	11.5	--	--	--	--	--	
LE-04	8.0	--	--	--	--	--	

Groundwater should be expected to fluctuate based on precipitation, localized irrigation, water levels in nearby water bodies and irrigation ditches, site development, and seasonal variations.

## 5 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings, geotechnical laboratory testing, information provided by the Client, engineering judgement, and our experience with similar subsurface conditions and projects. The boring logs presented in this report only depict the subsurface conditions at the actual boring locations. Subsurface conditions are typically variable, both laterally and vertically, and the nature and extent of the subsurface variations across the site may not become evident until construction. The boundaries between different soil types presented in this report are approximate, and in some cases may be more abrupt or gradational than described herein. Groundwater levels may vary with time, adjacent water source levels, precipitation, and changes to the hydrogeological conditions at or surrounding the project site.

This report has been prepared exclusively for our client for design purposes for the subject project. Lithos Engineering is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects. If differing site conditions are encountered during further evaluation of the subsurface conditions by others or during construction, Lithos Engineering should be notified immediately to determine if any changes to our recommendations presented in this report are warranted.

An environmental assessment was not included in Lithos Engineering scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos Engineering recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

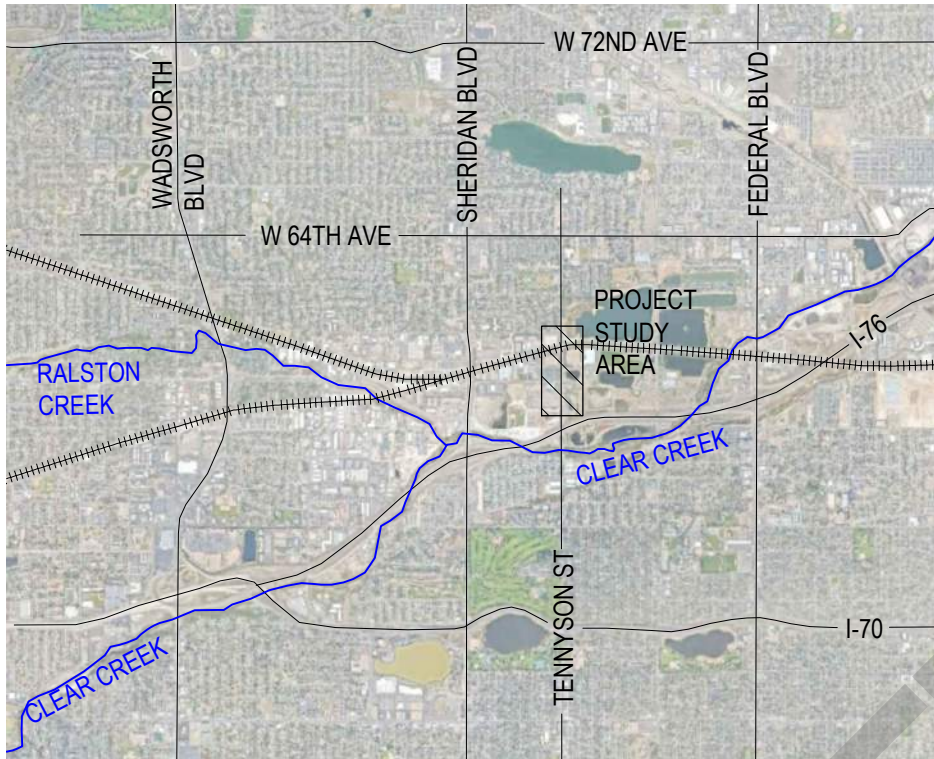
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- Lindvall, R.M. (1979). *Geologic map of the Arvada quadrangle, Adams, Denver, and Jefferson Counties, Colorado*, US Geological Survey, Geological Quadrangle Map GQ-1453
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LEGEND:

- BORING LOCATION
- ROADWAYS
- RIVERS AND CREEKS
- RAILROAD TRACKS

0 1 2 MILES  
SCALE

REGIONAL OVERVIEW MAP



0 1000 2000 FT  
SCALE

SITE VICINITY MAP

**LITHOS**  
ENGINEERING  
2750 S. WADSWORTH BLVD, SUITE D-200  
DENVER, COLORADO 80227  
303.625.9502

PROJECT TITLE  
DRAWING TITLE

NORTH TRUNK SEWER  
IMPROVEMENTS - TENNYSON AND  
58TH  
SITE VICINITY AND BORING  
LOCATION MAP

OWNER



CLIENT



FIGURE NUMBER

**FIG.1**

PROJECT NO.: 20088  
LOCATION: ARVADA, CO  
DATE: 02/09/2023

DRAWN BY: AM  
DESIGNED BY: JC  
CHECKED BY: BS



# BORING LOG KEY

## STANDARD GEOTECHNICAL DRILLING

### Soil Classifications:

Clear Square Sieve Openings		U.S. Standard Series Sieve Sizes					
12"	3"	3/4"	4	10	40	200	
Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	
300mm	75mm	19mm	4.75mm	2.0mm	0.42mm	0.075mm	

Gradation Estimates by Field Observation	
Description	Quantity (%)
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	> 50

Relative Density or Consistency of Non-cohesive and Cohesive Soils			
Non-cohesive Soils		Cohesive Soils	
Classification	Blows per 12 in	Classification	Blows per 12 in
Very Loose	0 to 4	Very Soft	0 to 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11-30	Medium Stiff	5 to 8
		Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	>50	Hard	>30

**Color:** Sample colors are in general accordance with basic brown, red, yellow, and gray combinations

Description of Moisture	
Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil below the groundwater table

Description of Odor	
Description	Criteria
No Organic Odor	Organic odor is not present
Trace Organic Odor	Mild organic odor; mixture of soil and organics
Strong Organic Odor	Prominent organic odor; sample is primarily organic

Plasticity	
Description	Criteria
Nonplastic	A $\frac{1}{8}$ " diameter thread cannot be rolled
Low	A $\frac{1}{8}$ " in diameter thread can be rolled with difficulty; a lump cannot be formed at a moisture lower than the plastic limit
Medium	A $\frac{3}{8}$ " in diameter thread can be rolled easily; a crumbly lump can be formed at a moisture lower than the plastic limit
High	A $\frac{3}{8}$ " in diameter thread can be rolled very easily; a lump can be formed at a moisture lower than the plastic limit

Cementation	
Description	Criteria
Weak	Crumbles with light finger pressure
Moderate	Crumbles with considerable finger pressure
Strong	Will not crumble with finger pressure

### Rock Descriptions:

Weathering	
Description	Criteria
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration of rock material on discontinuity surfaces.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones.
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Texture	
Description	Criteria
Very Fine Grained	Grains not individually visible to the unaided eye
Fine Grained	Grains barely visible to the unaided eye, up to $\frac{1}{16}$ " diameter
Medium Grained	Grain diameter between $\frac{1}{16}$ " and $\frac{3}{16}$ "
Coarse Grained	Grains diameter between $\frac{3}{16}$ " and $\frac{1}{4}$ "
Very Coarse Grained	Grains larger than $\frac{1}{4}$ " in diameter

Field Hardness	
Description	Criteria
Very Hard	Cannot be scratched with a knife or sharp pick.
Hard	Can be scratched with a knife or pick only with difficulty
Medium	Can be gouged $\frac{1}{16}$ " deep by firm pressure on knife or pick point
Soft	Can be grooved or gouged readily with knife or pick point
Very Soft	Can be carved with knife and scratched readily by fingernail

### Geologic Interpretation:

A **Geologic Interpretation** of encountered soil and bedrock units is provided for each specific **Visual Material Description**. Examples of geologic interpretations for soil that may be presented include: FILL, ALLUVIUM, AEOLIAN, AND GLACIAL TILL, AND RESIDUUM. Rock geologic interpretations are referenced based on a combination of field classifications and applicable geologic maps.

### Sample Graphics and Descriptions:

- California Barrel Sampler: Barrel sampler loaded with sample liners and driven to collect a relatively representative and intact specimen of soil or weak rock.
- Split-Spoon Sampler: Split-barrel sampler driven in accordance with ASTM D1586 used to provide visual material descriptions and collect a disturbed specimen.
- Shelby Tube Sampler: Thin wall tube hydraulically pushed into the subsurface to collect a representative and intact specimen of soil.
- Bulk Sample: Bulk or bagged sample taken from auger cuttings.
- Continuous Sampler: A 5-foot long sampler barrel that is driven to collect a continuous 5-foot run of cohesive and non-cohesive soil.

### Groundwater Monitoring Well Graphics:

- Riser Pipe with Auger Cuttings
- Well Screen with Silica Sand
- Riser Pipe with Silica Sand
- Riser Pipe with Bentonite Chips
- Auger Cuttings
- Stick-Up Well
- Flush Mounted Cap
- First Groundwater Reading
- Second Groundwater Reading
- Third Groundwater Reading

### Boring Graphics:

Below are the primary boring log graphics. Any classification combinations will result in a combination of graphics.

- Fill
- Lean Clay
- Silt
- Fat Clay
- Elastic Silt
- Well Graded Gravel
- Poorly Graded Gravel
- Well Graded Sand
- Poorly Graded Sand
- Sandstone
- Claystone
- Siltstone

# BORING: LE-01

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.80495, -105.044092\*  
 Boring Elevation: 5,249.0-feet\*  
 Notes: \*Location and Elevation approximate.

### Sampling Data

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)	Geologic Graphic
0						<b>PAVEMENT SECTION</b> Asphalt: 4.5-inches Base: 6.0-inches
0.9						<b>FILL</b> Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, little fine to coarse gravel, few clay, medium dense, olive brown, moist, iron oxidation.
2.5	5247.5	22 16 13	6 4	6		<b>FINE ALLUVIUM</b> LEAN CLAY (CL), few fine to coarse sand, trace fine gravel, stiff, olive brown, moist.
5	5245	3 4	10			LEAN CLAY with sand (CL), little to some fine to medium sand, trace fine gravel, medium stiff, olive brown, moist.
7.5	5242.5	1 1	11			As above except very soft, olive brown to dark blueish gray.
10	5240	4 8	11			LEAN CLAY (CL), few fine to coarse sand, stiff, olive brown, moist.
12.5	5237.5	4 7	10			As above.
13.3						<b>COARSE ALLUVIUM</b> Silty SAND (SM), mostly fine to medium sand, little silt, loose, olive brown to yellowish brown, moist, iron oxidation.
15	5235	30				Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt.

### Visual Material Description

Soil:  
 -GEOLOGIC INTERPRETATION-  
 USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:  
 -GEOLOGIC INTERPRETATION-  
 Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

### Laboratory Testing Results

Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA					Strength & Compressibility			
	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
	26.1	95.7			71.4	41	23				
	32.9	87.9			71.1	43	26		N/A	-0.4	
	29.2	93.4									

#### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days		17.0-feet



# BORING: LE-01

Project Name: N.TSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

# Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.80495, -105.044092\*  
 Boring Elevation: 5,249.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States	INDEX DATA					Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
12	5232.5	30 33		12		very dense, pale olive, moist, calcite, maximum particle size 1.25-inches.				40.4	49.6	10	NV	4			
17.5				12		As above except wet.											
20	5230	12 16 22		12		Poorly graded GRAVEL with sand (GP), mostly fine to coarse gravel, some fine to coarse sand, trace silt, dense, pale olive, wet, maximum particle size 2.0-inches.	2.8	158.5	63.6	31.8	4.6						
22.5	5227.5	21 25		12		Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt, very dense, pale olive to olive brown, wet, calcite, maximum particle size 1.25-inches. LEAN CLAY Interlayer (CL), few fine sand, olive brown, moist.											
25	5225	49 50		4		Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt, very dense, pale olive to olive brown, wet, calcite, maximum particle size 1.25-inches.											
27.5	5222.5	49 50 50		18		Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt, very dense, pale olive to olive brown, wet, calcite, maximum particle size 1.25-inches.											
30	5220	27 50/5"		18		Poorly graded SAND with gravel (SP), mostly fine to coarse sand, some fine to coarse gravel, trace silt, very dense, olive brown, wet, maximum particle size 1.25-inches.											
30	5217.5	49 33 27		11		Clayey SAND with gravel (SC), mostly fine to coarse sand, little fine to coarse gravel, little clay, very dense, pale olive, wet, maximum particle size 1.0-inches.											

### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data:	Depth to Groundwater:
01/27/23	0-days	17.0-feet

**BORING: LE-01**

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

**Drilling and Sampling Methods**

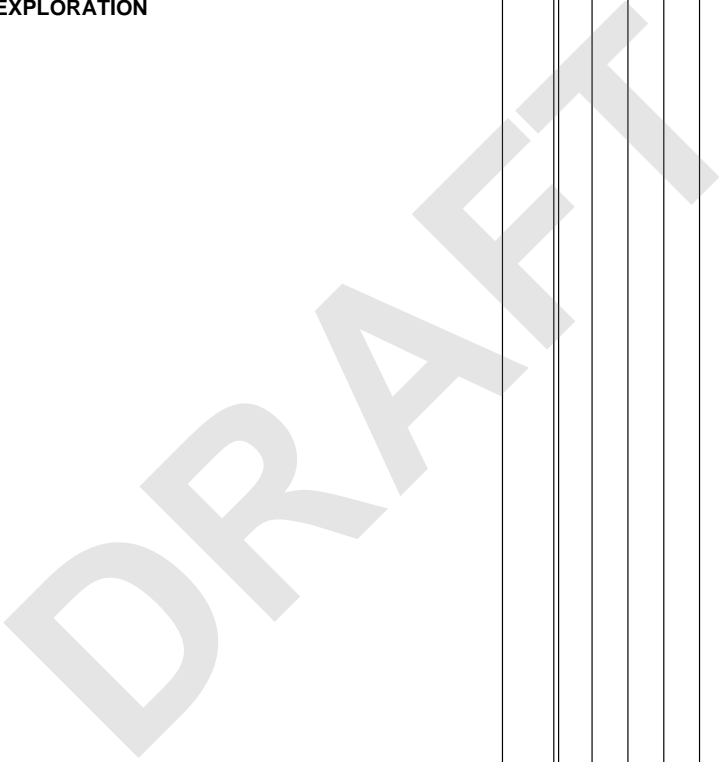
Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.80495, -105.044092\*  
 Boring Elevation: 5,249.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data						Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results									
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)			Geologic Graphic	In-Situ States	INDEX DATA					Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
	5217.5																
	32.5																
	5215																
	35																
	5212.5																
	37.5																
	5210																
	40																
	5207.5																
	42.5																
	5205																
	45																
	5202.5																

**END OF EXPLORATION** 31.5 ft.



**General Notes:**

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days		17.0-feet

# BORING: LE-02

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.804011, -105.044089\*  
 Boring Elevation: 5,247.0-feet\*  
 Notes: \*Location and Elevation approximate.

### Sampling Data

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)	Geologic Graphic
0						<b>PAVEMENT SECTION</b> Asphalt: 4.5-inches Base: 6.0-inches
0.9						<b>FILL</b> Clayey SAND with gravel (SC), mostly fine to coarse sand, little fine gravel, little clay, medium dense, olive brown, moist.
2.5	5245	11 6	18			<b>FINE ALLUVIUM</b> Sandy LEAN CLAY (CL), some fine to coarse sand, few fine to coarse gravel, very stiff, olive to dark brown, moist. As above except mottled olive to olive brown.
5	5242.5	6 7	10			As above except mottled olive to olive brown.
7.5	5240	4 5	12			As above except no gravel, olive gray, iron oxidation, calcite.
10	5237.5	5 7	10			<b>COARSE ALLUVIUM</b> Silty GRAVEL with sand (GM), mostly fine to coarse gravel, little to some fine to coarse sand, little silt, dense, yellowish brown, moist, iron oxidation, maximum particle size 2.0-inches.
12.5	5235	15 23	10			As above except medium dense.
15	5232.5	7 10	9			Poorly graded SAND with silt and gravel (SP-SM), mostly fine to coarse sand, little to some fine to coarse gravel, few silt,
15		28				

### Visual Material Description

Soil:  
 -GEOLOGIC INTERPRETATION-  
 USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:  
 -GEOLOGIC INTERPRETATION-  
 Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Groundwater Depth / Monitoring Well Configuration

### Laboratory Testing Results

In-Situ States		INDEX DATA					Strength & Compressibility			
Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
18.1	104.3				53.5	35	20	N/A		0.0
5.2	130.6									
12.1	117.7		56.1	25.7	18.2	NV	NP			

#### General Notes:

- Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data: Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	13.8-feet

# BORING: LE-02

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.804011, -105.044089\*  
 Boring Elevation: 5,247.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results													
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)				Drilling Rate (min./ft.)	In-Situ States	INDEX DATA					Strength & Compressibility						
						Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions															
						Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions															
50						very dense, dark brown, wet, maximum particle size 2.0-inches.															
5230						As above except olive, maximum particle size 1.25-inches.															
17.5			24	32	32																
5227.5						As above except olive, maximum particle size 1.25-inches.															
20			17	28	34																
5225																					
22.5																					
5222.5						As above except olive, maximum particle size 1.25-inches.															
25			27	50/1"	6																
5220																					
27.5																					
5217.5						As above except dense, olive, maximum particle size 1.25-inches.															
30			15	19	15																

### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		
Date:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	13.8-feet

# BORING: LE-02

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

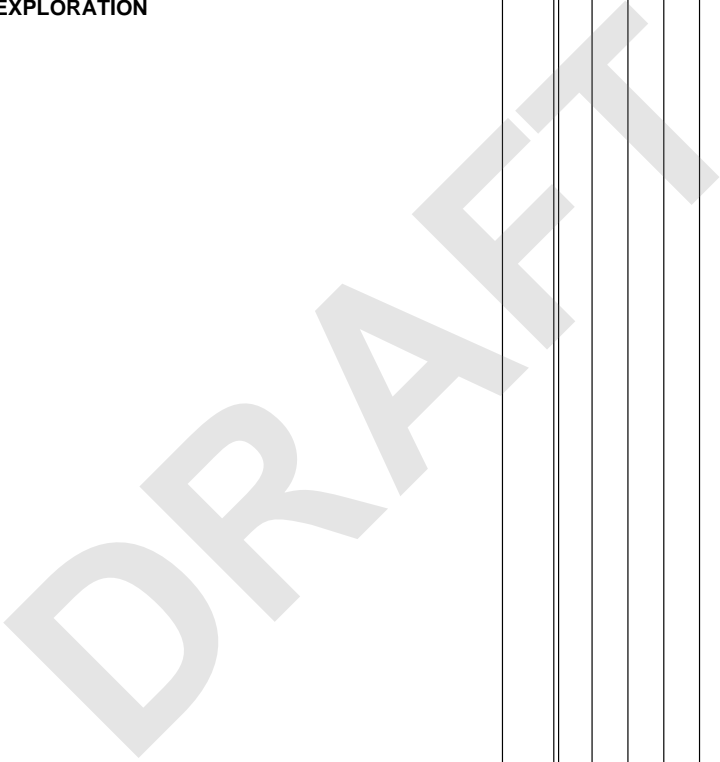
## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.804011, -105.044089\*  
 Boring Elevation: 5,247.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data						Visual Material Description						Laboratory Testing Results											
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions  Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions						Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA				Strength & Compressibility			
														Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)
31.5	5215						<b>END OF EXPLORATION</b>																



**General Notes:**  
 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)  
 2) The maximum particle size identified in the material description is dependent on sampler dimensions.  
 3) Additional information is provided on the Boring Log Key.  
 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:	
Date: <u>01/27/23</u>	Elapsed Time: <u>0-days</u>
Depth to Groundwater: <u>13.8-feet</u>	



# BORING: LE-03

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

# Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.801111, -105.043856\*  
 Boring Elevation: 5,244.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in Recovery (in) / ROD (%)	Drilling Rate (min./ft.)				In-Situ States	INDEX DATA					Strength & Compressibility				
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)	
0						<b>FINE ALLUVIUM</b> LEAN CLAY with sand (CL), little fine to coarse sand, few fine to coarse gravel, stiff, mottled dark brown to olive, moist, bark, roots, maximum particle size 1.5-inches.												
2.5	5242.5		5 7	10		As above except few fine gravel, iron oxidation, mica grains, maximum particle size 0.5-inches.												
5	5240		6 8	6		Sandy LEAN CLAY (CL), some to mostly fine to coarse sand, stiff, dark brown to olive, moist, iron oxidation, mica grains.	17.8	96.6			53.4	32	15					
7.5	5237.5		5 7	6														
10	5235		8 10	9		<b>COARSE ALLUVIUM</b> Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, some fine to coarse gravel, few clay, medium dense, olive to olive brown, moist, iron oxidation, maximum particle size 2.0-inches.	4.3	118.6	33.8	58.8	7.4							
12.5	5232.5		3 7 10	6		As above except little fine to coarse gravel, olive brown, maximum particle size 1.5-inches.												
15	5230		22 29	10		As above except wet.												
			24			Clayey SAND with gravel (SC), mostly fine to coarse sand, little clay, little fine to coarse gravel, very dense, olive to olive												

**General Notes:**

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		Date:	Elapsed Time:	Depth to Groundwater:
		01/27/23	0-days	11.5-feet

# BORING: LE-03

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



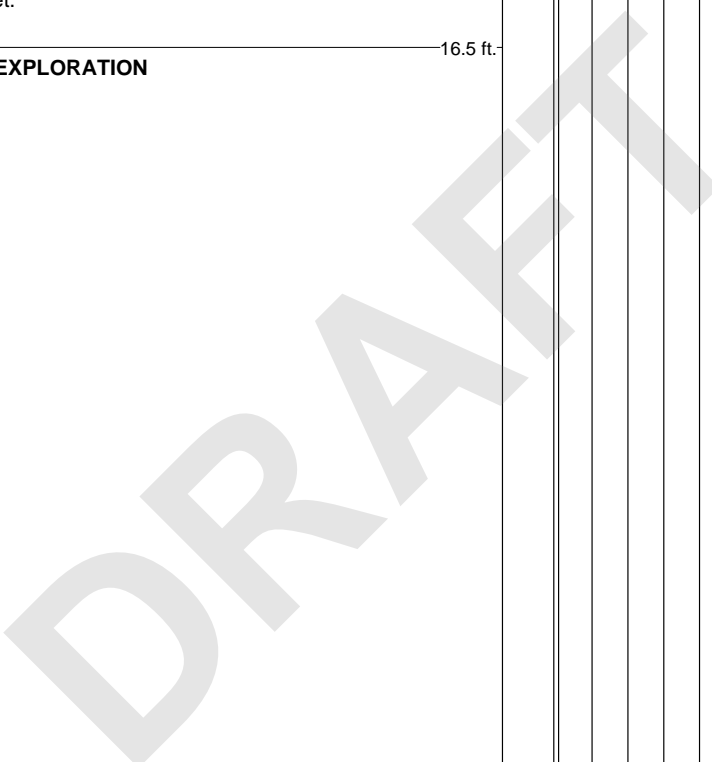
Boring Location: 39.801111, -105.043856\*  
 Boring Elevation: 5,244.0-feet\*  
 Notes: \*Location and Elevation approximate.

### Sampling Data

### Visual Material Description

### Laboratory Testing Results

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions	Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions	Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA					Strength & Compressibility					
										Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)		
16.5	5227.5		32 42	12			brown, wet.															
END OF EXPLORATION																						



#### General Notes:

- Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data: Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	11.5-feet

# BORING: LE-04

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.799083, -105.043825\*  
 Boring Elevation: 5,243.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States	INDEX DATA				Strength & Compressibility			
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
0	5242.5		6	9		<b>FINE ALLUVIUM</b> Sandy LEAN CLAY (CL), some fine to coarse sand, few fine gravel, stiff, dark brown, moist, roots.											
2.5	5240		3	5		As above.											
5	5237.5		2	12		Silty SAND (SM), mostly fine to coarse sand, little silt, olive brown, moist, iron oxidation.  As above except very loose, olive gray.											
7.5	5235		6	6		<b>FINE ALLUVIUM</b> SILT with sand (ML), little to some fine to medium sand, soft, dark gray, moist. 6' - Auger grinding indicative of gravel and cobbles.  As above except stiff. Silty SAND with gravel (SM), mostly fine to coarse sand, little fine to coarse gravel, little silt, medium dense, yellowish brown, moist. SILT (ML), stiff, dark gray, moist.	54.6	70.8			74.5	NV	NP				
10	5232.5		11	10		<b>COARSE ALLUVIUM</b> Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, some fine to coarse gravel, few clay, dense, dark olive, wet, maximum particle size 1.25-inches.				40.3	52.7	7.0					
12.5	5230		11	13		Clayey SAND with gravel (SC), mostly fine to coarse sand, some clay, little fine to coarse gravel, dense, dark olive to olive brown, wet, maximum particle size 1.25-inches.											
15	5227.5		13			As above.											

### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		Date:	Elapsed Time:	Depth to Groundwater:
▼	01/27/23	0-days	8.0-feet	
▼				
▼				

# BORING: LE-04

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.799083, -105.043825\*  
 Boring Elevation: 5,243.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States	INDEX DATA					Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
16.5	5212.5		35	18		Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions  Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions											
END OF EXPLORATION																	

### General Notes:

- Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	8.0-feet	





GEOTECHNICAL LABORATORY TESTING RESULTS													
Sample Identification		In-Place States		Material Classification and Index Testing						Stress Strain Behavior		USCS <sup>1</sup>	Description
Boring	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Particle Size Distribution (%)			Atterberg Limits (%)			One-Dimensional Consolidation/Swell			
				Gravel Content	Sand Content	Fines Content	Liquid Limit	Plastic Limit	Plasticity Index	Swell Percent (%) <sup>2</sup>	Swell Pressure (psf)		
LE-01	5.0	26.1	95.7			71.4	41	18	23			CL	LEAN CLAY with sand
LE-01	7.5	32.9	87.9			71.1	43	17	26	-0.4	N/A	CL	LEAN CLAY with sand
LE-01	10.0	29.2	93.4									CL	LEAN CLAY
LE-01	15.0			40.4	49.6	10.0	NV	NP	NP			SP-SM	poorly graded SAND with silt and gravel
LE-01	20.0	2.8	158.5	63.6	31.8	4.6						GP	poorly graded GRAVEL with sand
LE-02	5.0	18.1	104.3			53.5	35	15	20	0.0	N/A	CL	sandy LEAN CLAY
LE-02	10.0	5.2	130.6									GM	silty GRAVEL with sand
LE-02	12.5	12.1	117.7	56.1	25.7	18.2	NV	NP	NP			GM	silty GRAVEL with sand
LE-02	20.0			27.1	64.5	8.4						SP-SM	poorly graded SAND with silt and gravel
LE-03	5.0	17.8	96.6			53.4	32	17	15			CL	sandy LEAN CLAY
LE-03	7.5	4.3	118.6	33.8	58.8	7.4						SP-SC	poorly graded SAND with clay and gravel
LE-04	5.0	54.6	70.8			74.5	NV	NP	NP			ML	SILT with sand
LE-04	10.0			40.3	52.7	7.0						SP-SC	poorly graded SAND with clay and gravel

<sup>1</sup>Where Atterberg Limits and Fines Content testing was not performed, USCS classifications visually determined in the field during the subsurface investigation

<sup>2</sup>Swell percent as measured under an inundation pressure of 500 psf

**MOISTURE CONTENT & DENSITY DETERMINATION**

PROJECT: 58th and Tennyson JOB NO. 23-0029

TESTED BY A. Godat DATE 2/7/2023 CLIENT JOB NO.: 22134

LAB NO.	11775	11776	11777	11779	11780	11781
Boring No.	LE-01	LE-01	LE-01	LE-01	LE-02	LE-02
Depth, ft.	5'	7.5'	10'	20'	5'	10'
Diameter, in.	1.931	1.923	1.909	1.923	1.947	1.947
Length, in.	4.011	4.091	3.393	3.012	4.172	2.943
Wet Soil + Tare, gm.	380.5	372.6	316.0	382.7	410.2	324.4
Tare, gm.	8.2	8.1	8.0	8.1	8.2	8.0
Wet Soil, gm.	372.3	364.5	308.0	374.6	402.0	316.4
Volumn, cu. ft.	0.006798	0.006876	0.005620	0.005062	0.007188	0.005071
<b>Wet Density, pcf</b>	<b>120.6</b>	<b>116.8</b>	<b>120.7</b>	<b>163.0</b>	<b>123.2</b>	<b>137.4</b>
Cup No.	40	15	51	59	MOE	32
Cup Weight, gm	8.2	8.1	8.0	8.1	8.2	8.0
Wet Soil + Cup, gm.	380.5	301.6	316.0	382.7	331.7	324.4
Dry Soil + Cup, gm.	303.4	229.0	246.4	372.5	282.2	308.7
Water, gm.	77.1	72.6	69.6	10.2	49.5	15.7
Dry Soil, gm.	295.2	220.9	238.4	364.4	274.0	300.7
<b>Moisture Content, %</b>	<b>26.1</b>	<b>32.9</b>	<b>29.2</b>	<b>2.8</b>	<b>18.1</b>	<b>5.2</b>
<b>Dry Density, pcf</b>	<b>95.7</b>	<b>87.9</b>	<b>93.4</b>	<b>158.5</b>	<b>104.3</b>	<b>130.6</b>

LAB NO.	11782	11784	11785	11786
Boring No.	LE-02	LE-03	LE-03	LE-04
Depth, ft.	12.5'	5'	7.5'	5'
Diameter, in.	1.887	1.875	1.921	1.875
Length, in.	3.990	4.203	3.023	4.014
Wet Soil + Tare, gm.	394.7	355.1	292.4	326.9
Tare, gm.	8.1	8.2	7.9	8.0
Wet Soil, gm.	386.6	346.9	284.5	318.9
Volumn, cu. ft.	0.006457	0.006716	0.005070	0.006414
<b>Wet Density, pcf</b>	<b>131.9</b>	<b>113.8</b>	<b>123.6</b>	<b>109.5</b>
Cup No.	58	33	HBO	7
Cup Weight, gm.	8.1	8.2	7.9	8.0
Wet Soil + Cup, gm.	394.7	355.1	292.4	326.9
Dry Soil + Cup, gm.	353.1	302.8	280.8	214.3
Water, gm.	41.6	52.3	11.6	112.6
Dry Soil, gm.	345.0	294.6	272.9	206.3
<b>Moisture Content, %</b>	<b>12.1</b>	<b>17.8</b>	<b>4.3</b>	<b>54.6</b>
<b>Dry Density, pcf</b>	<b>117.7</b>	<b>96.6</b>	<b>118.6</b>	<b>70.8</b>

\* 11782 - approx. 1/2 of the liner was granular; dimensions are approximate

**Martinez Associates**

14025 W. 66th Avenue  
 Arvada, Colorado 80004  
 Phone: (303) 459-2216  
 Fax: (303) 482-2230



**One Dimensional Swell/Consolidation (ASTM D 4546)**  
 (Denver Area Swell/Consolidation Test)

Client Project No.: <u>22134</u>	Proj. Name: <u>58th and Tennyson</u>	Sampled By: <u>J. Halverson</u>
Martinez Job No.: <u>23-0029</u>	Lab Tech: <u>R.S. Kay</u>	Test Date: <u>2/10/23</u>
Sample ID: <u>11780</u>		Sample Date: <u>2/7/23</u>
Sample Location: <u>LE-02 Brass Liner @ 5'</u>		Reviewed By: <u>K. Runner</u>
Soil Description: _____		
USCS: _____		

**Sample Data:**

Ring No:	F	Dish No:	MOE
Ring Mass (g):	237.9	Dish Mass (g):	8.2
Sample Height (in):	0.75	Swell Machine #:	6
Pre-test Sample		Post-test Sample	
Ring + Sample (g):	314.2	Ring + Sample (g):	313.9
Dish wt:	8.2	Dish wt:	8.2
Wet wt (g):	331.7	Wet wt (g):	83.8
Dry wt (g):	282.2	Dry wt (g):	71.0

**Results:**

Pre-test Sample		Post-test Sample	
Moisture Content:	18.1%	Moisture Content:	20.4%
Wet Density (pcf):	131.7	Wet Density (pcf):	135.0
Dry Density (pcf):	111.5	Dry Density (pcf):	112.1

**Swell/Consolidation**

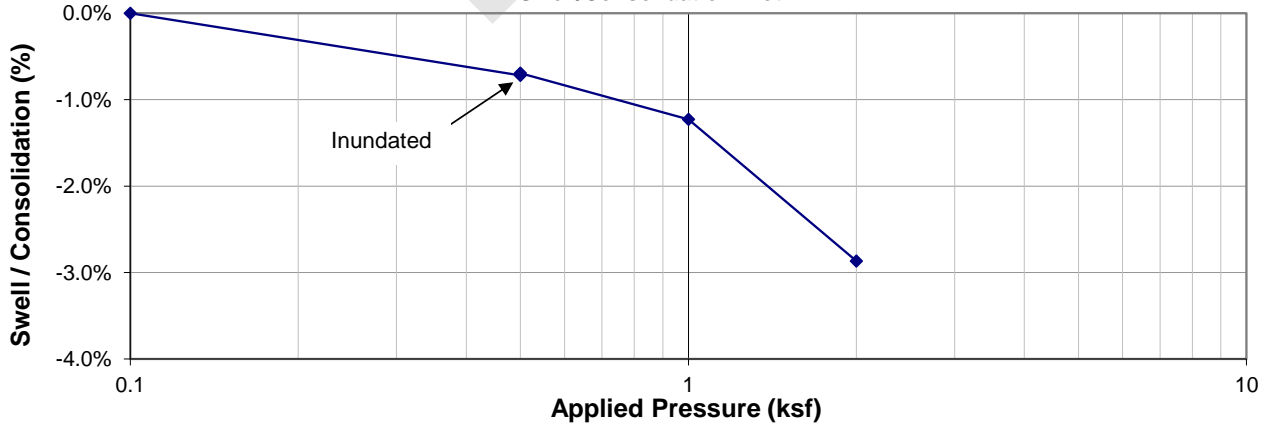
Load (ksf):	0.1	0.5	Add Water	0.5	1	2		
Correction (x 10-4):	0	19		19	39	76		
Dial Reading (x 10-4):	3301	3228		3230	3170	3010		
Swell/Consolidation %:	<b>0.0%</b>	<b>-0.7%</b>		<b>-0.7%</b>	<b>-1.2%</b>	<b>-2.9%</b>		

**Results:**

Swell Upon Wetting @  
 500 psf: 0.0%  
 Swell Pressure (psf): N/A

Tested By: R. S. Kay  
 Checked By: K. Runner

**Swell/Consolidation Plot**



**Martinez Associates**

14025 W. 66th Avenue  
 Arvada, Colorado 80004  
 Phone: (303) 459-2216  
 Fax: (303) 482-2230



**One Dimensional Swell/Consolidation (ASTM D 4546)**

(Denver Area Swell/Consolidation Test)

Client Project No.: 22134 Proj. Name: 58th and Tennyson Sampled By: J. Halverson  
 Martinez Job No.: 23-0029 Lab Tech: R.S. Kay Test Date: 2/10/23 Sample Date: 2/7/23  
 Sample ID: 11776 Reviewed By: K. Runner  
 Sample Location: LE-01 Brass Liner @ 7.5'  
 Soil Description: \_\_\_\_\_  
 USCS: \_\_\_\_\_

**Sample Data:**

Ring No:	D	Dish No:	15
Ring Mass (g):	236.7	Dish Mass (g):	8.1
Sample Height (in):	0.75	Swell Machine #:	4
Pre-test Sample		Post-test Sample	
Ring + Sample (g):	306.2	Ring + Sample (g):	303.5
Dish wt:	8.1	Dish wt:	8.1
Wet wt (g):	301.6	Wet wt (g):	73.9
Dry wt (g):	229.0	Dry wt (g):	59.8

**Results:**

Pre-test Sample		Post-test Sample	
Moisture Content:	32.9%	Moisture Content:	27.3%
Wet Density (pcf):	119.9	Wet Density (pcf):	128.2
Dry Density (pcf):	90.3	Dry Density (pcf):	100.7

**Swell/Consolidation**

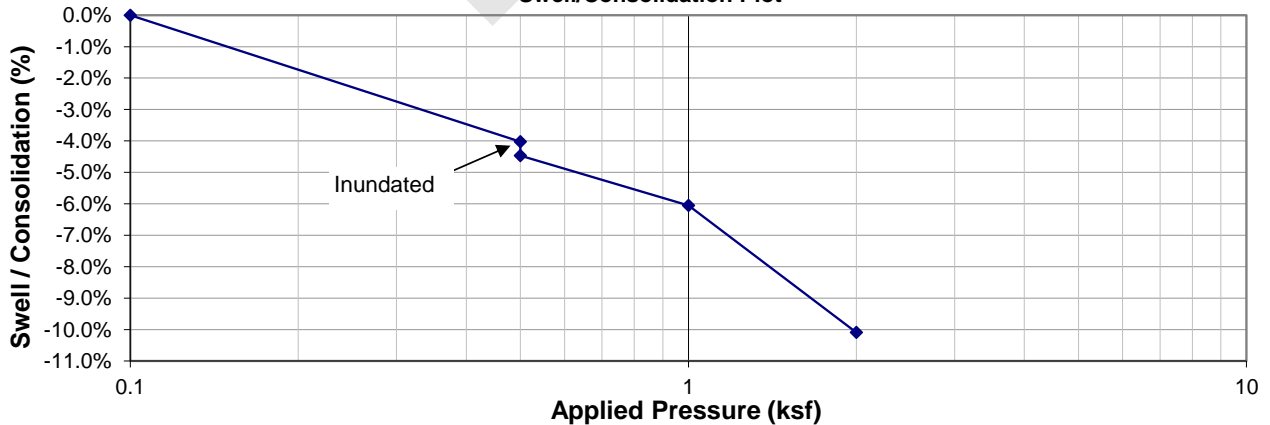
Load (ksf):	0.1	0.5	Add Water	0.5	1	2		
Correction (x 10-4):	0	37		37	74	110		
Dial Reading (x 10-4):	4580	4241		4208	4052	3713		
Swell/Consolidation %:	0.0%	-4.0%		-4.5%	-6.1%	-10.1%		

**Results:**

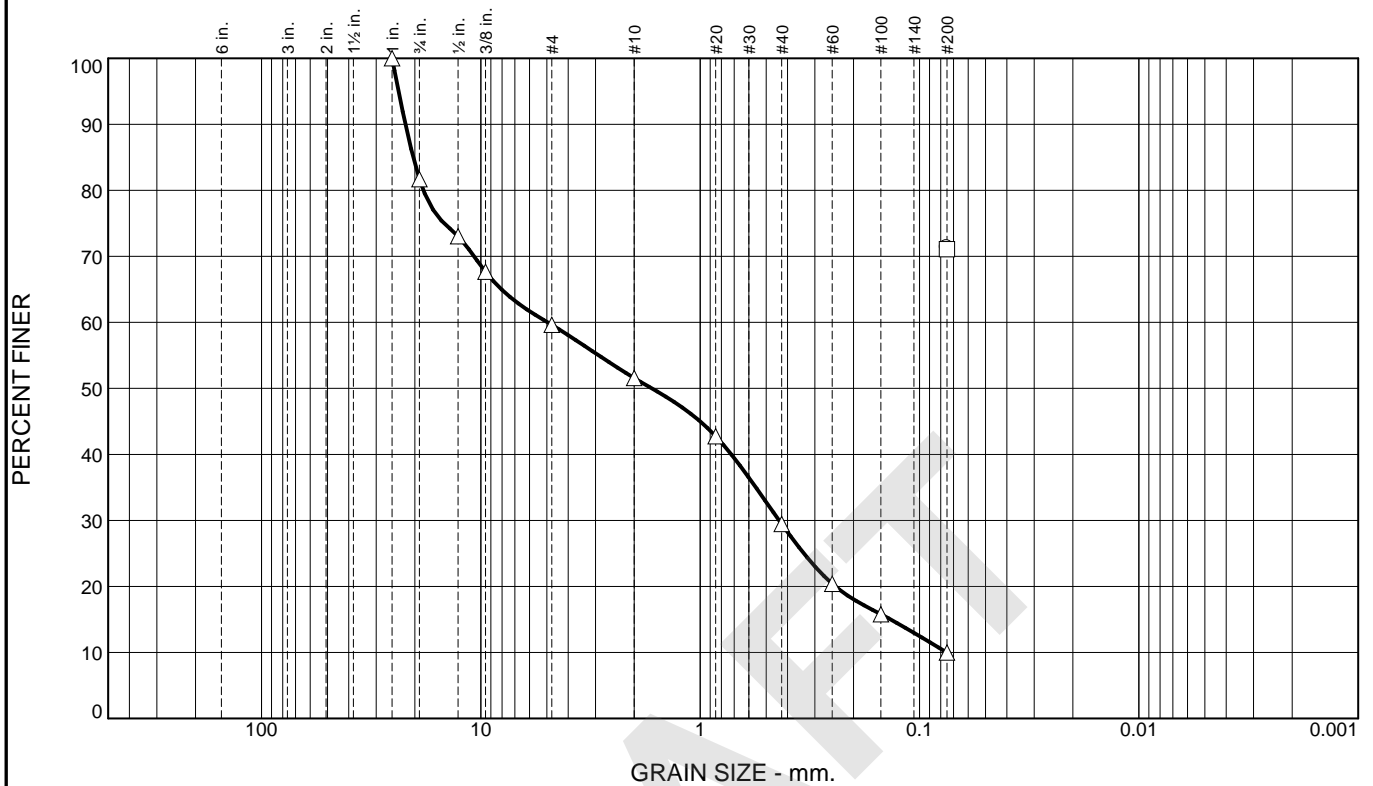
Settlement Upon Wetting @  
 500 psf: **-0.4%**  
 Swell Pressure (psf): **N/A**

Tested By: R. S. Kay  
 Checked By: K. Runner

**Swell/Consolidation Plot**



# Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							41	18	23
□							43	17	26
△	0.0	40.4	49.6	10.0		SP-SM	NV	NP	NP

SIEVE inches size	PERCENT FINER		
	○	□	△
1"			100.0
3/4"			81.7
1/2"			73.0
3/8"			67.7
GRAIN SIZE			
D60			4.9551
D30			0.4366
D10			0.0751
COEFFICIENTS			
C <sub>c</sub>			0.51
C <sub>u</sub>			65.96

SIEVE number size	PERCENT FINER		
	○	□	△
#4			59.6
#10			51.6
#20			42.7
#40			29.5
#60			20.4
#100			15.8
#200	71.4	71.1	10.0

**Material Description**

○

□

△ poorly graded sand with silt and gravel

**REMARKS:**

○ Natural Moisture Content: 26.1%

□ Natural Moisture Content: 32.9%

△

○ Location: LE-01 Brass Liner      Depth: 5'      Sample Number: 11775  
 □ Location: LE-01 Brass Liner      Depth: 7.5'      Sample Number: 11776  
 △ Location: LE-01 Bag      Depth: 15'      Sample Number: 11778

	Client: Lithos Engineering Project: 58th and Tennyson Lithos Project Number: 22134 Project No.: 23-0029
--	--



# Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	63.6	31.8		4.6	GP			
□							35	15	20
△	0.0	56.1	25.7		18.2	GM	NV	NP	NP

SIEVE inches size	PERCENT FINER		
	○	□	△
1"	100.0		100.0
3/4"	52.1		46.7
1/2"	48.0		
3/8"	43.1		45.6
GRAIN SIZE			
D60	20.3722		20.8082
D30	2.3418		0.3329
D10	0.2866		
COEFFICIENTS			
C <sub>c</sub>	0.94		
C <sub>u</sub>	71.08		

SIEVE number size	PERCENT FINER		
	○	□	△
#4	36.4		43.9
#10	28.4		42.7
#20	20.8		40.8
#40	13.0		33.0
#60	9.2		27.0
#100	6.6		23.6
#200	4.6	53.5	18.2

**Material Description**

○ poorly graded gravel with sand

□

△ silty gravel with sand

**REMARKS:**

○ Natural Moisture Content: 2.8%

□ Natural Moisture Content: 18.1%

△ Natural Moisture Content: 12.1%

○ Location: LE-01 Brass Liner      Depth: 20'      Sample Number: 11779  
 □ Location: LE-02 Brass Liner      Depth: 5'      Sample Number: 11780  
 △ Location: LE-02 Brass Liner      Depth: 12.5'      Sample Number: 11782

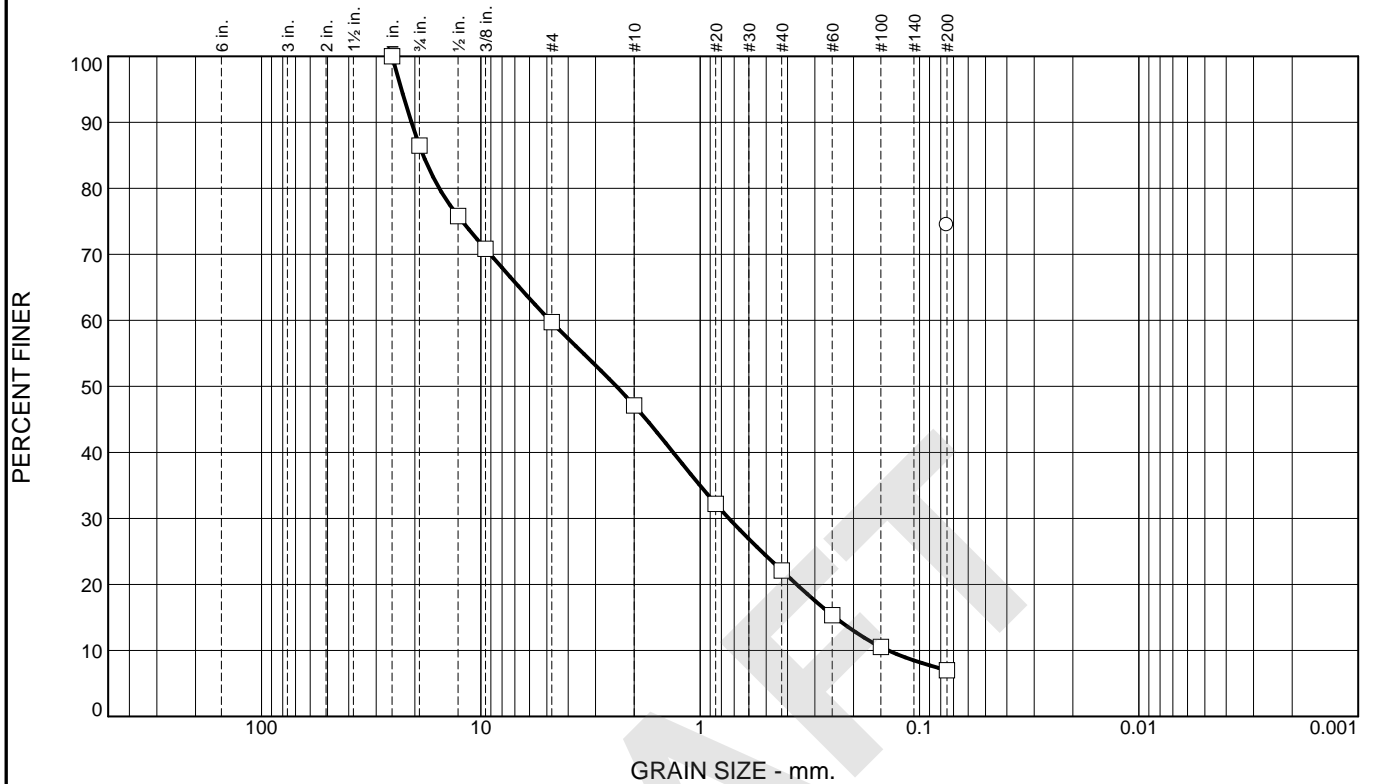


Client: Lithos Engineering  
 Project: 58th and Tennyson  
 Lithos Project Number: 22134  
 Project No.: 23-0029

Figure



# Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							NV	NP	NP
□	0.0	40.3	52.7		7.0				

SIEVE inches size	PERCENT FINER	
	○	□
1"		100.0
3/4"		86.5
1/2"		75.8
3/8"		70.8
GRAIN SIZE		
D60		4.8370
D30		0.7401
D10		0.1389
COEFFICIENTS		
Cc		0.82
Cu		34.82

SIEVE number size	PERCENT FINER	
	○	□
#4		59.7
#10		47.1
#20		32.2
#40		22.1
#60		15.3
#100		10.5
#200	74.5	7.0

**Material Description**

○

□

**REMARKS:**

○ Natural Moisture Content: 54.6%

□

○ Location: LE-04 Brass Liner      Depth: 5'      Sample Number: 11786  
 □ Location: LE-04 Bag      Depth: 10'      Sample Number: 11787

	Client: Lithos Engineering Project: 58th and Tennyson Lithos Project Number: 22134 Project No.: 23-0029
--	--



**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063      **Date Received:** 2/24/23  
**Client PO:**      **Date Reported:** 3/10/23  
**Client Project:** Dewatering Application      **Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<i>Dissolved</i>						
Chromium - Hexavalent	ND	SM 3500-Cr B	0.01 mg/L	3/2/23	QC63291	MAT
Manganese	0.7831 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Iron	0.015 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN
<i>Potentially Dissolved</i>						
Chromium - Trivalent	0.01 mg/L	Calculation	0.01 mg/L	3/1/23	-	MBN
Arsenic	0.0032 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0009 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0153 mg/L	EPA 200.8	0.0015 mg/L	2/28/23	QC63218	MBN
Copper	0.0644 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0534 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Manganese	1.49 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Nickel	0.0158 mg/L	EPA 200.8	0.0009 mg/L	2/28/23	QC63218	MBN
Selenium	0.0086 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	ND	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	ND	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0305 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.138 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
<i>Total</i>						
Mercury	0.0002 mg/L	EPA 245.7	0.0002 mg/L	2/28/23	QC63211	MLT
<i>Total Recoverable</i>						
Chromium - Trivalent	0.08 mg/L	Calculation	0.01 mg/L	3/1/23	-	MBN
Aluminum	41.9 mg/L	EPA 200.8	0.010 mg/L	2/28/23	QC63218	MBN

**Abbreviations/References:**

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Date Analyzed = Date Test Completed

(d) RPD acceptable due to low duplicate and sample concentrations.  
(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.



**Report To:** James Carroll

**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll

**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-01  
**Sample Date/Time:** 2/24/23 11:45 AM  
**Lab Number:** 230224063-01

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<i>Total Recoverable</i>						
Antimony	ND	EPA 200.8	0.0012 mg/L	2/28/23	QC63218	MBN
Arsenic	0.0085 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Barium	0.7867 mg/L	EPA 200.8	0.0007 mg/L	2/28/23	QC63218	MBN
Beryllium	0.0021 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0011 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0877 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.1621 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0969 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Molybdenum	0.0061 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Nickel	0.0656 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0088 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	0.0007 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	0.0010 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0420 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.351 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
Iron	59.5 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN

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Date Analyzed = Date Test Completed

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(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Dissolved</u>						
Chromium - Hexavalent	ND	SM 3500-Cr B	0.01 mg/L	3/2/23	QC63291	MAT
Manganese	8.46 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Iron	0.030 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN
<u>Potentially Dissolved</u>						
Chromium - Trivalent	ND	Calculation	0.01 mg/L	3/2/23	-	MBN
Arsenic	0.0056 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0028 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.0458 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.1060 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.0856 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Manganese	11.3 mg/L	EPA 200.8	0.0080 mg/L	2/28/23	QC63218	MBN
Nickel	0.0480 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0053 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	ND	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	ND	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0182 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.216 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
<u>Total</u>						
Mercury	0.0003 mg/L	EPA 245.7	0.0002 mg/L	2/28/23	QC63211	MLT
<u>Total Recoverable</u>						
Chromium - Trivalent	ND	Calculation	0.01 mg/L	3/2/23	-	MBN
Aluminum	68.7 mg/L	EPA 200.8	0.010 mg/L	2/28/23	QC63218	MBN

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Date Analyzed = Date Test Completed

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(s) The accuracy of the spike recovery value is reduced due to the analyte concentration in the sample being disproportionate to the spike level. The laboratory control sample recovery was acceptable

ND = Not Detected at Reporting Limit.

**Report To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Bill To:** James Carroll  
**Company:** Lithos Engineering  
2750 S Wadsworth Blvd  
Suite D-200  
Denver CO 80227

**Task No.:** 230224063  
**Client PO:**  
**Client Project:** Dewatering Application

**Date Received:** 2/24/23  
**Date Reported:** 3/10/23  
**Matrix:** Water - Ground

**Customer Sample ID** LB-02  
**Sample Date/Time:** 2/24/23 12:45 PM  
**Lab Number:** 230224063-02

Test	Result	Method	RL	Date Analyzed	QC Batch ID	Analyzed By
<u>Total Recoverable</u>						
Antimony	ND	EPA 200.8	0.0012 mg/L	2/28/23	QC63218	MBN
Arsenic	0.0153 mg/L	EPA 200.8	0.0006 mg/L	2/28/23	QC63218	MBN
Barium	1.58 mg/L	EPA 200.8	0.0007 mg/L	2/28/23	QC63218	MBN
Beryllium	0.0030 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Cadmium	0.0033 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Chromium	0.1397 mg/L	EPA 200.8	0.0150 mg/L	2/28/23	QC63218	MBN
Copper	0.2837 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Lead	0.1382 mg/L	EPA 200.8	0.0001 mg/L	2/28/23	QC63218	MBN
Molybdenum	0.0107 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Nickel	0.1071 mg/L	EPA 200.8	0.0090 mg/L	2/28/23	QC63218	MBN
Selenium	0.0086 mg/L	EPA 200.8	0.0008 mg/L	2/28/23	QC63218	MBN
Silver	0.0023 mg/L	EPA 200.8	0.0005 mg/L	2/28/23	QC63218	MBN
Thallium	0.0015 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Uranium	0.0218 mg/L	EPA 200.8	0.0002 mg/L	2/28/23	QC63218	MBN
Zinc	0.602 mg/L	EPA 200.8	0.001 mg/L	2/28/23	QC63218	MBN
Iron	112 mg/L	EPA 200.7	0.005 mg/L	2/28/23	QC63200	MBN

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ND = Not Detected at Reporting Limit.

**Analytical QC Summary**

**TASK NO: 230224063**

**Report To:** James Carroll  
**Company:** Lithos Engineering

**Receive Date:** 2/24/23  
**Project Name:** Dewatering Application

Test	QC Batch ID	QC Type	Result	Method
Chromium - Hexavalent	QC63291	Blank	ND	SM 3500-Cr B
Mercury	QC63211	Method Blank	ND	EPA 245.7
Aluminum	QC63218	Method Blank	ND	EPA 200.8
Antimony	QC63218	Method Blank	ND	EPA 200.8
Arsenic	QC63218	Method Blank	ND	EPA 200.8
Barium	QC63218	Method Blank	ND	EPA 200.8
Beryllium	QC63218	Method Blank	ND	EPA 200.8
Cadmium	QC63218	Method Blank	ND	EPA 200.8
Chromium	QC63218	Method Blank	ND	EPA 200.8
Copper	QC63218	Method Blank	ND	EPA 200.8
Lead	QC63218	Method Blank	ND	EPA 200.8
Manganese	QC63218	Method Blank	ND	EPA 200.8
Molybdenum	QC63218	Method Blank	ND	EPA 200.8
Nickel	QC63218	Method Blank	ND	EPA 200.8
Selenium	QC63218	Method Blank	ND	EPA 200.8
Silver	QC63218	Method Blank	ND	EPA 200.8
Thallium	QC63218	Method Blank	ND	EPA 200.8
Uranium	QC63218	Method Blank	ND	EPA 200.8
Zinc	QC63218	Method Blank	ND	EPA 200.8
Iron	QC63200	Method Blank	ND	EPA 200.7

Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
Chromium - Hexavalent	QC63291	Duplicate	0 - 20	-	1.7	SM 3500-Cr B
		LCS	90 - 110	103.5	-	
Mercury	QC63211	Duplicate	0 - 20	-	0.0	EPA 245.7
		LCS	90 - 110	105.8	-	
		MS	80 - 120	92.0	-	
Aluminum	QC63218	LCS	90 - 110	102.1	-	EPA 200.8
		MS	70 - 130	99.5	-	
		MSD	0 - 10	-	3.1	
Antimony	QC63218	LCS	90 - 110	99.9	-	EPA 200.8
		MS	70 - 130	103.3	-	
		MSD	0 - 10	-	1.3	
Arsenic	QC63218	LCS	90 - 110	100.6	-	EPA 200.8
		MS	70 - 130	113.8	-	
		MSD	0 - 10	-	3.7	
Barium	QC63218	LCS	90 - 110	96.1	-	EPA 200.8
		MS	70 - 130	91.6	-	
		MSD	0 - 10	-	0.7	
Beryllium	QC63218	LCS	90 - 110	99.4	-	EPA 200.8
		MS	70 - 130	97.5	-	

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Test	QC Batch ID	QC Type	Limits	% Rec	RPD	Method
		MSD	0 - 10	-	4.9	
Cadmium	QC63218	LCS	90 - 110	94.0	-	EPA 200.8
		MS	70 - 130	104.5	-	
		MSD	0 - 10	-	2.8	
Chromium	QC63218	LCS	90 - 110	100.7	-	EPA 200.8
		MS	70 - 130	104.4	-	
		MSD	0 - 10	-	0.2	
Copper	QC63218	LCS	90 - 110	96.6	-	EPA 200.8
		MS	70 - 130	86.2	-	
		MSD	0 - 10	-	0.4	
Lead	QC63218	LCS	90 - 110	98.1	-	EPA 200.8
		MS	70 - 130	94.8	-	
		MSD	0 - 10	-	6.8	
Manganese	QC63218	LCS	90 - 110	99.4	-	EPA 200.8
		MS	70 - 130	105.2	-	
		MSD	0 - 10	-	0.6	
Molybdenum	QC63218	LCS	90 - 110	95.3	-	EPA 200.8
		MS	70 - 130	97.4	-	
		MSD	0 - 10	-	0.5	
Nickel	QC63218	LCS	90 - 110	101.7	-	EPA 200.8
		MS	70 - 130	100.0	-	
		MSD	0 - 10	-	1.9	
Selenium	QC63218	LCS	90 - 110	94.4	-	EPA 200.8
		MS	70 - 130	110.0	-	
		MSD	0 - 10	-	2.1	
Silver	QC63218	LCS	90 - 110	94.9	-	EPA 200.8
		MS	70 - 130	93.8	-	
		MSD	0 - 10	-	1.0	
Thallium	QC63218	LCS	90 - 110	102.6	-	EPA 200.8
		MS	70 - 130	102.3	-	
		MSD	0 - 10	-	5.5	
Uranium	QC63218	LCS	90 - 110	100.1	-	EPA 200.8
		MS	70 - 130	94.5	-	
		MSD	0 - 10	-	7.1	
Zinc	QC63218	LCS	90 - 110	98.0	-	EPA 200.8
		MS	70 - 130	91.7	-	
		MSD	0 - 10	-	0.3	
Iron	QC63200	Duplicate	0 - 20	-	0.0	EPA 200.7
		LCS	90 - 110	98.4	-	
		MS	75 - 125	102.9	-	

All analyses were performed in accordance with approved methods under the latest revision to 40 CFR Part 136 unless otherwise identified. Based on my inquiry of the person or persons directly responsible for analyzing the wastewater samples and generating the report (s), the analyses, report, and information submitted are, to the best of my knowledge and belief, true, accurate, and complete.



DATA APPROVED FOR RELEASE BY

**Abbreviations/ References:**

RL = Reporting Limit = Minimum Level  
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ND = Not Detected at Reporting Limit.

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313

Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507







CAL Task

230224063

NAB

**Bottle Order  
Test Detail**

Order ID: QBO22090006

Date Created: 9/2/22

<b>Ship To:</b> Kennedy/Jenks Consultants 143 Union Blvd Suite 600 Lakewood CO 80228 303-985-3636	<b>Shipping Options:</b> Ship Via: Customer Pickup    Cooler: Yes
<b>Attention:</b> Emily Hudish	Chain of Custody    Drinking Water: Standard: 2
<b>**Verify All Shipping Addresses**</b>	<b>Customer Needs By: 1/23/23</b> <b>Ships From: Lakewood</b>
	<b>Project:</b> Dewatering Application

Qty	Bottle / Preservative / Test
2	3- VOA HCl / 3-VOA None 624 VOCs - Water - Ground
2	500 ml Amber Unpreserved 625 SOC's - Water - Ground
2	500 ml Cylinder - HNO3 Ag - PD - Water - Ground Ag - TR - Water - Ground Al - TR - Water - Ground As - PD - Water - Ground As - TR - Water - Ground Ba - TR - Water - Ground Be - TR - Water - Ground Cd - PD - Water - Ground Cd - TR - Water - Ground Cr - PD - Water - Ground Cr - TR - Water - Ground Cr - Tri - Water - Ground Cu - PD - Water - Ground Cu - TR - Water - Ground Fe - TR - Water - Ground Hg - Water - Ground

**\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\***

**Internal Shipping Instructions:**

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

10411 Heinz Way / Commerce City, CO 80640 / 303-659-2313  
Mailing Address: P.O. Box 507 / Brighton, CO 80601-0507

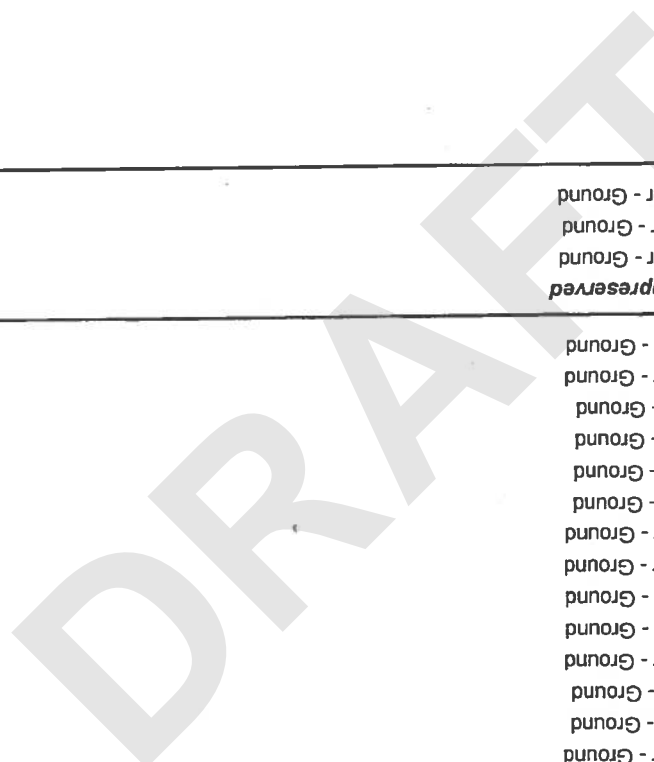
**Internal Shipping Instructions:**

\*\*Samples should be shipped or hand delivered the same day they are collected. Orders that require sub-lab analysis should be delivered to the lab Monday thru Wednesday only.\*\*

2  
500 ml Cylinder - Unpreserved  
Cr - Hex - Water - Ground  
Fe - Dis - Water - Ground  
Mn - Dis - Water - Ground

Mn - PD - Water - Ground  
Mo - TR - Water - Ground  
Ni - PD - Water - Ground  
Ni - TR - Water - Ground  
Pb - PD - Water - Ground  
Pb - TR - Water - Ground  
Sb - TR - Water - Ground  
Se - PD - Water - Ground  
Se - TR - Water - Ground  
Ti - PD - Water - Ground  
Ti - TR - Water - Ground  
U - PD - Water - Ground  
U - TR - Water - Ground  
Zn - PD - Water - Ground  
Zn - TR - Water - Ground

Qty. Bottle / Preservative / Test



**Ship To:** Kennedy/Jenks Consultants  
143 Union Blvd  
Suite 600  
Lakewood CO 80228  
303-985-3636  
Attention: Emily Hudish  
NAB

**Ship To:** 230224063  
CAL Task

**Shipping Options:** Ship Via: Customer Pickup Cooler: Yes  
Chain of Custody Drinking Water: Standard: 2  
Customer Needs By: 1/23/23  
Ships From: Lakewood  
Project: [Redacted]  
Dewatering Application

**\*\*Verify All Shipping Addresses\*\***

# **Stormwater Management Plan**

---



# STORMWATER MANAGEMENT PLAN

## North Trunk Line Sanitary Sewer Improvements

Date of Preparation: November 2023

Arvada Site Disturbance Permit: (SITE##-####)  
CDPS Number: XXXXXXXXX

### Property Owner:

City of Arvada  
c/o Kris Gardner  
8101 Ralston Rd., Arvada, CO 80002  
720-898-7647  
kgardner@arvada.org

### Property Operator:

City of Arvada  
c/o Kris Gardner  
8101 Ralston Rd., Arvada, CO 80002  
720-898-7647  
kgardner@arvada.org

### SWMP Preparer:

Kennedy-Jenks  
c/o Travis Stevens  
215 Union Blvd., Suite 500  
Lakewood, CO 80228



# STORMWATER MANAGEMENT PLAN

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## **APPENDICES**

- Appendix A – CDPS Construction Permit
- Appendix B – Erosion and Sediment Control Plans, BMP Details and Landscape Plan
- Appendix C – Soils Report
- Appendix D – National Flood Hazard Layer - FIRMette
- Appendix E – Inspection Forms

## 1.0 INTRODUCTION

This SWMP identifies possible pollutant sources at this construction site that may contribute pollutants to stormwater, and identifies control measures that, when implemented in accordance with good engineering, hydrologic, and pollution control practices, will reduce or eliminate any possible water quality impacts. A copy of this SWMP will be available onsite or will be easily accessible via an electronic format. This SWMP will be revised, as necessary, when site conditions change.

This SWMP was prepared in accordance with good engineering, hydrologic and pollution control practices. Changes or additions may be required to address changes in conditions at the project. If such changes are made, this SWMP will be updated accordingly. This SWMP will be implemented as written and updated from commencement of construction activity until final stabilization is achieved. This SWMP was developed to meet the Colorado Discharge Permit System (CDPS) General Permit for Stormwater Discharges Associated with Construction Activity (Permit No. COR-400000, effective April 1, 2019) authorizing stormwater discharges from construction activities that result in a total land disturbance of one acre or greater or if a project is less than an acre but part of a larger common plan of development. This SWMP was also developed to meet the City of Arvada's requirements. The City regulates stormwater through its Site Development Permit (SDP). A copy of the CDPS Construction Permit for this project is included in **Appendix A**.

## 2.0 PROJECT SITE LOCATION AND DESCRIPTION

The project site location is along Tennyson St., primarily in the western/southbound lane beginning at the intersection of W. 61<sup>st</sup> Place and ending just north of the I-76 CDOT ROW. The limits of construction generally consist of a 9-foot-wide strip extending the distance of the project, and the limits of disturbance generally consist of a 7-foot-wide trench extending the distance of the project.

- Total Area of Construction Limits: 0.74 acres
- Total Area of Disturbance Limits: 0.96 acres

The project generally includes replacement of sanitary sewer piping including earthwork, trenching, backfilling, pipe testing and removal of existing sanitary sewer piping. This project also involves new water piping, relocation of utilities as needed for construction, a flow metering vault with associated electrical improvements, trenchless piping installation, and roadway repair as required for pipeline installation.

The existing trunkline at the south end of the project is immediately adjacent to an existing storm swale for approximately 900 feet. The existing trunkline will be removed and replaced. During construction, the existing storm swale will require temporary stabilization and rerouting of storm flow.

Erosion and Sediment Control Plans are included in **Appendix B**.

## 3.0 SITE CONTACT INFORMATION

**Owner: City of Arvada**  
Name: Kris Gardner  
Title: Project Manager

Address: 8101 Ralston Rd., Arvada, CO 80002  
Phone: 720-898-7647  
Email: kgardner@arvada.org

**Operator City of Arvada**

Name: Kris Gardner  
Title: Project Manager  
Address: 8101 Ralston Rd., Arvada, CO 80002  
Phone: 720-898-7647  
Email: kgardner@arvada.org

**Project Manager/Site Supervisor: [See BT Construction]**

Name:  
Title:  
Address:  
Phone:  
Email:

**Qualified Stormwater Manager: [See BT Construction]**

Name:  
Title:  
Address:  
Phone:  
Email:

**Control Measure Contractor: [See BT Construction]**

Name:  
Title:  
Address:  
Phone:  
Email:

**Other:**

Name:  
Title:  
Address:  
Phone:  
Email:

**4.0 PROPOSED SEQUENCE FOR MAJOR CONSTRUCTION ACTIVITIES**

<b>Project Phase</b>	<b>Estimate Date</b>	<b>Controls to be implemented during each phase*</b>
Pre-Disturbance/Site Preparation		No pre-disturbance or site preparation activities are anticipated for this project.
Construction		The project consists of replacement of sanitary sewer piping including earthwork, trenching, backfilling, pipe testing and removal of existing sanitary sewer piping. This project also involves new water piping, relocation of utilities as needed for

Project Phase	Estimate Date	Controls to be implemented during each phase*
		construction, a flow metering vault with associated electrical improvements, trenchless piping installation, and roadway repair as required for pipeline installation.
Final Stabilization		Final stabilization will include roadway repair as required for pipeline installation and reseeded of disturbed areas including the existing storm swale.

**5.0 EXISTING STORM SWALE STABILIZATION**

At the time that the south portion of the project is under construction, the existing storm swale will be disturbed in order to remove and replace the existing trunkline. The storm swale will be reestablished whenever possible at the end of each day. A large pipe will be provided to aid in stormwater conveyance across the swale when construction activities may block the flow of water. Pumps will also be kept onsite at all times for the removal of accumulated water as needed. If any overflow does occur, a street sweeper will be kept onsite to ensure that the road is clear.

Swale will be temporarily supported with berms on each side. An erosion control blanket or mulch control netting will align the channel to minimize erosion potential during construction. After construction is complete the swale will be returned to existing conditions as defined in the contract documents.

**6.0 EXISTING SOIL DATA**

The majority of this project occurs within the City ROW beneath pavement. Fill material exists immediately beneath the pavement. The fill material consists of poorly grades SAND and clay and gravel (SP-SC), mostly fine to coarse sand, little fine to coarse gravel, few clay, medium dense, olive brown, moist, iron oxidation. See geotechnical report for additional information.

**A copy of the soils report is included in Appendix C.**

**7.0 EXISTING VEGETATION**

There are some grasses present in the existing storm swale on the south end of the project. Vegetative coverage is approximately 65% based on aerial data. This area will necessarily be disturbed during construction. During final stabilization, the area will be seeded and mulched. Otherwise, no significant impact to vegetation is anticipated.

**8.0 RECEIVING WATERS**

**8.1 Immediate and Ultimate Receiving Waters**

The project area immediately enters the Adams County Stormwater Conveyance system MS4, which includes large diameter stormwater piping and drainage swales. The ultimate receiving water for stormwater entering this system is Clear Creek.

Stormwater is conveyed via Adams Co stormwater System and enters a buffer zone of at least 50 feet upstream of its discharge into Clear Creek. This construction project is within the City of

Arvada, which has a Phase II Municipal Separate Storm Sewer System (MS4) Permit from the State of Colorado.

Are their anticipated wetland impacts (Circle)? Yes **No**  
 Stream impacts (Circle)? Yes **No**

Site south of W. 58<sup>th</sup> Ave is within the 100-year floodplain and the floodway as determined by FEMA.

A copy of the flood insurance rate map (FIRM) for this site (FIRMette) is included in Appendix E.

## 8.2 Stream Crossings

The proposed construction project does not cross any streams or rivers.

## 8.3 Impaired Waters

This project comes into contact with Clear Creek Segment ID COSPCL15\_C: mainstream of Clear Creek from Wadsworth Blvd to the confluence with the South Platte River. This stream segment is listed by CDPHE as impaired on the 303(d) list. The parameters of impairment include E. coli, manganese, organic sediment, temperature, and arsenic. Erosion and sediment control plans are being used to prevent any contaminants from entering the stream. Construction is not expected to increase the prevalence of any of the parameters of impairment beyond existing levels.

The stream segment is impaired but is not listed as having a total maximum daily load (TMDL) per CDPHE's website.

## 9.0 POTENTIAL POLLUTANT SOURCES

Potential Source of Pollution	Potential Exists for this Project?	Description of Activities & Control Measures Used
Disturbed and stored soils <ul style="list-style-type: none"> <li>Stockpiled soils (e.g. topsoil, embankments, wetland, spoils, etc.)</li> <li>Disturbed soils (exposed areas, staging areas, parking, etc.)</li> </ul>	Yes	Potential during all phases of construction, including but not limited to excavating, backfilling, landscaping, etc. Potential pollutants include disturbed eroded sediment entering state waterways, inlets and sewers, and off right of way.  <u>Control Measures-</u> Sediment control and stockpile containment may include usage of silt fence, rock socks, sediment control logs, and inlet protection as outlined in the SWMP narratives.  Administrative BMPs include site management and limiting number and location of stockpiles. Phased construction to reduce the amount of open area at any given time.
Vehicle tracking of sediments	Yes	Potential during all construction activities.



Potential Source of Pollution	Potential Exists for this Project?	Description of Activities & Control Measures Used
		<p><u>Control Measures</u> - Sediment control including vehicle tracking pads, street sweeping, and inlet protection.</p> <p>Minimize the number of entry and exit points, add orange perimeter fence to define construction entries/exits and establish perimeter control, and require equipment to be cleaned prior to arrival on site.</p>
Management of contaminated soils	No	No known contaminated soils are expected to be encountered during this project. If contaminated soils/water are encountered, all activity shall be stopped until the situation can be assessed. The owner will be contacted.
Loading and unloading operations	Yes	<p>Potential during delivery and staging of materials, equipment, soil, debris, etc.</p> <p><u>Control Measures</u> - Loading and unloading operations shall occur within the disturbance limits of the project using designated vehicle tracking pads.</p> <p>Administrative controls include site management to minimize the number of areas at which loading/unloading occurs. Education as to where access points are on the project to prevent vehicle tracking.</p>
Outdoor storage activities (erodible building materials, fertilizers, chemicals, etc.)	Yes	<p>Potential during all phases of construction activities including delivery, staging/storage and use of various materials.</p> <p><u>Control Measures</u> – Containment of the storage or staging areas using temporary berms or plastic/metal containment structures. Use of secondary containment device for storage of chemicals and petroleum products. Chemicals shall not be used, stored or stockpiled within 50 feet of state waters.</p> <p>Administrative controls including site management to ensure limited amount of materials are stored on site and are placed in proper designated areas.</p>
Vehicle and equipment maintenance and fueling	Yes	Fueling of equipment or vehicles and equipment or vehicle repair activities may

Potential Source of Pollution	Potential Exists for this Project?	Description of Activities & Control Measures Used
		<p>occur during all phases of construction activity.</p> <p>Control Measures – Limit areas where fueling occurs (no less than 50 feet from any state water, inlet, flow line). Ensure spill response kit is accessible where fueling is taking place. Use of plastic sheeting, drip pans, dirt berms and other measures to contain fluids. Immediate clean-up and disposal of spoils as detailed in the Spill Prevention, Control and Countermeasure Plan (Section 13). Secondary containment will be provided for containers 55 gallons or greater.</p> <p>Administrative controls include site management to limit equipment and vehicle maintenance that occurs on site.</p>
Significant dust or particulate generating processes (e.g., saw cutting material, including dust)	Yes	<p>Potential during cut/fill activities, saw cutting/sanding work and final stabilization.</p> <p><u>Control Measures</u> – Water truck on site for use as needed to minimize dust production. Use of pickup broom or vacuum during or immediately following saw cutting projects.</p>
Routine maintenance activities including fertilizers, pesticides, herbicides, detergents, fuels, solvents, oils, etc.	No	<p>Very few routine maintenance activities will occur on site. See Vehicle and Equipment maintenance for activities associated with those items.</p> <p><u>Control Measures</u> – See Vehicle and Equipment Maintenance</p>
On-site waste management practices (waste piles, liquid wastes, dumpsters)	Yes	<p>All activities including clear and grubbing, demolition activities, et.</p> <p><u>Control Measures</u> – Trash receptacles will be placed on site and garbage disposed of when full. Public trash will be routinely picked up around the site (daily) and disposed of in proper containers. Waste piles shall be placed a minimum of 50 feet from state waters, contained by earthen berms, silt fence, erosion logs, and landforms. Waste piles shall be placed in areas where stormwater runoff would not result in contamination of state waters.</p> <p>Liquid wastes will be contained and removed from site and properly disposed of</p>

Potential Source of Pollution	Potential Exists for this Project?	Description of Activities & Control Measures Used
		by the subcontractors/contractor generating wastes in accordance with the Spill Prevention, Control and Countermeasure Plan (Section 13).
Concrete truck/equipment washing, including washing of the concrete truck chute and associated fixtures and equipment	Yes	Activities associated with this pollution source are concrete pours. <u>Control Measures</u> – Dedicated concrete washout areas that are clearly marked and maintained.
Dedicated asphalt, concrete batch plants and masonry mixing stations	No	Not applicable for this site. If these activities are added, then the SWMP will be amended.
Non-industrial waste sources such as worker trash and portable toilets	Yes	Potential throughout construction. <u>Control Measures</u> – See onsite waste management.  Cleanup of trash will occur daily. A dumpster will be placed on site, at our office trailer. This will be emptied on a weekly basis, and more often, if waste amounts warrant extra pick-ups. Portable toilets will be located a minimum of 50 feet from state waters. They shall be adequately staked and cleaned on a weekly basis. They will be inspected daily for spills.  Administrative controls will include site management practices to ensure workers are placing trash in the appropriate dumpsters. Monitoring to ensure trash dumpsters are removed from the site when full. Monitoring to ensure portable toilets are cleaned as needed and repaired or removed if found to be leaking.
Other areas or procedures where spills can occur	No	Not applicable for this site. If these activities are added, then the SWMP will be amended.

## 10.0 NON-STORMWATER DISCHARGES

Potential Non-Stormwater Discharges	Potential Exists for this Project?	Description of Activities & Control Measures Used
Discharges from uncontaminated springs	No	Not applicable for this site. If these activities are

Potential Non-Stormwater Discharges	Potential Exists for this Project?	Description of Activities & Control Measures Used
that do not originate from an area of land disturbance		added, then the SWMP will be amended.
Discharges to the ground of concrete washout water associated with the washing of concrete tools and concrete mixer chutes. Discharges of concrete washout water must not leave the site as surface runoff or reach receiving waters	Yes	A concrete wash-out area will be utilized to capture wastewater and waste products resulting from the cleaning of concrete and masonry equipment.
Discharges of landscape irrigation return flow	No	Not applicable for this site. If these activities are added, then the SWMP will be amended.
Discharges from emergency fire-fighting activities	Yes	<p>To the extent allowed by the circumstances at the scene and without compromising the health and safety of personnel or the public, emergency firefighting activities should be performed in a manner that avoids or minimizes discharges to the MS4.</p> <p><u>BMPs</u> – If possible, avoid directing firefighting flows directly on erodible surfaces if runoff will enter Receiving Waters or MS4 facilities. If possible, apply fire-fighting flows so that runoff will flow over vegetated areas.</p>
Dewatering activities meeting a low-risk discharge guidance	No	<p>Groundwater is anticipated to be encountered based on the Geotechnical Investigation.</p> <p>Groundwater dewatering is not expected to qualify as low-risk due to high metals content and the presence of PFAS and Radium. A short-term remediation activities</p>

Potential Non-Stormwater Discharges	Potential Exists for this Project?	Description of Activities & Control Measures Used
		<p>permit will likely be required from CDPHE.</p> <p>Treatment of dewatering is expected for the duration of the project.</p>
Discharges covered under other CDPS discharge permits?	No	Based on groundwater sampling results, a short-term remediation activities permit is recommended by CDPHE. No other discharge permits are required for the site.

## 11.0 EFFLUENT LIMITATIONS

### 11.1 Control Measure Details

This section includes the narrative description of appropriate control measures that will be implemented before, during, and after construction activities. Both structural and non-structural control measures will be described.

Control Measure Name	Description	Phase
Concrete Washout Area	Designating and properly managing a specific area of the construction site as a concrete washout area. Designed to receive wash water from washing of tools and concrete mixer chutes, liquid concrete waste from dump trucks, mobile batch mixers, or pump trucks. <b><u>Surface discharges of concrete washout water from construction sites are prohibited.</u></b>	All phases
Construction Fencing	Restricts site access to designated entrances and exits, delineates construction site boundaries, and keeps construction out of sensitive areas such as natural areas to be preserved as open space, wetlands and riparian areas.	All phases
Construction Phasing	Attention to construction phasing, scheduling, and sequencing of land disturbing activities. Erosion and sediment controls needs adjustment as the project progresses and should be documented in the SWMP.	All phases
Good House-keeping	Prevents pollution associated with solid, liquid and hazardous construction-related materials and wastes.	All phases
Inlet Protection	Permeable barriers installed around an inlet to filter runoff and remove sediment prior to entering a storm drain inlet. Inlet protection can be constructed from rock socks, sediment control logs, silt fence, block and rock socks, or other materials.	All phases



Control Measure Name	Description	Phase
Outlet Protection	Helps reduce erosion immediately downstream of a pipe, culvert, slope drain, rundown or other conveyance with concentrated, high-velocity flows. Typical outlet protection consists of riprap or rock aprons at the conveyance outlet.	All phases
Rock Socks	Used either as a perimeter control or as part of inlet protection. Traps sediment from stormwater runoff that flows onto roadways as a result of construction activities. Constructed of gravel that has been wrapped by wire mesh or a geotextile to form an elongated cylindrical filter.	All phases
Sediment Control Log	A linear roll made of natural materials such as straw, coconut fiber, or other fibrous material trenched into the ground and held with a wooden stake. They are used as a sediment barrier to intercept sheet flow runoff from disturbed areas.	All phases
Seeding and Mulching	Seeding is used to stabilize disturbed areas that will be inactive for an extended period or at final grade that will not be otherwise stabilized. Effective seeding includes preparation of a seedbed, selection of an appropriate seed mixture, proper planting techniques, and protection of the seeded area with mulch, geotextiles, or other appropriate measures. Mulching consists of evenly applying straw, hay, shredded wood mulch, rock, bark or compost to disturbed soils and securing the mulch by crimping, tackifiers, netting or other measures. Reduces erosion by protecting bare soil from rainfall impact, increasing infiltration, and reducing runoff.	Final
Silt Fencing	Geotextile fabric installed using stakes on down-gradient side and trenched into soil. Provides sediment control by reducing runoff velocity. Used as perimeter control and back of curb control	All phases
Stabilized Staging Area	A clearly designated area where construction equipment and vehicles, stockpiles, waste bins, and other construction-related materials are stored. The contractor office trailer may also be located in this area.	All phases
Stockpile Management	Minimizes erosion and sediment transport from soil stockpiles. Should be used when soils or other erodible materials are stored at the construction site. Special attention should be given to stockpiles in close proximity to natural or manmade storm systems.	All phases
Street Sweeping	Uses mechanical pavement cleaning practices to reduce sediment, litter and other debris washed into storm sewers by runoff. Reduces pollutant loading to receiving waters and in some cases reduces clogging of storm sewers and prolong the life of infiltration oriented BMPs and reduce clogging of outlet structures in detention BMPs.	All phases; as needed

Control Measure Name	Description	Phase
Tree Protection	Used to maintain a stable surface cover as part of construction phasing or provide protection in areas designated to remain in natural conditions under post-development conditions. Includes installation of a construction fence around the area requiring protection. Where upgradient areas are disturbed, it may also be necessary to install perimeter controls to minimize sediment loading to sensitive areas.	All phases
Vehicle Tracking Control	Provides stabilized construction site access where vehicles exit the site onto paved public roads. Helps remove sediment (mud or dirt) from vehicles, reducing tracking onto the paved surface. Constructed from angular rock or other proprietary materials.	Interim
Erosion Control Blanket	A temporary degradable rolled erosion control product composed of processed natural or polymer fibers which are mechanically, structurally or chemically bound together to form a continuous matrix to provide erosion control and facilitate vegetation establishment.	All phases, as needed

Drawings and specifications for the implementation of control measures are included in the Erosion and Sediment Control Details section of the design drawings.

### 11.2 Other Effluent Limitations

Additional controls measures:

- Soil Compaction – Soil compaction must be minimized for areas where infiltration control measures will occur or where final stabilization will be achieved through vegetative cover.
- Topsoil Preservation – Unless infeasible, topsoil will be preserved for those areas of a site that will utilize vegetative final stabilization
- Minimize Disturbances – Disturbances will be minimized to the extent feasible especially on steep slopes.
- Temporary Stabilization – Temporary stabilization must be implemented for earth disturbing activities on any portion of the site where ground disturbing construction activity has permanently ceased, or temporarily ceased for more than 14 calendar days. Temporary stabilization methods may include, but are not limited to, surface roughening, tarps, soil tackifier, and hydroseed and although not specifically outlined in the permit may also include temporary hard surfaces. During the seasons when seeding does not produce vegetative cover, temporary stabilization will occur. The permittee may exceed the 14-day schedule when either the function of the specific area of the site requires it to remain disturbed, or, physical characteristics of the terrain and climate prevent stabilization. The SWMP must document the constraints necessitating the alternative schedule, provide the alternate stabilization schedule, and identify all locations where the alternative schedule is applicable on the site map.
- Construction activities will be limited to those areas within the limits of disturbance as shown on the plans. Construction activities in addition to normal construction procedures will include the on-site parking of vehicles or equipment, on-site staging, on-site batch plants, haul roads or work access and any other action which would disturb existing

conditions. Off road staging areas or stockpiles must be pre-approved by the City of Arvada. Disturbances beyond these limits will be restored to original condition.

Other controls related to final stabilization, bulk storage, spill prevention, and protection of vegetation within 50 feet of receiving waters are covered in other sections of this SWMP.

## 12.0 MATERIALS HANDLING

This section includes the narrative description of all potential pollutants other than sediment that will be handled and disposed of in an appropriate manner that does not contaminate stormwater.

Material/Waste Product Name	Description and Intended Use and Associated Control Measure	Phase
Concrete Curing Compounds	Used for concrete work. Containers will be kept intact with no leakage and in an area with good housekeeping practices to avoid spills	During concrete pouring activities
Diesel	Used to fuel equipment. Containers will be kept intact with no leakage and in an area with good housekeeping practices to avoid spills	All phases when heavy equipment is in use
Diesel Engine Antifreeze Coolant	Used in equipment. Containers will be kept intact with no leakage and in an area with good housekeeping practices to avoid spills	All phases when heavy equipment is in use
Hydraulic Oil	Used in equipment. Containers will be kept intact with no leakage and in an area with good housekeeping practices to avoid spills	All phases when heavy equipment is in use
Motor Oil	Used in equipment. Containers will be kept intact with no leakage and in an area with good housekeeping practices to avoid spills	All phases when heavy equipment is in use
Unleaded Gasoline	Used to fuel equipment. Containers will be kept intact with no leakage and in an area with good housekeeping practices to avoid spills	All phases when heavy equipment is in use

## 13.0 CONTROL MEASURE MAINTENANCE

All erosion and sediment control practices and other protective measures identified in the SWMP will be maintained in effective operating condition. Control measures that are not adequately maintained in accordance with good engineering, hydrologic and pollution control practices,

including removal of collected sediment outside the acceptable tolerances of the control measures are considered to be no longer operating effectively and must be addressed.

Assessment of control measures will be performed as part of the comprehensive inspection. Where site assessment results in the determination that new or replacement control measures are necessary, the control measures must be installed to ensure ongoing compliance with this SWMP. Where control measures have failed or are otherwise non-compliant, they must be addressed immediately or an alternative schedule with rationale will be supplied in the inspection corrective action log. See control measures details and specification for specific maintenance information.

## **14.0 SPILL PREVENTION AND RESPONSE PLAN**

### **14.1 Spill Prevention**

All parties on site will take all measures necessary to prevent spills that could negatively impact stormwater quality. The following general spill prevention methods should be used on site:

- Ensuring personal safety for all personnel affected by the spill;
- Proper storage of all materials;
- Proper maintenance of all containers;
- Bulk storage, 55 gallons or greater, for petroleum products and other liquid chemicals must have secondary containment or equivalent;
- Train employees in spill prevention and cleanup;
- Designate responsible individuals to oversee and enforce control measures;
- Spills should be covered and protected from stormwater run-on during rainfall to the extent that it doesn't compromise cleanup activities;
- Do not bury or clean/wash spills with water without using a wet vacuum;
- Store and dispose of used clean up materials, contaminated materials, and recovered spill material properly;
- Do not allow water used for cleaning and decontamination to enter storm drains or waterways;
- Contain water overflow or minor water spillage and do not allow it to discharge into storm drains or waterways;
- Loading and unloading of chemicals should be observed by on site personnel at all times;
- Do not store chemicals within 50 feet of a storm drain or waterway; and
- All spills must be documented and properly cleaned up immediately.

### **14.2 Spill Prevention and Response Training**

Prior to project startup, personnel and contractors will be trained in the following spill control procedures by the Erosion Control Specialist/Qualified Stormwater Manager.

- Chemicals planned to be used on site;
- Spill control;
- Containment, vessel, tank, and piping inspection and maintenance;
- Spill response, containment, and clean-up; and
- Company policies on reporting and responding to spills.

### 14.3 Environmental Sensitive Areas

Wetlands exist on the east side of Tennyson within Clear Creek Valley Park. Erosion and sediment control measures including silt fencing and rock socks will be implemented as shown on the Erosion and Sediment Control Plans to prevent any potential impact to the area.

### 14.4 Spill Reporting and Cleanup Contacts

All responsible personnel and their corresponding contact information are presented in the table below.

Responsibility	Name and Title	Phone Number
Emergency Local Fire, Police, & Ambulance	N/A	911
EPA National Response Center	N/A	1-800-424-8802
CDPHE Spill Reporting Hotline	N/A	1-877-518-5608
Primary Contact for Spills	TBD	TBD
Secondary Contact for Spills	TBD	TBD
On-Site Spill Responder	TBD	TBD
Arvada Stormwater Team	Jake Moyer/Stormwater Administrator	720-898-7812

### 14.5 Location of Spill Kits

The kit will contain an absorbent boon, absorbent rags, absorbent litter and an over-pack drum to storm the material. Spill kit materials should be replenished after use in the field. Spill kits should be inspected regularly to check if materials need to be replenished.

Type of Spill Kit	Location
TBD	TBD

### 14.6 Quantities of Chemical and Locations Stored On-Site

The following is a table of chemical quantities and where they are located on site. (Note: Also refer to the Potential Pollutants list and evaluation in Section 8 of this SWMP.)

Material	Quantity	Staging/Storage Location
TBD	TBD	TBD



## 14.7 Chemical Container Labeling

Any products/chemicals that are located or stored on site shall be properly labeled as to the contents of the material. The Safety Data Sheet (SDS) for all products/chemicals utilized on site can be found in a notebook at the project trailer.

## 14.8 Minor Spills (less than 5 gallons)

Notification and cleanup procedures to be implemented in the event of a spill for spills which do not enter state waters or are under reporting limits of the chemical of concern (e.g. diesel fuel, hydraulic fluid, motor oil, used hydraulic fluid and motor oil, tack oil).

- Minor spills typically involve small quantities of oil, gasoline, paint, etc. which can be controlled by the first responder at the discovery of the spill.
- Use absorbent materials on small spills rather than hosing down or burying the spills.
- Absorbent materials should be promptly removed and disposed of properly.
- Follow the practice below for a minor spill:
  - Contain the spread of the spill.
  - Recover spilled materials.
  - Clean the contaminated area and properly dispose of contaminated materials.
- Keep within permitted area.
- It must not threaten any stormwater conveyance.

## 14.9 Major Spills (greater than 5 gallons)

Significant spill procedures for spills of any size that enter state waters or have the potential to do so and can be controlled by the first responder along with the aid of other trained personnel. Section 13.4 above contains spill notification contacts and phone numbers. This response may require all work to stop. Spills must be clean up immediately

- Contain spread of the spill.
- Notify the project foreman immediately.
- If the spill occurs on paved or impermeable surfaces, clean up using dry methods. Contain the spill by encircling with absorbent materials and do not let the spill spread. Make sure nearby storm drains and waterways are protected.
- If the spill occurs in a dirt area, immediately contain the spill by constructing an earthen berm. Dig up and properly disposed of contaminated soil.
- If the spill occurs during a rain event, cover the spill with tarps, visqueen or similar material to prevent contaminating runoff. Make sure nearby storm drains and waterways are protected.

## 14.10 Notification of Regulatory Agencies

For non-hazardous materials which may endanger health or the environment; spills or discharge of hazardous substance or oil, which may cause pollution of the waters of the state; the following measures shall be implemented:

- Contact the CDPHE Environmental Emergency Spill Reporting Line (1-877-518-5608) within 24 hours of the spill event. A written notification to the CDPHE-EMP is necessary within 5 days.
- Contact the Colorado State Patrol 24-hour hotline (1-303-239-4501) if the spill is on a state highway.
- Report spill to the Project Engineer.
- Call the Arvada Stormwater Hotline (720-898-7640) if spilled material spreads to a Westminster storm drain or a waterway.

For spills involving hazardous materials, the following measures shall be implemented:

- Contact the local emergency response team by dialing 911.
- Contact the CDPHE Environmental Emergency Spill Reporting Line (1-877-518-5608) within 24 hours of the spill event. A written notification to the CDPHE-EMP is necessary within 5 days.
- Contact the Colorado State Patrol 24-hour hotline (1-303-239-4501) if the spill is on a state highway.
- Call the Arvada Stormwater Hotline (720-898-7640) if spilled material spreads to a Westminster storm drain or a waterway.

## **15.0 FINAL STABILIZATION**

### **15.1 Establishing Final Stabilization**

Final stabilization is reached when all ground surface disturbing activities at the construction site are complete; and, for all areas of ground surface disturbing activities, a uniform vegetative cover with an individual plant density of at least 70 percent (uniform) of what would have been provided by native vegetation in a local, undisturbed area.

### **15.2 Final Stabilization Measures**

Asphalt will be used as a final stabilization measure along the majority of the project. In the south section of Tennyson St, installation of the piping will occur next to an existing storm swale. In this section, vegetative cover will be used to achieve final stabilization in accordance with Section 1000 of the City of Arvada's Engineering Standards and Specifications.

Whenever possible, topsoil shall be preserved for the section affecting the existing storm swale. If sufficient material is not available, the contractor shall furnish and install imported topsoil. Topsoil shall not be placed until the areas to be covered have been properly prepared and grading operations in the area have been completed. Areas to receive topsoil shall be scarified to a 6-inch depth to improve the bond of topsoil to subsoil. Topsoil shall be placed to a minimum depth of 6-inches after settlement and spread evenly and graded to elevations and slopes shown on the approved plans.

**All final stabilization methods shall be in accordance with Section 1000 of the City of Arvada's Engineering Standards and Specifications**

#### **15.2.1 Seeding Plan**

This area shall be seeded with Native Seed consisting of the following:

1. 20% Perennial Ryegrass, Elgon (Tetraploid)
2. 20% Desert Wheat Grass (Nordan)
3. 10% Blue Grama (Alma)
4. 10% Side Oats Grama (Butte)
5. 10% Big Bluestem (Bison)
6. 10% Coated Creeping Meadow Foxtail (Garrison)
7. 10% Indian Grass (Tomahawk)
8. 10 % Streambank Wheatgrass (Sodar)

Seeding shall be hydroseeded unless other method is approved. If hydroseeding is used, it shall occur as a separate process prior to hydro-mulching. Seed and mulch shall not be mixed together in one slurry application process. Seeding may be by hand or mechanical broadcasted if the area is

not accessible to machine methods. All seed sown by broadcast-type seeders shall be “raked in” or otherwise covered with soil to a depth of at least 1 1/4- inch.

Mulching shall be applied immediately after seeding. Hydro-mulch (wood fibers in a water slurry) shall be applied at a minimum rate of 2,000 lbs/acre with a three (3) percent guar gum tackifier. Mulch netting may be used if seeding is hand or mechanical broadcasted. Mulch netting shall be firmly held in place with pins spaced not more than ten linear feet apart. In sandy or extremely loose soil, the pins shall be located not more than 5 linear feet apart.

An erosion control blanket/ mulch control netting may be used if appropriate to sustain vegetation and provide slope stabilization if flow conditions are expected to be high.

### **15.2.2 Reseeding Operations /Corrective Stabilization**

Areas where seed has not germinated after one season will be evaluated by the City. Areas that have not germinated will have seed, mulch and mulch tackifier (or blanket) reapplied in accordance with Section 1000 of the City’s Engineering Standards and Specifications.

### **15.3 Long-Term/Permanent Stormwater Control Measures**

Site will be returned to pre-construction vegetative conditions.

## **16.0 INSPECTIONS**

During construction the site will be inspected by a Qualified Stormwater Manager at one of the following frequencies approved by the CDPHE:

- At least one inspection every 7 calendar days
- At least one inspection every 14 calendar days including post storm inspections within 24 hours of a storm that causes surface erosion.

The City of Westminster allows a 14-day and post storm inspection frequency.

Inspect the following areas for evidence of, or the potential for, pollutants leaving the construction site boundaries, entering the stormwater drainage system, or discharging to state waters:

- Construction site perimeter;
- All disturbed areas;
- Designated haul routes;
- Material and waste storage areas exposed to precipitation;
- Locations where stormwater has the potential to discharge offsite; and
- Locations where vehicles exit the site.

A reduced frequency inspection schedule may be followed with approval from the City of Westminster for the following site conditions:

- Inspections at completed sites that are awaiting final stabilization
- Winter conditions exclusion

A copy of a blank inspection form is included in **Appendix E**. Completed inspection forms must be kept on site or be easily accessible via an electronic format.

## **17.0 RECORDKEEPING**

A copy of this SWMP and all inspection records must be retained for three years from the permit termination date.

## **APPENDIX A**

### **CDPS Construction Permit**

Note: To be provided by contractor



## **APPENDIX B**

### **EROSION AND SEDIMENT CONTROL PLANS, BMP DETAILS, AND LANDSCAPE PLANS**



CITY OF ARVADA EROSION CONTROL NOTES	
1.	AT ANYTIME THE CITY DETERMINES THE PROJECT TO BE OUT OF COMPLIANCE WITH EROSION AND SEDIMENT CONTROL/GOOD HOUSEKEEPING REQUIREMENTS, THEY HAVE THE AUTHORITY TO IMMEDIATELY STOP WORK ON THE PROJECT UNTIL THE DETERMINATION HAS BEEN MADE BY THE CITY STAFF THAT THE SITE HAS REGAINED COMPLIANCE WITH REQUIREMENTS.
2.	THE CONTRACTOR SHALL ENSURE STORMWATER QUALITY BEST MANAGEMENT PRACTICES SHALL BE IMPLEMENTED TO MINIMIZE SOIL EROSION, SEDIMENTATION, INCREASED POLLUTANT LOADS, AND CHANGED WATER FLOW CHARACTERISTICS RESULTING FROM LAND DISTURBING ACTIVITY TO THE MAXIMUM EXTENT PRACTICAL, SO AS TO MINIMIZE POLLUTION TO THE MS4 OR RECEIVING WATERS.
3.	CONTRACTOR SHALL BE RESPONSIBLE FOR ANY REQUIRED STATE OR LOCAL PERMITS. STANDARD FEES FOR THE CITY PERMIT SHALL BE WAIVED BY THE CITY. THE CITY RESERVES THE RIGHT TO WITHHOLD RETAINAGE ON A PROJECT AS NECESSARY FOR PERFORMANCE OF MAINTENANCE ON BMP'S DUE TO CONTRACTOR'S FAILURE TO COMPLY OR PERFORM EROSION CONTROL MEASURES IN ACCORDANCE WITH THIS PLAN.
4.	AT A MINIMUM ALL BEST MANAGEMENT PRACTICES (BMP'S) AS GENERALLY OUTLINED IN STANDARD DRAWINGS, IN ACCORDANCE WITH THE CITY OF ARVADA SITE DEVELOPMENT PERMIT REQUIREMENTS AND IN ACCORDANCE WITH APPROVED INSTALLATION AND MAINTENANCE DETAILS, SHALL BE CORRECTLY INSTALLED AND FUNCTIONING AS DESIGNED AT ALL TIMES.
5.	CONTRACTOR SHALL DESIGNATE AN EROSION CONTROL REPRESENTATIVE AVAILABLE ON-CALL AT ALL TIMES. REPRESENTATIVE SHALL PERFORM ROUTINE AND POST-STORM INSPECTIONS OF ALL BMP'S PER CITY SITE DEVELOPMENT PERMIT REQUIREMENTS.
6.	ALL BMP'S IDENTIFIED BY THE CITY AS DEFICIENT SHALL BE MAINTAINED, REPAIRED, OR INSTALLED BY CONTRACTOR AS SOON AS POSSIBLE, IN MOST CASES IMMEDIATELY.
7.	CONTRACTOR IS RESPONSIBLE FOR IMPLEMENTING AND MAINTAINING EROSION AND SEDIMENT CONTROL MEASURES AT ALL TIMES BEFORE, DURING AND AFTER LAND DISTURBING ACTIVITIES. SUCH MEASURES SHALL BE PLACED AS CONSTRUCTION SEQUENCING AND ACCESS DICTATES. CONTRACTOR SHALL REMOVE ALL SEDIMENT FROM EROSION CONTROL MEASURES AFTER EACH EROSION EVENT, AS NEEDED AND AT THE DIRECTION OF THE CITY.
8.	THE CITY MAY REQUEST THE MODIFICATION OF THE EROSION AND SEDIMENT CONTROLS AS FIELD CONDITIONS WARRANT.
9.	SEE ARVADA DETAILS FOR BMP INSTALLATION AND MAINTENANCE STANDARDS FOR THE FOLLOWING BMP'S: ROCK SOCKS, INLET PROTECTION, SILT FENCE, SEDIMENT CONTROL LOGS, CONCRETE WASHOUT AREA, EROSION CONTROL BLANKET, STABILIZED STAGING AREA AND VEHICLE TRACKING CONTROL. OTHER APPROVED BMP INSTALLATION/MAINTENANCE DETAILS CAN BE FOUND IN THE UDFCD VOLUME III CRITERIA MANUAL.
10.	SURFACE DRAINAGE PASSING THROUGH OR ORIGINATING FROM EACH SITE SHALL BE TREATED/CAPTURED BY ONE OR MORE BMP'S DEPENDENT ON AREA OF DISTURBANCE.
11.	SOIL STABILIZATION MEASURES SHALL BE IMPLEMENTED WITHIN 14 DAYS TO ALL DISTURBED AREAS THAT MAY OR MAY NOT BE AT FINAL GRADE BUT WILL REMAIN UNDISTURBED FOR PERIODS LONGER THAN 30 CALENDAR DAYS OR FOR AN INDETERMINATE LENGTH OF TIME.
12.	ALL TEMPORARY EROSION AND SEDIMENT CONTROL BMP'S MUST BE REMOVED UPON FINAL STABILIZATION.
13.	ALL CONSTRUCTION WASTES, FUEL, LUBRICANTS, CHEMICAL WASTES, TRASH OR DEBRIS SHALL BE CONTAINED WHEN STORED ON-SITE AND PROTECTED FROM CONTACT WITH RAIN/SNOWFALL OR SURFACE RUNOFF. PROPER DISPOSAL OF SUCH WASTES SHALL BE IMMEDIATE AND THE RESPONSIBILITY OF THE CONTRACTOR.
14.	ROUTINE VEHICLE MAINTENANCE SHALL NOT BE PERFORMED ON-SITE. IF EQUIPMENT MAINTENANCE/REPAIR BECOMES NECESSARY, APPROPRIATE BMP'S SHALL BE IMPLEMENTED SUCH AS DRIP PANS, SPILL MATERIALS, ETC. ON-SITE FUELING SHOULD BE PERFORMED BY DELIVERY VEHICLES WITH ADEQUATE SPILL PREVENTION AND RESPONSE CAPABILITY.
15.	CONCRETE WASHOUT ACTIVITIES MUST BE CONDUCTED IN A MANNER THAT DOES NOT CONTRIBUTE POLLUTANTS TO SURFACE WATERS OR STORMWATER RUNOFF. CONCRETE WASHOUT SHALL BE PERFORMED IN A DESIGNATED CONCRETE WASHOUT AREA OR OFF-SITE WASHOUT. PORTABLE UNITS ARE ACCEPTABLE WITH A MANUFACTURERS SPECIFICATION.
16.	CONTRACTOR IS RESPONSIBLE FOR CONTROLLING DUST EMISSIONS. A WATER TRUCK SHALL BE USED WITHIN TWENTY-FOUR (24) HOURS OF REQUEST BY CITY.
17.	CONTRACTOR IS RESPONSIBLE FOR THE REMOVAL OF TRACKED MATERIALS ON STREETS, SIDEWALKS, DRIVEWAYS OR PARKING LOTS. TRACKED MATERIAL SHALL BE REMOVED IMMEDIATELY BY SCRAPING AND SWEEPING. FLUSHING MATERIALS FROM HARD SURFACE WITH WATER IS PROHIBITED. CONTRACTOR SHALL HAVE ACCESS TO MEANS OF MECHANICAL SWEEPING AT ALL TIMES.
18.	AREAS TO BE RESEDED AT THE COMPLETION OF UTILITY INSTALLATION OR GRADING ACTIVITIES SHALL BE IN ACCORDANCE WITH UDFCD VOL III SEED/MULCH SPECIFICATIONS.
19.	NECESSARY EROSION CONTROL MEASURES MUST REMAIN IN PLACE AND FUNCTIONING AS DESIGNED UNTIL A VIABLE VEGETATIVE COVER HAS BEEN ESTABLISHED OR ROAD RESURFACED.
20.	IN HIGH TRAFFIC AREAS WHERE LANE CLOSURES ARE OPENED AT THE END OF THE WORK DAY, BMP'S MAY BE REMOVED AT THE END OF THE DAY AND REINSTALLED AT THE BEGINNING OF THE NEXT WORK DAY PROVIDED ALL DIRT AND MATERIALS ARE REMOVED FROM THE AREA AND AT THE DISCRETION OF THE CITY OF ARVADA INSPECTOR.

<b>APPROVED</b> City of Arvada, Colorado	
CITY ENGINEER	DATE
JOB NUMBER	
<small>REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.</small>	
NO	REVISION
	DATE
	BY

ADAMS COUNTY EROSION CONTROL NOTES	
<u>GENERAL:</u>	
1.	ALL CONSTRUCTION PROJECTS, REGARDLESS OF THE SIZE, SHALL INSTALL, MAINTAIN AND REPAIR STORMWATER POLLUTION CONTROL MEASURES (CM'S) TO EFFECTIVELY MINIMIZE EROSION, SEDIMENT TRANSPORT, AND THE RELEASE OF POLLUTANTS RELATED TO CONSTRUCTION ACTIVITY. CM'S EXAMPLE INCLUDE: SEDIMENT CONTROL LOGS (SCL), SILT FENCE (SF), DIKES/SWALES, SEDIMENT TRAPS (ST), INLET PROTECTION (IP), OUTLET PROTECTION (OP), CHECK DAMS (CD), SEDIMENT BASINS (SB), TEMPORARY/PERMANENT SEEDING AND MULCHING (MU), SOIL ROUGHENING, MAINTAINING EXISTING VEGETATION AND PROTECTION OF TREES. CM'S MUST BE SELECTED, DESIGNED, ADEQUATELY SIZED, INSTALLED AND MAINTAINED IN ACCORDANCE WITH GOOD ENGINEERING, HYDROLOGIC AND POLLUTION CONTROL PRACTICES. CM'S/BMP'S INSTALLATION AND MAINTENANCE DETAILS SHALL CONFORM TO URBAN DRAINAGE FLOOD CONTROL CRITERIA MANUAL VOLUME 3, OR THE COLORADO DEPARTMENT OF TRANSPORTATION (CDOT) ITEM CODE BOOK. CM'S MUST FILTER, SETTLE, CONTAIN OR STRAIN POLLUTANTS FROM STORMWATER FLOWS IN ORDER TO PREVENT BYPASS OF FLOWS WITHOUT TREATMENT. CM'S MUST BE APPROPRIATE TO TREAT THE RUNOFF FROM THE AMOUNT OF DISTURBED AREA, THE EXPECTED FLOW RATE, DURATION, AND FLOW CONDITIONS (I.E. SHEET OR CONCENTRATED FLOW). CM'S/BMP'S SHALL BE SPECIFIED IN THE SWMP (IF APPLICABLE), AND THE LOCATIONS SHOWN ON THE EC PLAN.
1)	PRIOR TO CONSTRUCTION, PROJECTS DISTURBING 1 OR MORE ACRES OF LAND, OR ANY PROJECT BELONGING TO A COMMON PLAN OF DEVELOPMENT DISTURB 1 OR MORE ACRES, MUST OBTAIN: <ul style="list-style-type: none"> <li>A GENERAL PERMIT FOR STORMWATER DISCHARGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES, FROM THE COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT, AND</li> <li>AN ADAMS COUNTY STORMWATER QUALITY PERMIT WITHIN THE UNINCORPORATED ADAMS COUNTY MS4 AREA.</li> </ul>
2)	PERMITTED PROJECTS SHALL DEVELOP A STORMWATER MANAGEMENT PLAN (SWMP), AKA EROSION AND SEDIMENT CONTROL PLAN (ESCP), IN COMPLIANCE WITH CDPHE MINIMUM REQUIREMENTS. THE APPROVED SWMP, INCLUDING EROSION CONTROL (EC) PLAN (SITE MAP), SHALL BE KEPT ON-SITE AND UPDATED AT ALL TIMES. THE QUALIFIED STORMWATER MANAGER IS RESPONSIBLE FOR IMPLEMENTING THE SWMP AND CM'S (AKA BMP'S) DURING CONSTRUCTION.
3)	PERMITTED PROJECTS SHALL PERFORM REGULAR STORMWATER INSPECTIONS EVERY 7 CALENDAR DAYS, OR EVERY 14 CALENDAR DAYS AND WITHIN 24 HOURS AFTER ANY PRECIPITATION OR SNOWMELT EVENT THAT CAUSES SURFACE EROSION. INSPECTION FREQUENCY CAN BE REDUCED FOR POST-STORM EVENT INSPECTIONS AT TEMPORARILY IDLE SITES AND ALSO FOR STORMWATER INSPECTIONS AT COMPLETED SITES WAITING FOR FINAL STABILIZATION. INSPECTION REPORTS MUST IDENTIFY ANY INCIDENTS OF NON-COMPLIANCE.
4)	TRACKING OF DIRT ONTO PAVED PUBLIC OR PRIVATE PAVED ROADS IS NOT ALLOWED. THE USE OF DIRT RAMPS TO ENTER/EXIT FROM AN UNPAVED INTO A PAVED AREA IS PROHIBITED. VEHICLE TRACKING CONTROLS SHALL BE IMPLEMENTED, OTHERWISE ENTRANCE AREA MUST DRAIN THRU A CM TOWARDS THE PRIVATE SITE.
5)	TRUCK LOADS OF FILL MATERIAL IMPORTED TO OR CUT MATERIAL EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT LOSS OF THE MATERIAL DURING TRANSPORTATION ON PUBLIC RW. HAUL ROUTES MUST BE PERMITTED BY THE COUNTY. NO MATERIAL SHALL BE TRANSPORTED TO ANOTHER SITE WITHOUT APPLICABLE PERMITS.
6)	CONTROL MEASURES DESIGNED FOR CONCRETE WASHOUT WASTE MUST BE IMPLEMENTED. THIS INCLUDES WASHOUT WASTE DISCHARGED TO THE GROUND AND WASHOUT WASTE FROM CONCRETE TRUCKS AND MASONRY OPERATIONS.
7)	TEMPORARY CM'S/BMP'S SHALL BE REMOVED AFTER THE SITE HAS REACHED FINAL STABILIZATION.
8)	DEWATERING OPERATIONS DISCHARGING OFF-SITE INTO ANY WATERS CONVEYANCE SYSTEMS INCLUDING WETLANDS, IRRIGATION DITCHES, CANALS, RIVERS, STREAMS, OR STORM SEWER SYSTEMS, REQUIRE A STATE CONSTRUCTION DEWATERING PERMIT.
9)	PERMITTED PROJECTS SHALL KEEP THE CDPHE'S STORMWATER DISCHARGE PERMIT, STORMWATER MANAGEMENT PLAN (SWMP) AND INSPECTION LOGS AVAILABLE ON-SITE THROUGHOUT THE DURATION OF THE PROJECT, AND FOR AN ADDITIONAL 3 YEARS AFTER PERMIT CLOSE-OUT.
10)	PERMITTED LANDOWNER AND/OR CONTRACTOR SHALL CLOSE THE STATE AND CITY/COUNTY PERMIT ONCE FINAL STABILIZATION IS REACHED. STORMWATER INSPECTIONS SHALL CONTINUE UNTIL INACTIVATION NOTICE IS FILED WITH CDPHE.

<b>DESIGNED</b> TS	
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ADAMS COUNTY EROSION CONTROL NOTES (CONT)	
<u>PERFORMANCE STANDARD:</u>	
1.	STORMWATER RUNOFF FROM DISTURBED AREAS MUST FLOW TO AT LEAST ONE (1) CM TO MINIMIZE SEDIMENT IN THE DISCHARGE. DO NOT ALLOW SEDIMENT TO LEAVE THE SITE. THE BEST WAY TO PREVENT SEDIMENT OR POLLUTANTS FROM ENTERING THE STORM SEWER SYSTEM IS TO STABILIZE THE SITE AS QUICKLY AS POSSIBLE, PREVENTING EROSION AND STOPPING SEDIMENT RUN-OFF AT ITS SOURCE.
2.	PHASE CONSTRUCTION TO MINIMIZE DISTURBED AREAS, INCLUDING DISTURBANCE OF STEEP SLOPES (I.E. THE ENTIRE PROJECT SITE SHOULD NOT BE DISTURBED IF CONSTRUCTION WILL ONLY BE OCCURRING IN ONE PARTICULAR SECTION OF THE SITE). LIMIT SOIL EXPOSURE TO THE SHORTEST POSSIBLE PERIOD OF TIME. PROTECT NATURAL FEATURES AND EXISTING VEGETATION WHENEVER POSSIBLE. REMOVAL OF EXISTING VEGETATION SHALL BE LIMITED TO THE AREA REQUIRED FOR IMMEDIATE CONSTRUCTION OPERATIONS. MAINTAIN PRE-EXISTING VEGETATION (OR EQUIVALENT CM'S) FOR AREAS WITHIN 50 HORIZONTAL FEET OF RECEIVING WATERS.
3.	SOIL COMPACTION MUST BE MINIMIZED FOR AREAS WHERE INFILTRATION CM'S WILL OCCUR OR WHERE FINAL STABILIZATION WILL BE ACHIEVED THROUGH A VEGETATIVE COVER.
4.	ALL SOIL IMPORTED TO OR EXPORTED FROM THE SITE SHALL BE PROPERLY COVERED TO PREVENT THE LOSS OF MATERIAL DURING TRANSPORT.
5.	DUST EMISSIONS RESULTING FROM GRADING ACTIVITIES OR WIND SHALL BE CONTROLLED.
6.	INSTALL CONSTRUCTION FENCE (ORANGE) TO PROTECT WETLANDS AND OTHER SENSITIVE AREAS AND THE PREVENT ACCESS, AND TO DELINEATE THE LIMITS OF CONSTRUCTION. DO NOT USE SILT FENCE TO PROTECT WETLANDS SINCE TRENCHING MAY IMPACT THESE AREAS.
7.	CM'S INTENDED TO CAPTURE OVERLAND, LOW VELOCITY SHEET FLOW AT A FAIRLY LEVEL GRADE SHALL ONLY BE INSTALLED ALONG CONTOURS.
8.	INSTALL CM'S, SUCH AS CHECK DAMS, PERPENDICULAR TO THE CONCENTRATED FLOWS TO REDUCE FLOW VELOCITY.
9.	STORM DRAIN INLETS WITHIN AND ADJACENT TO THE CONSTRUCTION SITE MUST BE PROTECTED. ANY PONDING OF STORMWATER AROUND INLET PROTECTION MUST NOT CAUSE EXCESSIVE FLOODING OR DAMAGE ADJACENT AREAS OR STRUCTURES.
10.	INSTALL VEHICLE TRACKING CONTROL (VTC) TO ENTER/EXIT UNPAVED AREA. DO NOT USE RECYCLED CRUSHED CONCRETE OR ASPHALT MILLINGS FOR VEHICLE TRACKING PADS.
11.	STRAW BALES SHALL NOT BE USED FOR PRIMARY EROSION OR SEDIMENT CONTROL (I.E. STRAW BALES MAY BE USED FOR REINFORCEMENT BEHIND ANOTHER BMP SUCH AS A SILT FENCE).
12.	OUTLETS SYSTEMS (SUCH AS SKIMMER OR PERFORATED RISER PIPE) SHALL BE INSTALLED TO WITHDRAW WATER FROM OR NEAR THE SURFACE LEVEL WHEN DISCHARGING FROM BASINS. WATER CANNOT DRAIN FROM THE BOTTOM OF THE POND.
13.	TEMPORARY STABILIZATION MUST BE IMPLEMENTED FOR EARTH DISTURBING ACTIVITIES ON ANY PORTION OF THE SITE WHERE LAND DISTURBING ACTIVITIES HAVE PERMANENTLY OR TEMPORARILY CEASED (FOR MORE THAN 14 CALENDAR DAYS). TEMPORARY STABILIZATION METHODS EXAMPLES: TARPS, SOIL TACKIFIER, AND HYDROSEED. TEMPORARY STABILIZATION REQUIREMENT MAY EXCEED THE 14-DAY SCHEDULE WHEN EITHER THE FUNCTION OF THE SPECIFIC AREA REQUIRES IT TO REMAIN UNDISTURBED, OR PHYSICAL CHARACTERISTICS OF THE TERRAIN AND CLIMATE PREVENT STABILIZATION AS LONG AS THE CONSTRAINTS AND ALTERNATIVE SCHEDULE IS DOCUMENTED ON THE SWMP, AND LOCATIONS ARE IDENTIFIED ON THE EC PLAN (SITE MAP).
14.	RUNOFF FROM STOCKPILE AREA MUST BE CONTROLLED. SOILS THAT WILL BE STOCKPILED FOR MORE THAN 30 DAYS SHALL BE PROTECTED FROM WIND AND WATER EROSION WITHIN 14 DAYS OF STOCKPILE CONSTRUCTION. INSTALL CM'S/BMP'S 5 FEET AWAY FROM THE TOE OF THE STOCKPILE'S SLOPE.
15.	WATER USED TO CLEAN CONCRETE TRUCKS SHALL BE DISCHARGED INTO A CONCRETE WASHOUT AREA (CWA). THE PREDEFINED CONTAINMENT AREA MUST BE IDENTIFIED WITH A SIGN, AND SHALL ALLOW THE LIQUIDS TO EVAPORATE OR DRY OUT. CWA DISCHARGES THAT MAY REACH GROUNDWATER MUST FLOW THROUGH SOIL THAT HAS BUFFERING CAPACITY PRIOR TO REACHING GROUNDWATER. THE CONCRETE WASHOUT LOCATION SHALL NOT BE LOCATED IN AN AREA WHERE SHALLOW GROUNDWATER MAY BE PRESENT AND WOULD RESULT IN BUFFERING CAPACITY NOT BEING ADEQUATE, SUCH AS NEAR NATURAL DRAINAGES, SPRINGS, OR WETLANDS. IN THIS CASE, A LINER UNDERNEATH IS NEEDED FOR AREAS WITH HIGH GROUNDWATER LEVELS. CWA SHALL NOT BE PLACED IN LOW AREAS, DITCHES OR ADJACENT TO STATE WATERS. PLACE CWA 50 FEET AWAY FROM STATE WATERS.
16.	WASTE, SUCH AS BUILDING MATERIALS, WORKERS TRASH AND CONSTRUCTION DEBRIS, MUST BE PROPERLY MANAGED TO PREVENT STORMWATER POLLUTION.
17.	INSTALL STABILIZED STAGING AREAS (SSA) TO STORE MATERIALS, CONSTRUCTION TRAILER, ETC.
18.	IF CONDITIONS IN THE FIELD WARRANT ADDITIONAL CM'S/BMP'S TO THE ONES ORIGINALLY APPROVED ON THE SWMP OR EC PLAN (CIVIL DRAWING), THE LANDOWNER OR CONTRACTOR SHALL IMPLEMENT MEASURES DETERMINED NECESSARY, AS DIRECTED BY THE COUNTY.
19.	PERMANENT CM'S/BMP'S FOR SLOPES, CHANNELS, DITCHES, OR DISTURBED LAND AREA SHALL BE PERFORMED IMMEDIATELY AFTER FINAL GRADING. CONSIDER THE USE OF EROSION CONTROL BLANKETS ON SLOPES 3:1 OR STEEPER AND AREAS WITH CONCENTRATED FLOWS SUCH AS SWALES, LONG CHANNELS AND ROADSIDE DITCHES.
20.	THE DISCHARGE OF SANITARY WASTE INTO THE STORM SEWER SYSTEM IS PROHIBITED. PORTABLE TOILETS MUST BE PROVIDED, SECURED AND PLACED ON PERMEABLE SURFACES, AWAY FROM THE CURBSIDE, STORM INLETS AND/OR DRAINAGE WAYS.
21.	REMOVE TEMPORARY CM'S/BMP'S ONCE FINAL STABILIZATION IS REACHED, UNLESS OTHERWISE AUTHORIZED.
22.	FINAL STABILIZATION MUST BE IMPLEMENTED. FINAL STABILIZATION IS REACHED WHEN ALL SOIL DISTURBING ACTIVITIES HAVE BEEN COMPLETED, AND EITHER A UNIFORM VEGETATIVE COVER HAS BEEN ESTABLISHED WITH AN INDIVIDUAL PLANT DENSITY OF AT LEAST 70% OF PRE-DISTURBED LEVELS, OR EQUIVALENT PERMANENT ALTERNATIVE METHOD HAS BEEN IMPLEMENTED.

	<b>CITY OF ARVADA</b> <b>NORTH TRUNK SEWER IMPROVEMENTS</b> <b>NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11</b>
	<b>Kennedy Jenks</b>

ADAMS COUNTY EROSION CONTROL NOTES (CONT)	
<u>PERFORMANCE STANDARD (CONT):</u>	
23.	PROVIDE SPILL PROTECTION AND CONTAINMENT MEASURES FOR CONSTRUCTION MATERIALS, WASTE AND FUEL STORAGE AREAS. BULK STORAGE (55 GALLONS OR GREATER) OF PETROLEUM PRODUCTS AND LIQUID CHEMICALS MUST HAVE SECONDARY CONTAINMENT, OR EQUIVALENT PROTECTION, IN ORDER TO CONTAIN SPILLS AND TO PREVENT SPILLED MATERIAL FROM ENTERING STATE WATERS.
24.	REPORT SPILLS OR RELEASES OF CHEMICAL, OIL, PETROLEUM PRODUCT, SEWAGE, ETC., WHICH MAY REACH THE STORM SEWER OR ENTER STATE WATERS WITHIN 24-HOURS FROM TIME OF DISCOVERY. GUIDANCE AVAILABLE AT WWW.CDPHE.STATE.CO.US/EMP/SPILLSANDRELEASED.HTML; STATE OF COLORADO SPILL-LINE: 877-518-5608; ADAMS COUNTY STORMWATER HOTLINE: 720-523-6400; PUBLIC WORKS: 303-453-8787; AND THE TRI-COUNTY HEALTH DEPARTMENT AT 303-220-9200.
<u>MAINTENANCE STANDARD:</u>	
1.	MAINTAIN AND REPAIR CM'S ACCORDING TO APPROVED EROSION CONTROL PLAN (CIVIL DRAWING) TO ASSURE THEY CONTINUE PERFORMING AS ORIGINALLY INTENDED.
2.	CM'S/BMP'S REQUIRING MAINTENANCE OR ADJUSTMENT SHALL BE REPAIRED IMMEDIATELY AFTER OBSERVATION OF THE FAILING BMP.
3.	CM'S SHALL BE CLEANED WHEN SEDIMENT LEVELS ACCUMULATE TO HALF THE DESIGN UNLESS OTHERWISE SPECIFIED.
4.	SWMP AND EC PLAN SHALL BE CONTINUOUSLY UPDATED TO REFLECT NEW OR REVISED CM'S/BMP'S DUE TO CHANGES IN DESIGN, CONSTRUCTION, OPERATION, OR MAINTENANCE, TO ACCURATELY REFLECT THE ACTUAL FIELD CONDITIONS. A NOTATION SHALL BE MADE IN THE SWMP, INCLUDING DATE OF CHANGES IN THE FIELD, IDENTIFICATION OF THE CM'S REMOVED, MODIFIED OR ADDED, AND THE LOCATIONS OF THOSE CM'S. UPDATES MUST BE MADE WITHIN 72-HOURS FOLLOWING THE CHANGE.
5.	MAINTAIN VEHICLE TRACKING CONTROL (VTC), IF SEDIMENT TRACKING OCCURS, CLEAN-UP IMMEDIATELY. SWEEP BY HAND OR USE STREET SWEEPERS (WITH VACUUM SYSTEM). FLUSHING OFF PAVED SURFACES WITH WATER IS PROHIBITED.
6.	CWA MUST BE CLEANED ONCE WASTE ACCUMULATION REACHES 2/3 OF THE WET STORAGE CAPACITY OF THE STRUCTURE. LEGALLY DISPOSE OF CONCRETE WASTE. DO NOT BURY ON-SITE.
7.	CLEAN-UP SPILLS IMMEDIATELY AFTER DISCOVERY, OR CONTAIN UNTIL APPROPRIATE CLEANUP METHODS CAN BE EMPLOYED. FOLLOW MANUFACTURER'S RECOMMENDED METHODS FOR SPILL CLEANUP, ALONG WITH PROPER DISPOSAL METHODS. RECORDS OF SPILLS, LEAKS, OR OVERFLOWS THAT RESULT IN DISCHARGE OF POLLUTANTS MUST BE DOCUMENTED AND MAINTAINED.
8.	REMOVE SEDIMENT FROM STORM SEWER INFRASTRUCTURE (PONDS, STORM PIPES, OUTLETS, INLETS, ROADSIDE DITCHES, ETC.), AND RESTORE VOLUME CAPACITY UPON COMPLETION OF PROJECT OR PRIOR TO INITIAL ACCEPTANCE OF PUBLIC IMPROVEMENTS (IF APPLICABLE). DO NOT FLUSH SEDIMENT OFF-SITE, CAPTURE ON-SITE AND DISPOSE OF AT AN APPROVED LOCATION.
<small>THESE NOTES ARE NOT INTENDED TO BE ALL-INCLUSIVE, BUT TO HIGHLIGHT THE BASIC STORMWATER POLLUTION PREVENTION REQUIREMENTS FOR CONSTRUCTION ACTIVITIES TO COMPLY WITH CDP'S STORMWATER CONSTRUCTION PERMIT AND BE IN CONFORMANCE WITH COUNTY STANDARDS.</small>	
<u>LEGEND</u>	
CONSTRUCTION FENCE	(CF)
SILT FENCE	(SF)
VEHICLE TRACKING CONTROL	(VTC)
LIMITS OF CONSTRUCTION	(LOC)
EROSION CONTROL BLANKET	(ECB)
STABILIZED STAGING AREA*	(SSA)
SEDIMENT CONTROL LOG	(SCL)
INLET PROTECTION	(IP)
CURB SOCK	(CS)
CONCRETE WASHOUT	(CWA)
DRAINAGE FLOW DIRECTION	
* STABILIZED STAGING AREA LOCATIONS TO BE DETERMINED BY THE CONTRACTOR AND APPROVED BY THE PARCEL OWNER AND CITY PRIOR TO MOBILIZATION.	

SCALE	NTS
JOB NO	2246059*00
DATE	NOV 2023
SHEET	45 OF 51
EC-601	

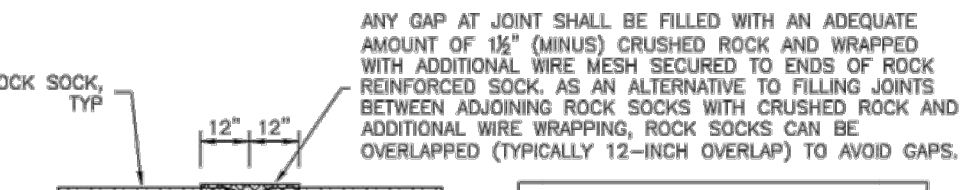
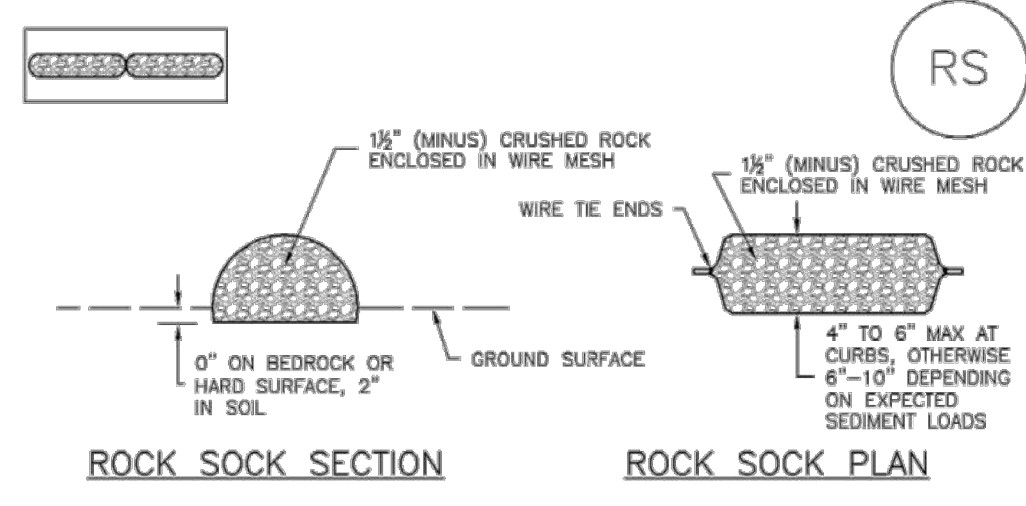


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SC-5 Rock Sock (RS)



GRADATION TABLE for Rock Sock material with sieve sizes and mass percent passing.

- ROCK SOCK INSTALLATION NOTES: 1. SEE PLAN VIEW FOR LOCATION(S) OF ROCK SOCKS. 2. CRUSHED ROCK SHALL BE 1/2" (MINUS) IN SIZE WITH A FRACTURED FACE (ALL SIDES) AND SHALL COMPLY WITH GRADATION SHOWN ON THIS SHEET (1/2" MINUS).

RS-1. ROCK SOCK PERIMETER CONTROL

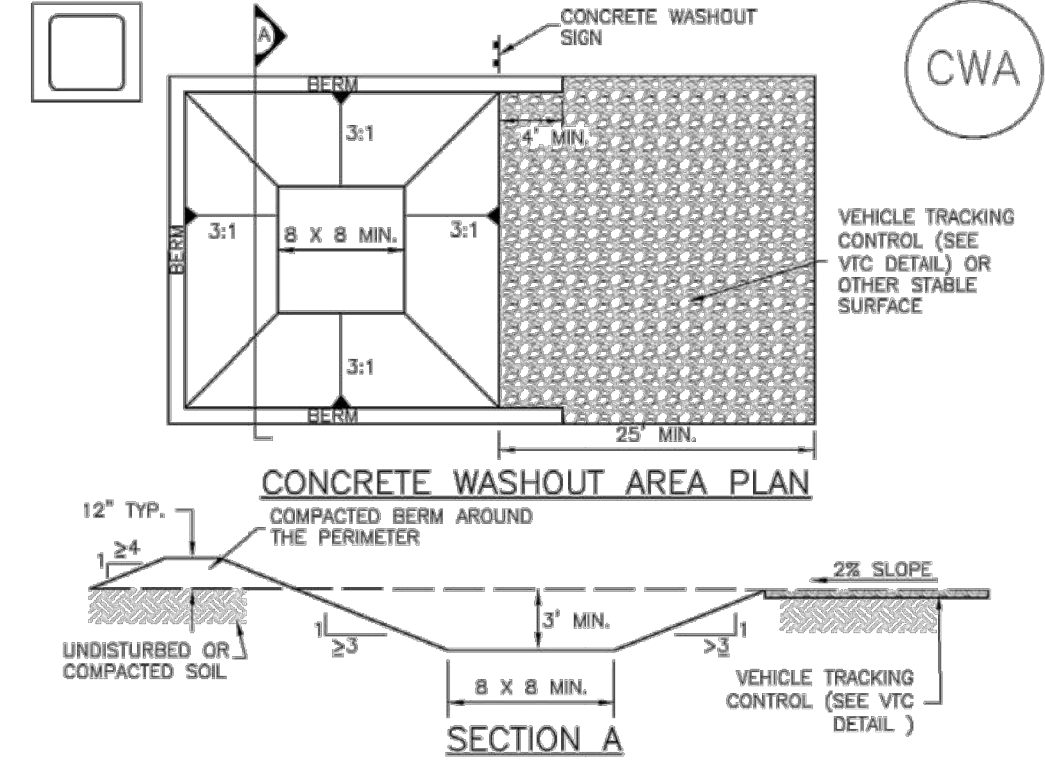
Rock Sock (RS)

- ROCK SOCK MAINTENANCE NOTES: 1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

NOTE: THE DETAILS INCLUDED WITH THIS FACT SHEET SHOW COMMONLY USED, CONVENTIONAL METHODS OF ROCK SOCK INSTALLATION IN THE DENVER METROPOLITAN AREA. THERE ARE MANY OTHER SIMILAR PROPRIETARY PRODUCTS ON THE MARKET, UDFCD NEITHER ENDORSES NOR DISCOURAGES USE OF PROPRIETARY PROTECTION PRODUCTS. HOWEVER, IN THE EVENT PROPRIETARY METHODS ARE USED, THE APPROPRIATE DETAIL FROM THE MANUFACTURER MUST BE INCLUDED IN THE SWMP AND THE BMP MUST BE INSTALLED AND MAINTAINED AS SHOWN IN THE MANUFACTURER'S DETAILS.

SC-5

Concrete Washout Area (CWA)



CWA-1. CONCRETE WASHOUT AREA

- CWA INSTALLATION NOTES: 1. SEE PLAN VIEW FOR CWA INSTALLATION LOCATION. 2. DO NOT LOCATE AN UNLINED CWA WITHIN 400' OF ANY NATURAL DRAINAGE PATHWAY OR WATERBODY. DO NOT LOCATE WITHIN 1,000' OF ANY WELLS OR DRINKING WATER SOURCES.

MM-1

- CWA MAINTENANCE NOTES: 1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

CONCRETE WASHOUT AREA

RS-2 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3 November 2010

November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

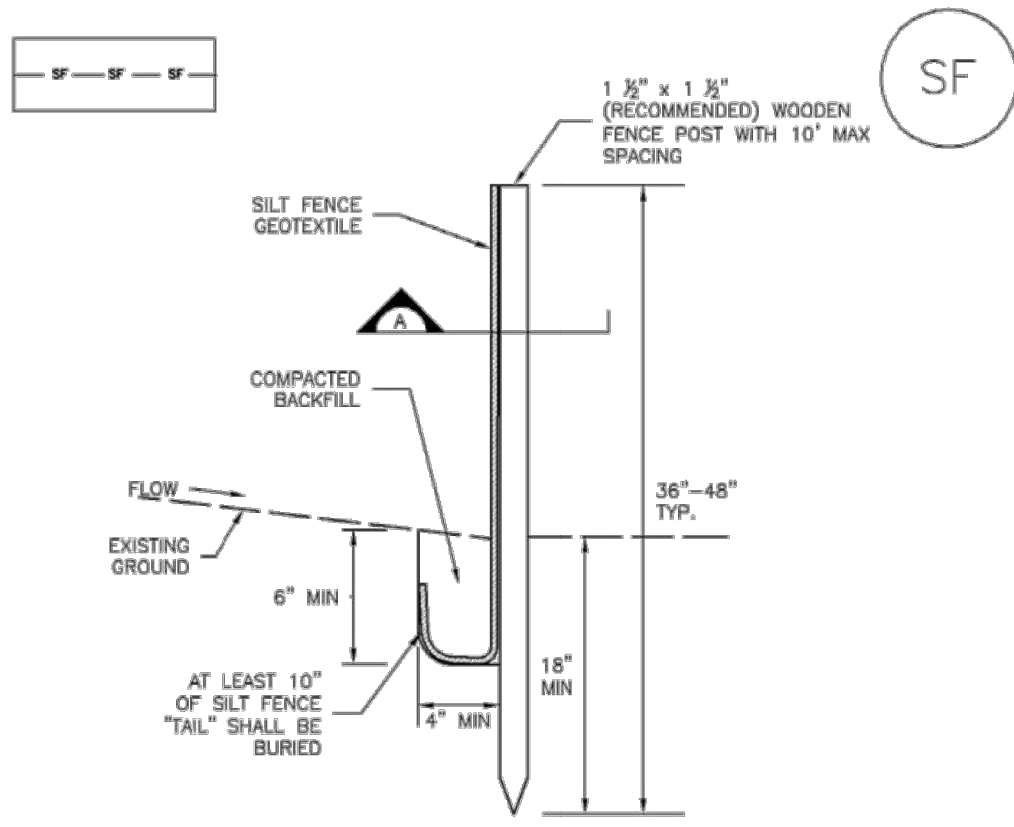
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CWA-3 CWA-4 November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

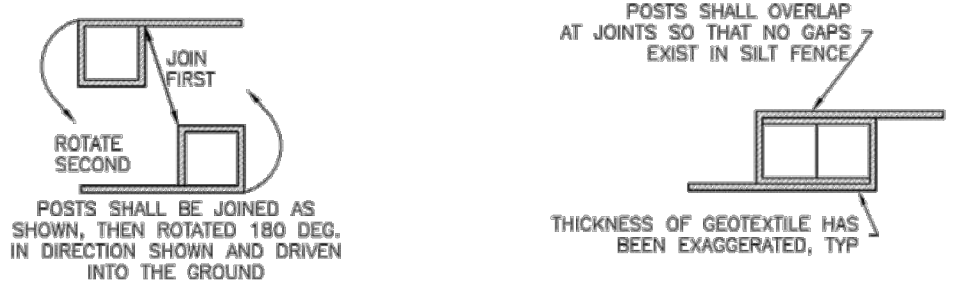
Silt Fence (SF)

SC-1

Silt Fence (SF)



SILT FENCE



SECTION A

SF-1. SILT FENCE

- SILT FENCE INSTALLATION NOTES: 1. SILT FENCE MUST BE PLACED AWAY FROM THE TOE OF THE SLOPE TO ALLOW FOR WATER PONDING. SILT FENCE AT THE TOE OF A SLOPE SHOULD BE INSTALLED IN A FLAT LOCATION AT LEAST SEVERAL FEET (2-5 FT) FROM THE TOE OF THE SLOPE TO ALLOW ROOM FOR PONDING AND DEPOSITION.

- SILT FENCE MAINTENANCE NOTES: 1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE. INSPECT BMPs AS SOON AS POSSIBLE (AND ALWAYS WITHIN 24 HOURS) FOLLOWING A STORM THAT CAUSES SURFACE EROSION, AND PERFORM NECESSARY MAINTENANCE.

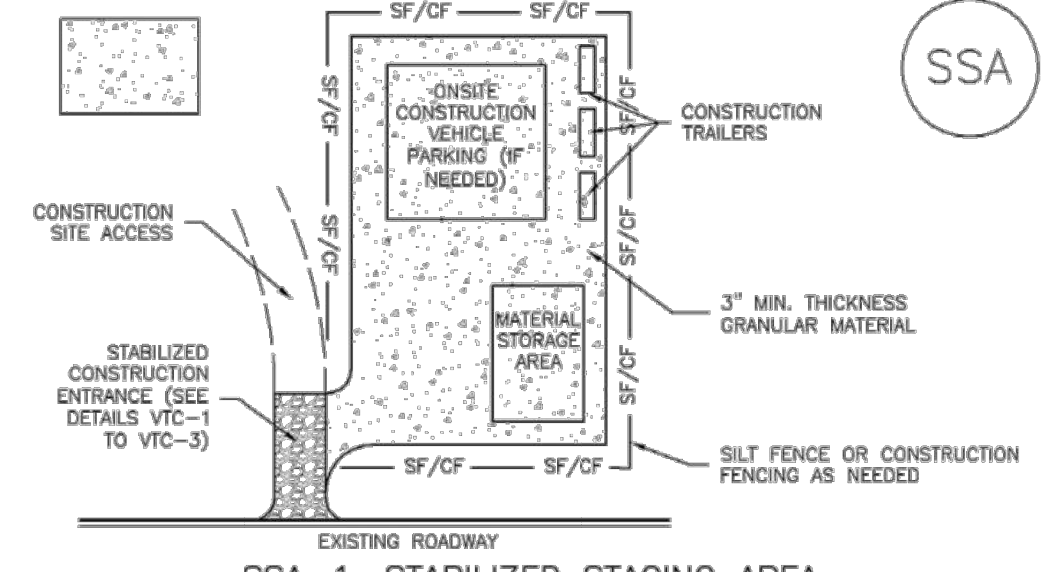
November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

SF-3 SF-4 November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

Stabilized Staging Area (SSA)

SM-6

Stabilized Staging Area (SSA)



SSA-1. STABILIZED STAGING AREA

- STABILIZED STAGING AREA INSTALLATION NOTES: 1. SEE PLAN VIEW FOR LOCATION OF STAGING AREA(S). CONTRACTOR MAY ADJUST LOCATION AND SIZE OF STAGING AREA WITH APPROVAL FROM THE LOCAL JURISDICTION.

- STABILIZED STAGING AREA MAINTENANCE NOTES: 5. STABILIZED STAGING AREA SHALL BE ENLARGED IF NECESSARY TO CONTAIN PARKING, STORAGE, AND UNLOADING/LOADING OPERATIONS.

November 2010 Urban Drainage and Flood Control District Urban Storm Drainage Criteria Manual Volume 3

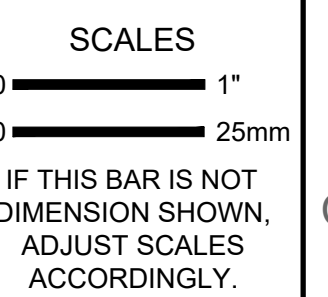
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DESIGNED TS DRAWN CLL CHECKED LS

CITY OF ARVADA NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

Kennedy Jenks

EROSION AND SEDIMENT CONTROL DETAILS - I

SCALE NTS JOB NO 2246059\*00 DATE NOV 2023 SHEET 46 OF 51 EC-602

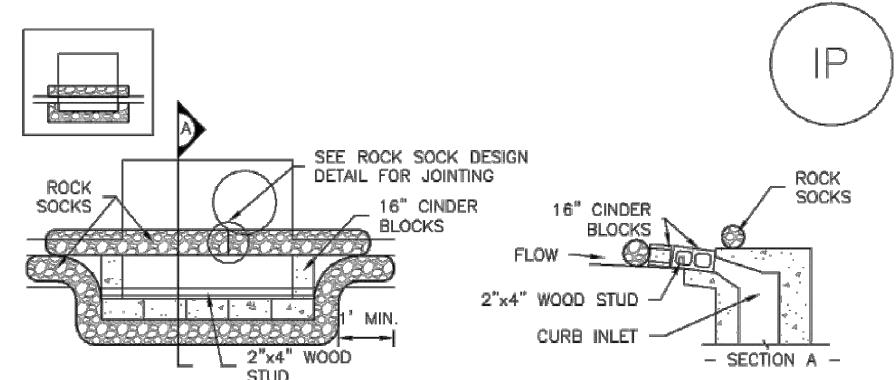


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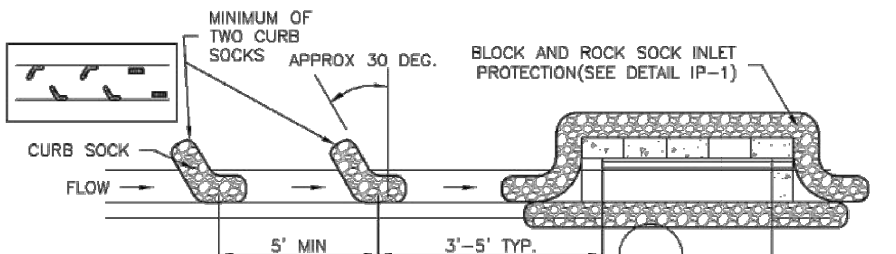
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SC-6 Inlet Protection (IP)



IP-1. BLOCK AND ROCK SOCK SUMP OR ON GRADE INLET PROTECTION

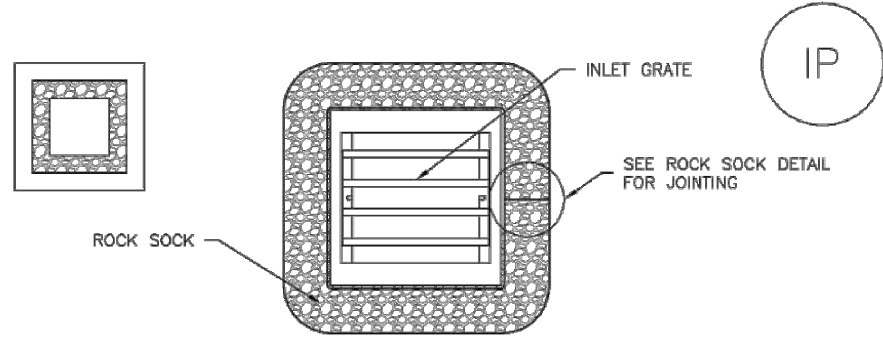
- INSTALLATION NOTES: 1. SEE ROCK SOCK DESIGN DETAIL FOR INSTALLATION REQUIREMENTS. 2. CONCRETE "CINDER" BLOCKS SHALL BE LAID ON THEIR SIDES AROUND THE INLET...



IP-2. CURB ROCK SOCKS UPSTREAM OF INLET PROTECTION

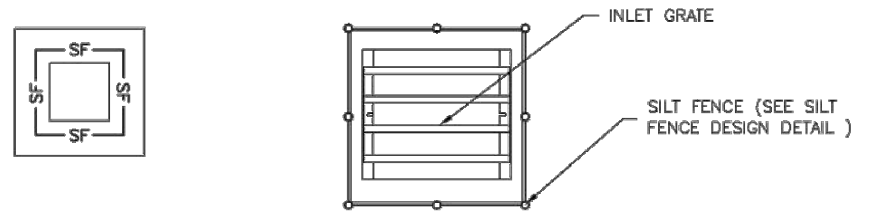
- INSTALLATION NOTES: 1. SEE ROCK SOCK DESIGN DETAIL FOR INSTALLATION REQUIREMENTS. 2. PLACEMENT OF THE SOCK SHALL BE APPROXIMATELY 30 DEGREES FROM PERPENDICULAR...

Inlet Protection (IP) SC-6



IP-3. ROCK SOCK SUMP/AREA INLET PROTECTION

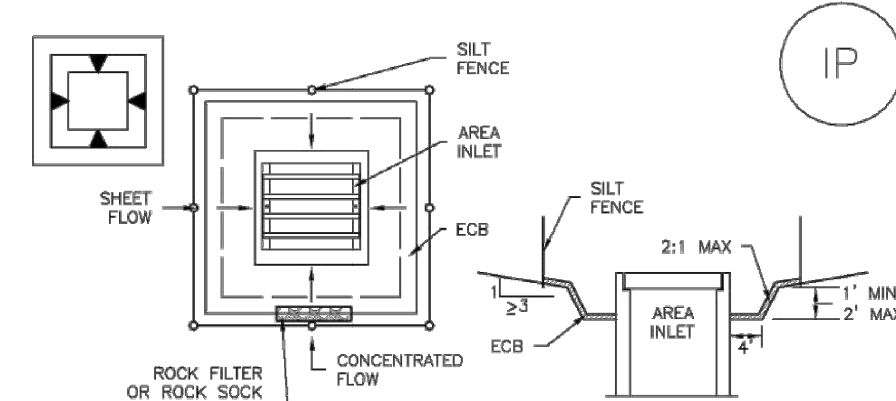
- INSTALLATION NOTES: 1. SEE ROCK SOCK DESIGN DETAIL FOR INSTALLATION REQUIREMENTS. 2. STRAW WATTLES/SEDIMENT CONTROL LOGS MAY BE USED IN PLACE OF ROCK SOCKS...



IP-4. SILT FENCE FOR SUMP INLET PROTECTION

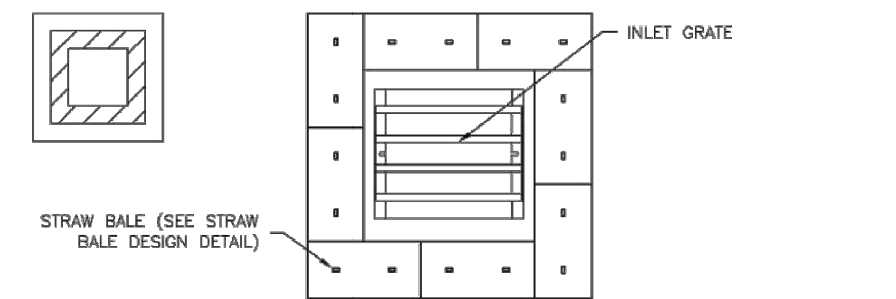
- INSTALLATION NOTES: 1. SEE SILT FENCE DESIGN DETAIL FOR INSTALLATION REQUIREMENTS. 2. POSTS SHALL BE PLACED AT EACH CORNER OF THE INLET AND AROUND THE EDGES...

SC-6 Inlet Protection (IP)



IP-5. OVEREXCAVATION INLET PROTECTION

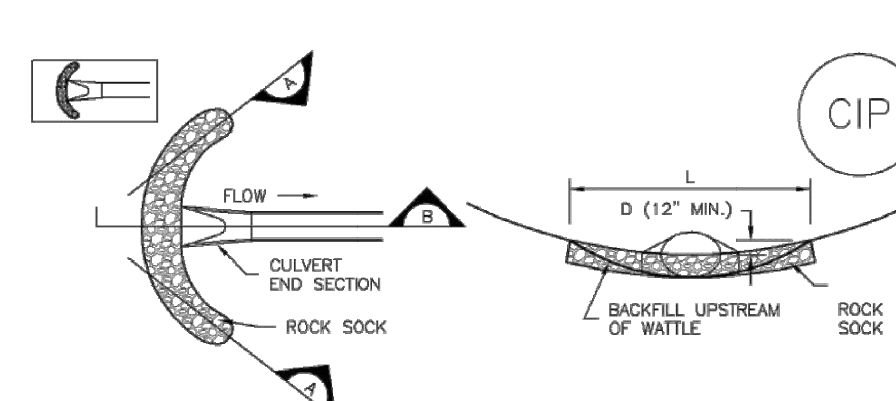
- INSTALLATION NOTES: 1. THIS FORM OF INLET PROTECTION IS PRIMARILY APPLICABLE FOR SITES THAT HAVE NOT YET REACHED FINAL GRADE AND SHOULD BE USED ONLY FOR INLETS WITH A RELATIVELY SMALL CONTRIBUTING DRAINAGE AREA.



IP-6. STRAW BALE FOR SUMP INLET PROTECTION

- INSTALLATION NOTES: 1. SEE STRAW BALE DESIGN DETAIL FOR INSTALLATION REQUIREMENTS. 2. BALES SHALL BE PLACED IN A SINGLE ROW AROUND THE INLET WITH ENDS OF BALES TIGHTLY ADJUTING ONE ANOTHER.

Inlet Protection (IP) SC-6



CIP-1. CULVERT INLET PROTECTION

- INSTALLATION NOTES: 1. SEE PLAN VIEW FOR LOCATION OF CULVERT INLET PROTECTION. 2. SEE ROCK SOCK DESIGN DETAIL FOR ROCK GRADATION REQUIREMENTS AND JOINTING DETAIL.

- MAINTENANCE NOTES: 1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE.

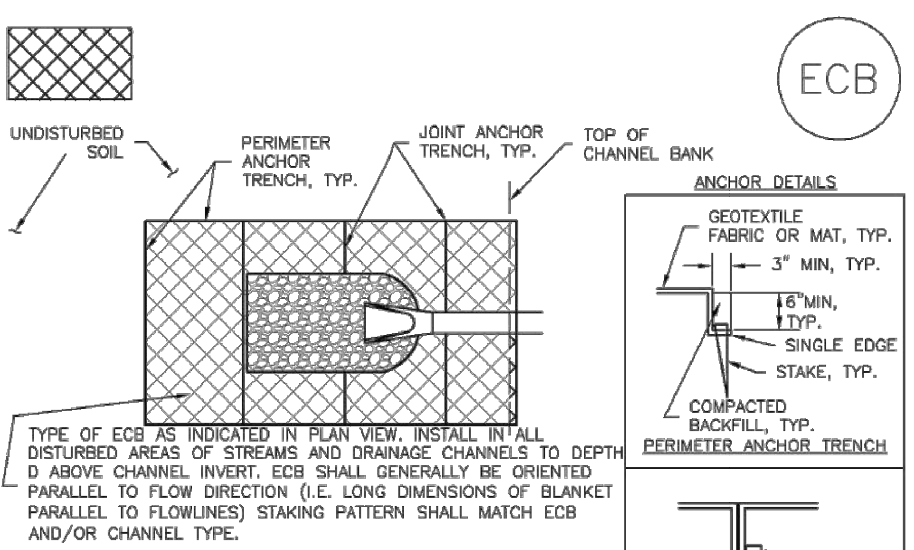
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IP-5 Urban Drainage and Flood Control District August 2013

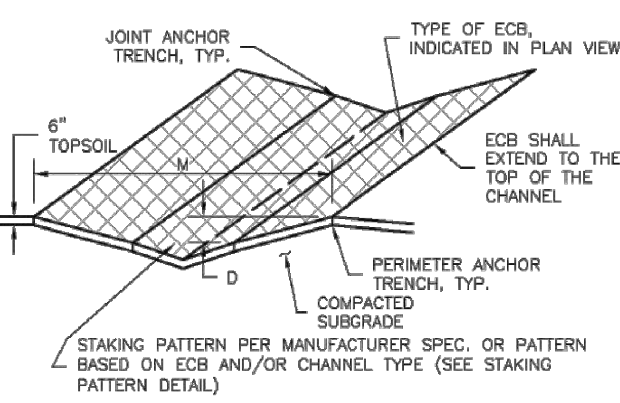
IP-6 Urban Drainage and Flood Control District August 2013

IP-7 Urban Drainage and Flood Control District August 2013

EC-6 Rolled Erosion Control Products (RECP)

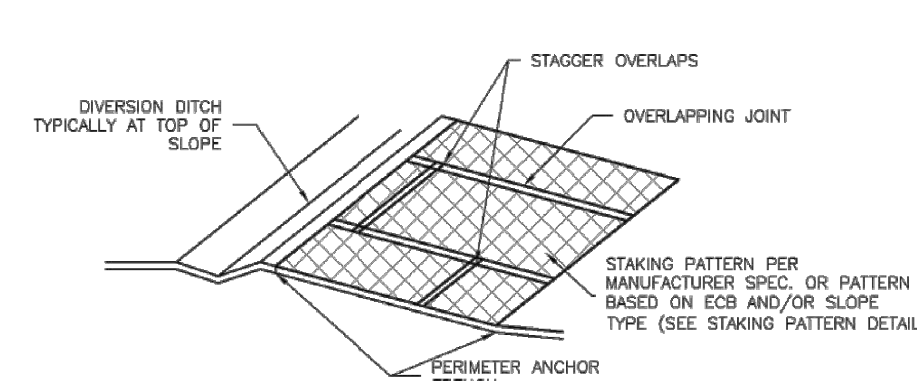


ECB-1. PIPE OUTLET TO DRAINAGEWAY

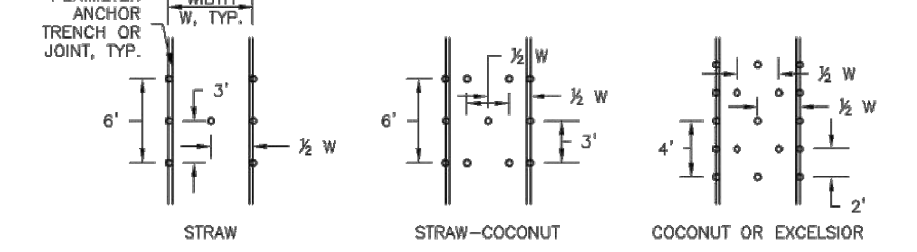


ECB-2. SMALL DITCH OR DRAINAGEWAY

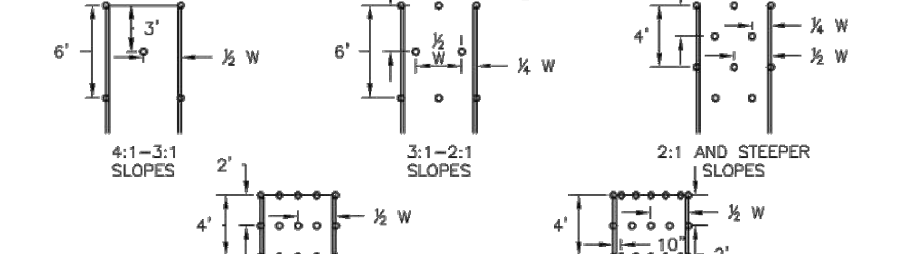
EC-6 Rolled Erosion Control Products (RECP)



ECB-3. OUTSIDE OF DRAINAGEWAY



STAKING PATTERNS BY ECB TYPE



STAKING PATTERNS BY SLOPE OR CHANNEL TYPE

EC-6 Rolled Erosion Control Products (RECP)

- INSTALLATION NOTES: 1. SEE PLAN VIEW FOR LOCATION OF ECB. 2. 100% NATURAL AND BIODEGRADABLE MATERIALS ARE PREFERRED FOR RECPs, ALTHOUGH SOME JURISDICTIONS MAY ALLOW OTHER MATERIALS...

TABLE ECB-1. ECB MATERIAL SPECIFICATIONS. Table with columns: TYPE, COCONUT CONTENT, STRAW CONTENT, EXCELSIOR CONTENT, RECOMMENDED NETTING.

EC-6 Rolled Erosion Control Products (RECP)

- MAINTENANCE NOTES: 1. INSPECT BMPs EACH WORKDAY, AND MAINTAIN THEM IN EFFECTIVE OPERATING CONDITION. MAINTENANCE OF BMPs SHOULD BE PROACTIVE, NOT REACTIVE.

RECP-6 Urban Drainage and Flood Control District November 2010

RECP-7 Urban Drainage and Flood Control District November 2010

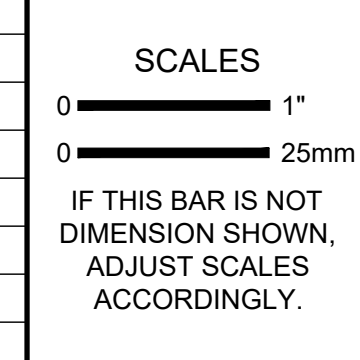
RECP-8 Urban Drainage and Flood Control District November 2010

RECP-9 Urban Drainage and Flood Control District November 2010

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REVISION table with columns: NO, REVISION, DATE, BY.



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CITY OF ARVADA. NORTH TRUNK SEWER IMPROVEMENTS NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11. Kennedy Jenks logo.

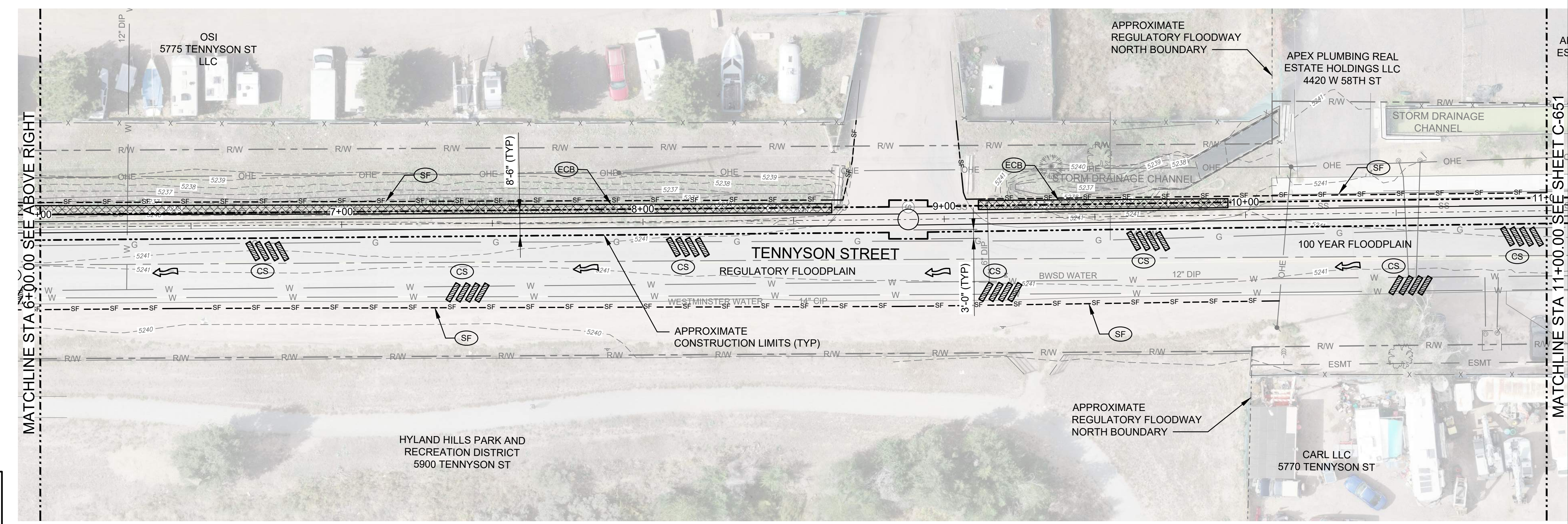
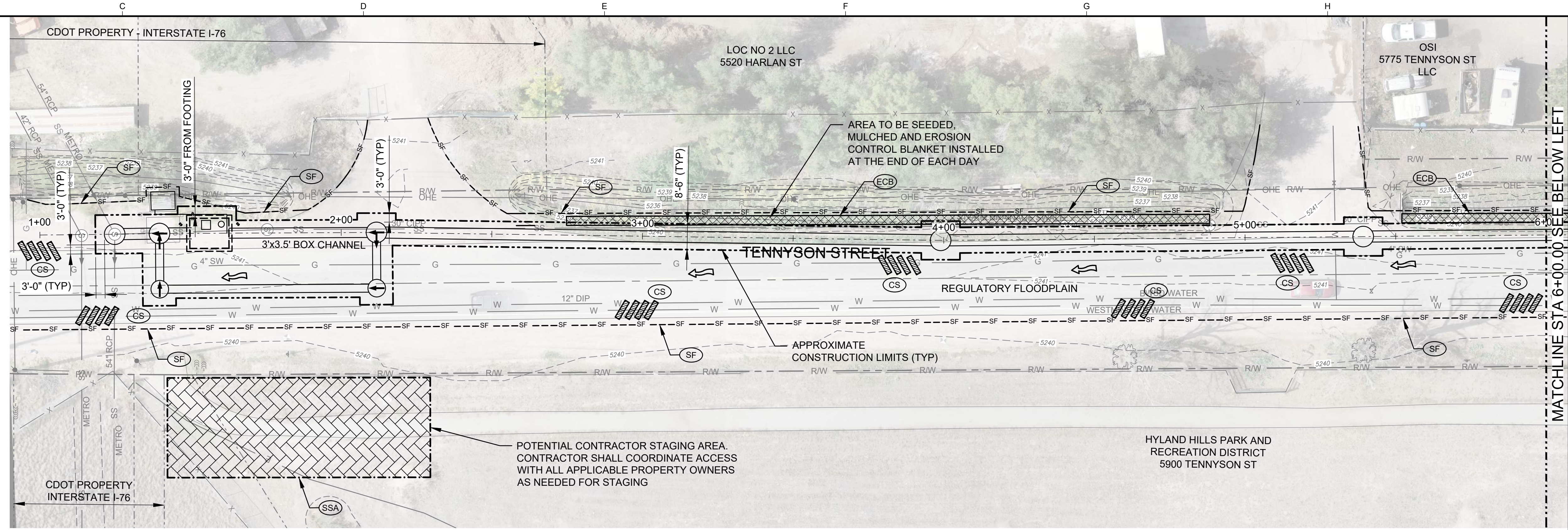
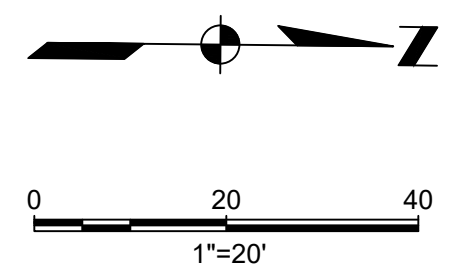
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City of Arvada, Colorado

CITY ENGINEER	DATE	JOB NUMBER
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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

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DATE NOV 2023
SHEET 48 OF 51 EC-650

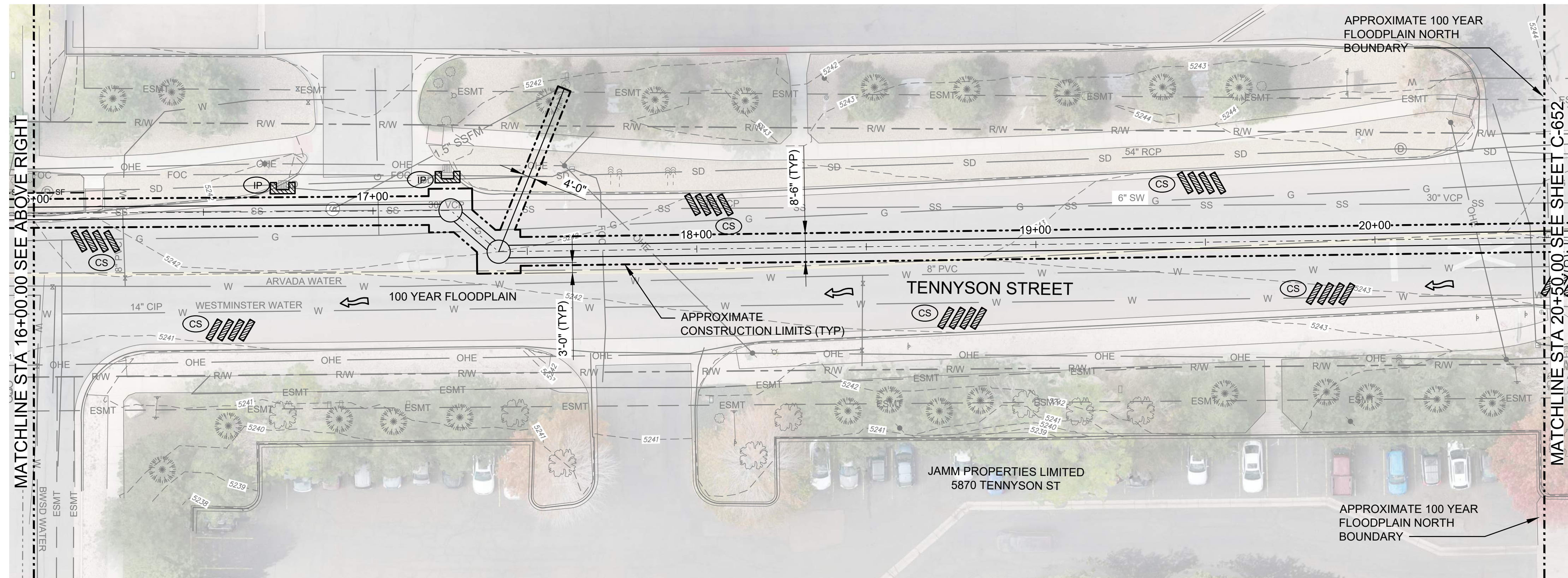
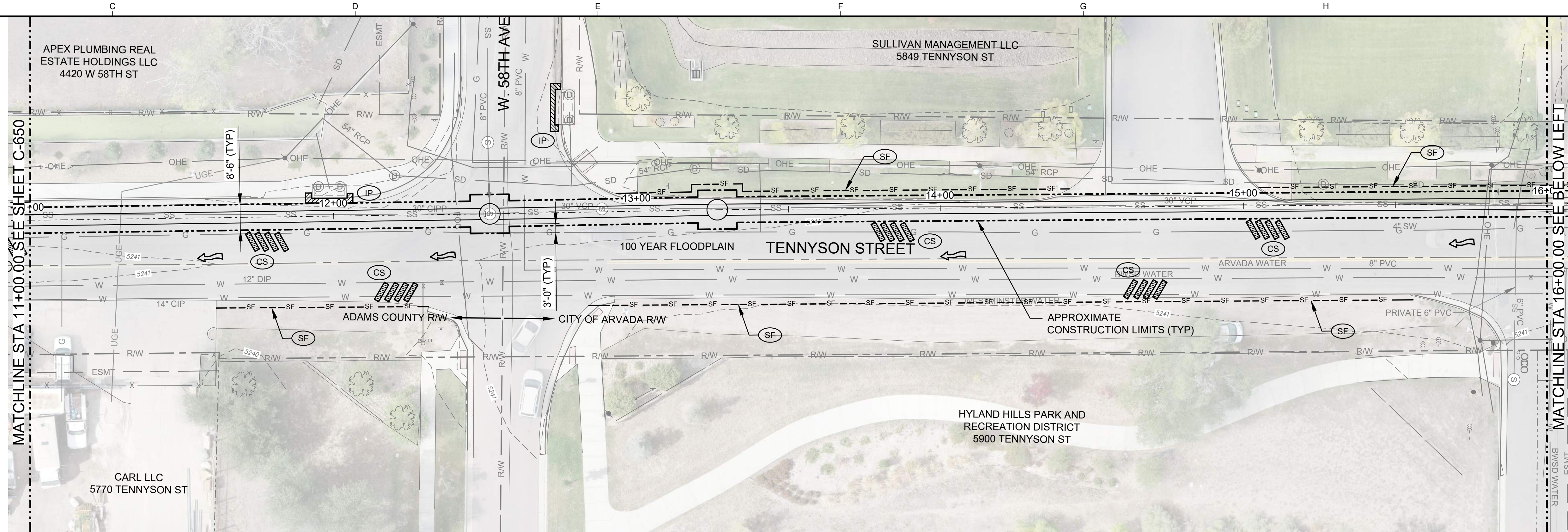
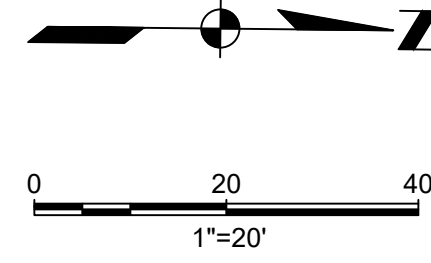
GRADING, EROSION,  
AND SEDIMENT CONTROL  
STA 1+00 TO 11+00



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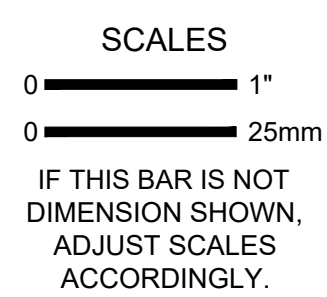
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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**KJ Kennedy Jenks**

**GRADING, EROSION,  
AND SEDIMENT CONTROL  
STA 11+00 TO 20+50**

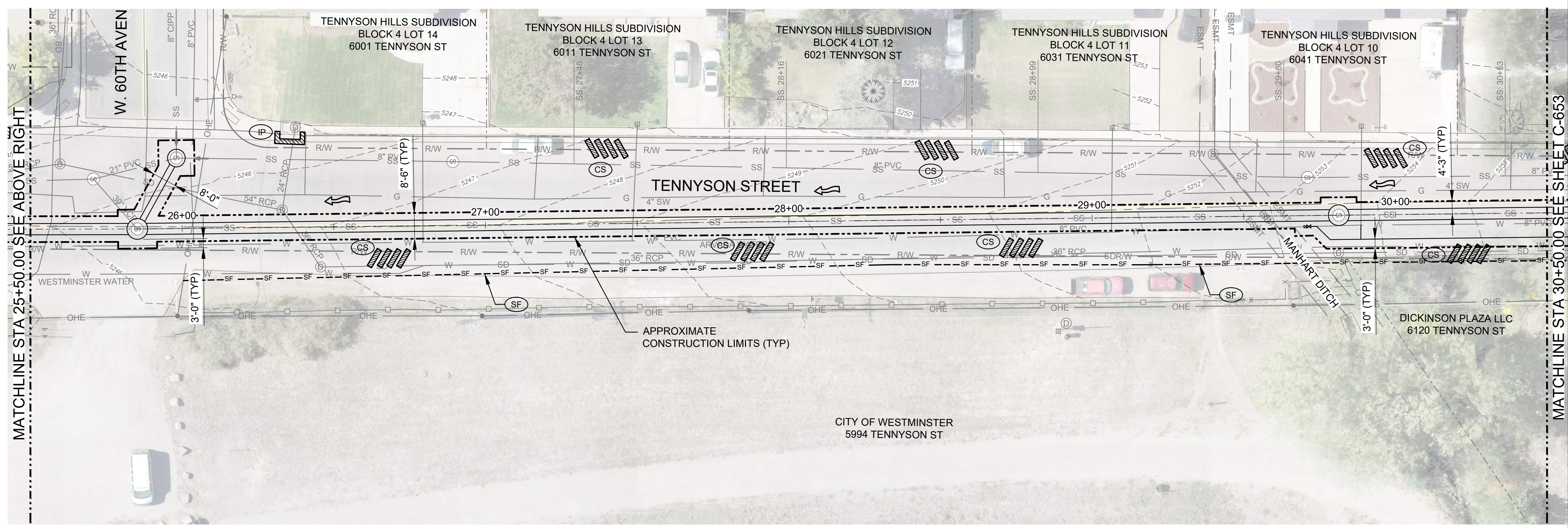
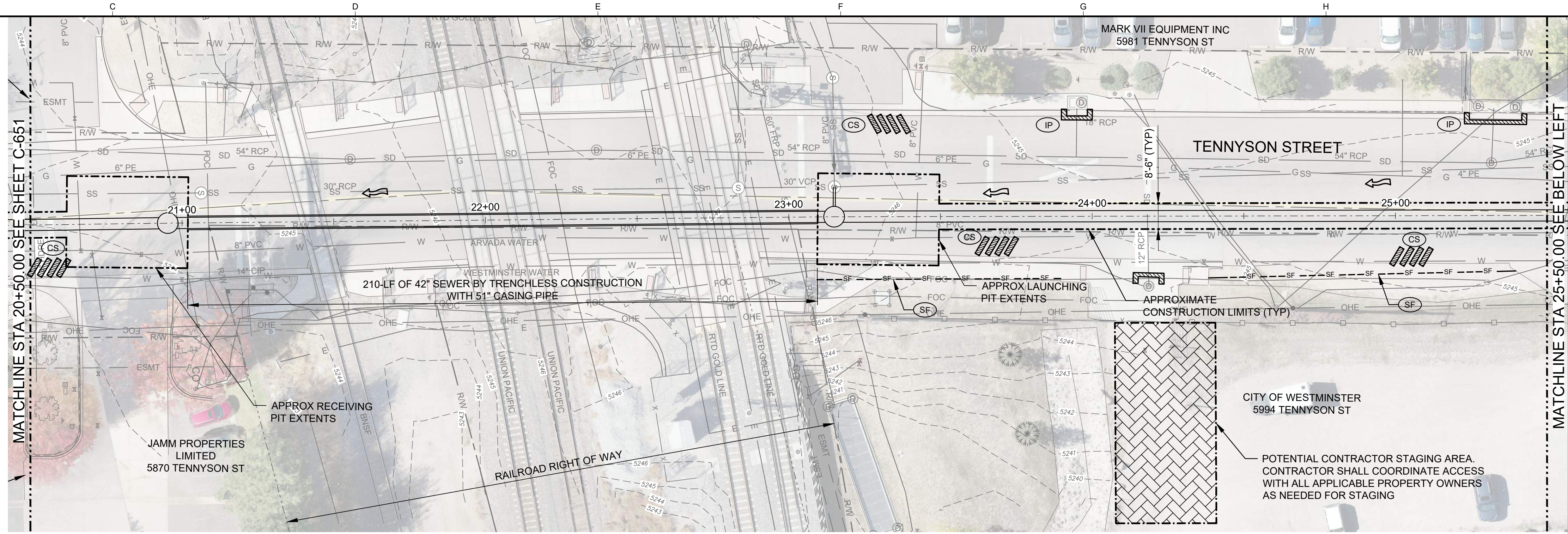
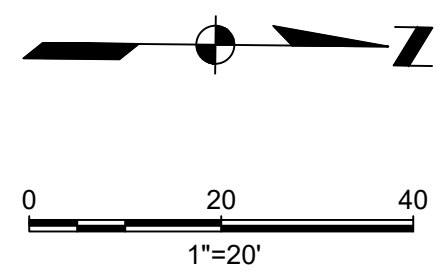
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City of Arvada, Colorado

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0" = 25mm

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CONSTRUCTION**

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**CITY OF ARVADA**  
 NORTH TRUNK SEWER IMPROVEMENTS  
 NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11  
**Kennedy Jenks**

**GRADING, EROSION,  
AND SEDIMENT CONTROL**  
 STA 20+50 TO 30+50

SCALE: 1" = 20'

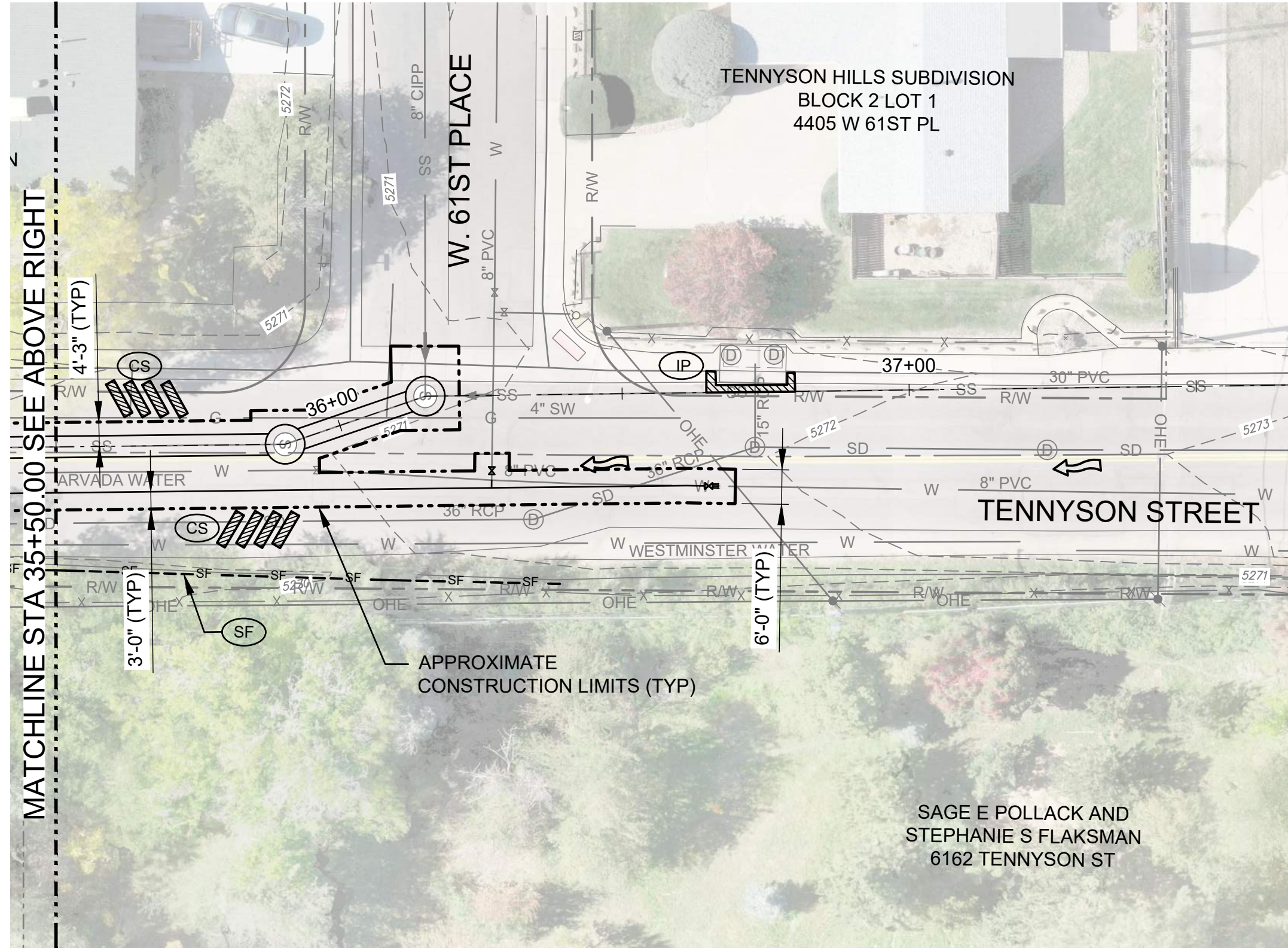
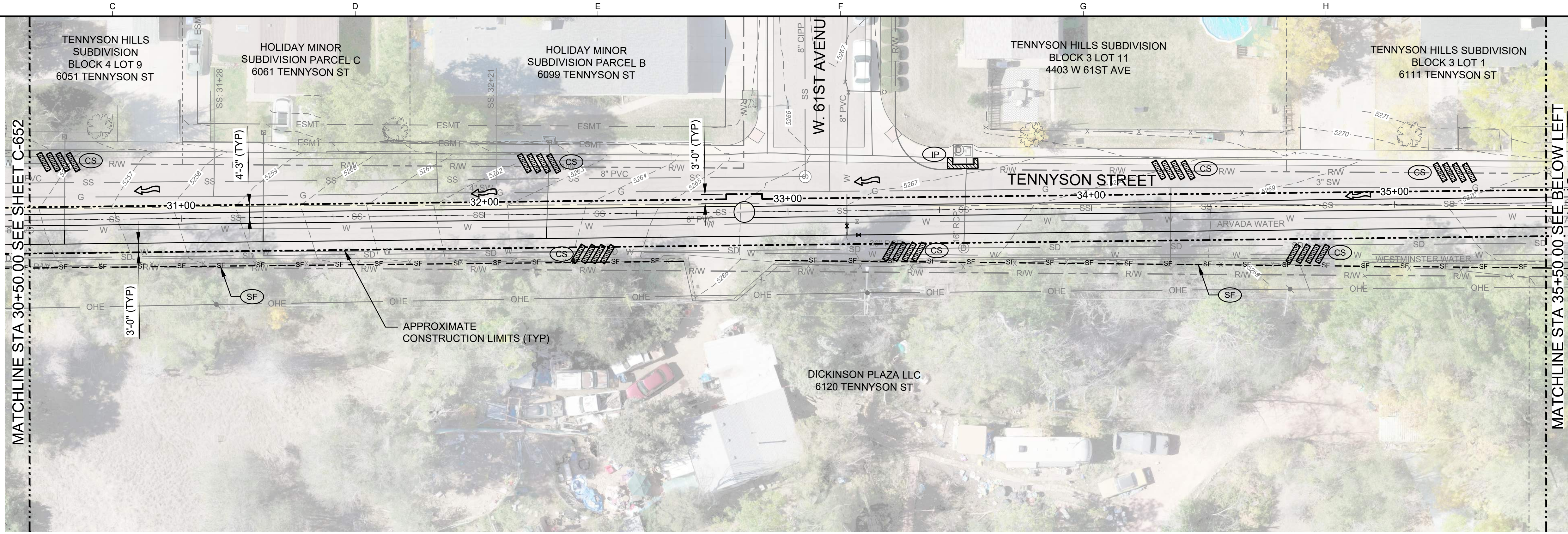
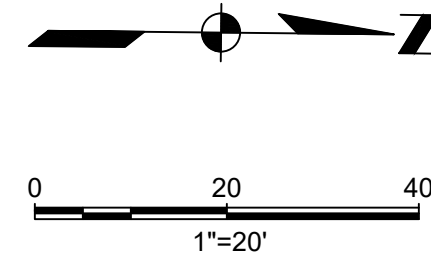
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DATE: NOV 2023

SHEET: 50 OF 51

EC-652





**GENERAL SHEET NOTES**

- TOTAL AREA OF SITE DISTURBANCE IS APPROXIMATELY 1 ACRE, ALL PHASES.

**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

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**SCALES**

0 1" = 20'

0 25mm

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DESIGNED TS

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CHECKED LS

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
**NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11**

**Kennedy Jenks**

SCALE 1" = 20'

JOB NO 2246059\*00

DATE NOV 2023

SHEET 51 OF 51

EC-653

**GRADING, EROSION, AND SEDIMENT CONTROL**  
**STA 30+50 TO 37+00**



**APPENDIX C**  
**SOILS REPORT**

**GEOTECHNICAL DATA REPORT**

60% Design

***NORTH TRUNK SEWER IMPROVEMENTS – TENNYSON AND 58<sup>TH</sup>***  
**ARVADA, COLORADO**

July 2023





July 28, 2023  
22134

Kennedy Jenks Consultants, Inc.  
165 South Union Boulevard  
Arvada, CO 80003

Attention: Jerry Pena, PE  
Client Director

Regarding: Geotechnical Data Report – 60% Design  
North Trunk Sewer Improvements – Tennyson and 58<sup>th</sup>  
Arvada, Colorado

Mr. Pena,

Submitted herewith is the Geotechnical Engineering Investigation for the North Trunk Sewer Improvements – Tennyson and 58th project. This study was conducted in accordance with our contract between Lithos Engineering and Kennedy Jenks Consultants, Inc. (KJ) dated October 3rd, 2022. This report contains the results of our findings, an engineering interpretation with respect to the available project characteristics, and recommendations to aid design and construction of earth-related phases of this project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,  
**Lithos Engineering**

Adam Malsam, EIT  
Staff Engineer

James Carroll, PE  
Project Manager

Robin Dornfest, PG  
President

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<u>Figure Number</u>	<u>Title</u>
1	Site Vicinity and Boring Location Map

## APPENDICES

<u>Appendix</u>	<u>Title</u>
A	Standard Geotechnical Drilling Keys and Boring Logs
B	Geotechnical Laboratory Testing Results
C	Water Quality Testing Results

## 1 INTRODUCTION

The North Trunk Sewer Improvements – Tennyson and 58th (Project) includes the installation of approximately 3,600 feet of new sanitary sewer main to meet the demand for increased capacity. The Owner of the Project is The City of Arvada (Arvada) and the lead engineer for the project is Kennedy Jenks (KJ). KJ retained Lithos to function as the Project's geotechnical and tunnel design engineer. The purpose of this report is to provide data collected during the Geotechnical Investigation at the Project site. The following sections generally describe the site and proposed construction.

### 1.1 Site Description

The Project site is located in Adams County, Colorado along Tennyson Street approximately between the intersection with W 61<sup>st</sup> Place and the underpass of Interstate 76 (Figure 1). This stretch of Tennyson Street consists of a mixture of residential and industrial uses and parks. Historically, this area served as a source of aggregate, and many gravel ponds were created as aggregates were extracted. Today, many of these gravel pits have been reclaimed and used for other purposes, though several remain.

### 1.2 Proposed Construction

A new gravity sanitary sewer main is needed to meet expected increases in required capacity. The proposed sewer will tie into an existing 30-inch sanitary sewer at the intersection of N. 61<sup>st</sup> Place and Tennyson St and will continue south beneath Tennyson St to a vault just north of the I-76 underpass. This alignment will necessitate crossing beneath five railroad tracks belonging to the Regional Transportation District (RTD), Union Pacific (UP) and Burlington Northern and Santa Fe (BNSF) along the way. Open cut trenches will be used to install most of this alignment, but trenchless techniques will be required to install the new sewer main beneath the railroad tracks without disrupting railroad operations. Proposed pipe includes 30-inch and 42-inch PVC. The proposed tunnel crossing beneath the railroad tracks includes the following properties:

- 42-inch PVC carrier pipe
- 0.24% grade
- Minimum depth of cover: 6 feet
- 51-inch steel casing pipe
- Approximately 200-feet long

Tunnel properties are based upon the 60% submittal drawings by KJ and may be adjusted as the design moves forward.

## 2 GEOLOGIC SETTING

### 2.1 Regional Geology

Geologically, the site is located within the historic floodplain of Clear Creek. The position of Clear Creek has changed several times over many years within this floodplain with gravel, sand, silt, and clay having been deposited as the creek has meandered. Lindvall (1979) mapped these deposits as Post Piney Creek Alluvium, which is described as being predominately composed of sands and silts within the floodplains of Clear Creek and the South Platte River. Below this alluvium, Lindvall (1979) has mapped the Denver Formation, which outcrops along the south bank of Clear Creek and near the intersection of W 64<sup>th</sup> St and Tennyson St. The Denver Formation is described as containing interbedded claystone, sandstone, and siltstone with the claystone being prone to swelling when wet. Lindvall (1979) also notes the presence of

artificial fill along Tennyson St. associated with the construction of the railroad tracks discussed in section 1.1.

### 3 GEOTECHNICAL INVESTIGATION

Lithos conducted a geotechnical investigation for the Project consisting of a subsurface investigation and a geotechnical laboratory testing program. The subsurface investigation included two borings for the proposed tunnel crossing and two borings for the open-cut sections of the pipeline. Borings were drilled on January 27<sup>th</sup>, 2023. Boring locations are included in Figure 1. Results from the subsurface investigation and the laboratory testing program are presented in Section 4.

#### 3.1 Subsurface Investigation

Geotechnical borings LE-01 and LE-02 are associated with the proposed tunnel crossing and were drilled to depths of 31.5 feet below the existing ground surface (BGS). Geotechnical borings LE-03 and LE-04 are associated with the open cut portion of the new pipeline and were advanced to depths of 16.5 feet BGS. Lithos subcontracted geotechnical drilling to a qualified local subcontractor who utilized a truck-mounted CME-75 rig. Drilling and sampling procedures were conducted in general accordance with the ASTM standards identified in the following table:

Subsurface Investigation ASTM Standards	
Procedure	ASTM Standard
<i>Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils</i>	D 1586
<i>Standard Practice for Thick Wall, Ring-Line, Split Barrel, Drive Sampling of Soils</i>	D 3550

Continuous-flight, hollow-stem augers were used to advance borings LE-01 and LE-02 below the existing ground surface and through surficial soil deposits. Hollow stem augers were used in this instance as the borings were converted to temporary groundwater monitoring wells upon completion so that repeat water level measurements could be taken and water samples could be collected for testing. Continuous-flight solid stem augers, meanwhile, were used to advance borings LE-03 and LE-04. During boring advancement, Modified California (2.0-inch inner diameter) or split-spoon (1.5-inch inner diameter) samples were obtained in 2.5-foot intervals. The modified California barrel sampler was utilized to obtain relatively undisturbed samples of cohesive materials. The split-spoon sampler was used to obtain disturbed samples of non-cohesive materials. The number of blows by a 140-pound hammer falling 30 inches required for 12 inches of sampler penetration (recorded in 6-inch increments) are presented on the boring logs (Appendix A). Blow counts with less than 6 inches of penetration are presented showing the number of blows for the resulting depth of penetration ( $50/2'' = 50$  blows to drive the sampler 2 inches).

#### 3.2 Geotechnical Laboratory Testing

A geotechnical laboratory testing program was developed by Lithos on representative samples collected during the subsurface investigation. A laboratory summary table and graphical testing results are provided in Appendix B. Laboratory tests conducted in general accordance with associated ASTM standards are presented in the table below.

Geotechnical Laboratory Testing	
Test	Standard
Grain Size Distribution	ASTM D422
#200 Sieve Wash	ASTM D1140
Swell / Consolidation	ASTM D4546
Atterberg Limits	ASTM D4318
Moisture Content & Dry Density	ASTM D2216 & D2937

If field characterized soil and bedrock descriptions differed from results indicated by laboratory classification testing, the boring logs presented in Appendix A were amended to reflect laboratory testing results.

### 3.3 Groundwater Testing

Groundwater samples were collected from the temporary wells installed at LE-01 and LE-02 on February 24<sup>th</sup>, 2023. Laboratory testing was conducted on these water samples to determine the concentration of trace elements and evaluate contaminants. Tests conducted are presented in the table below. Results of groundwater laboratory testing are presented in Appendix C.

Water Quality Laboratory Testing	
Test	Standard
Determination of Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry	EPA 245.7
Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Atomic Emission Spectrometry	EPA 200.7
Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma – Mass Spectrometry	EPA 200.8
Determination of Hexavalent Chromium by Colorimetric Method	SM 3500-CR B

## 4 SUBSURFACE CONDITIONS

Subsurface conditions were assessed based on the findings of the geotechnical investigation described in the previous section. Soil descriptions noted on the boring logs and below are in general accordance with ASTM D 2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)* and D 2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

### 4.1 Subsurface Materials

Primary materials encountered during the subsurface investigation include fill, fine alluvium, and coarse alluvium. Bedrock was not encountered in any of the four borings. Boring logs, including a supplementary boring log key explaining boring log details and additional details regarding sampled materials, are provided in Appendix A.



#### 4.1.1 Fill

Fill was encountered beneath the pavement section (4.5" asphalt, 6" base coarse) in LE-01 and LE-02. Fill extended from the bottom of this pavement section to 2.0 to 2.5 feet BGS. Fill was classified as the following in accordance with USCS:

- Clayey Sand (SC)
- Poorly Graded Sand with Clay (SP-SC)

Fill contained few to mostly fine to coarse sand, little fine to coarse gravel, and few to little clay. Based on recorded blow-counts, fill density is medium dense.

#### 4.1.2 Fine Alluvium

Fine alluvium was encountered in all borings and ranged in depth from the surface or base of fill to 7.5 to 13.3 feet BGS. Fine alluvium was classified as the following in accordance with USCS:

- Lean clay (CL)
- Silt (ML)

In addition to the fine soil grains, fine alluvium also contained few to some fine to coarse sand and occasional trace to few fine to coarse gravel (maximum 2.0-inch diameter). Based on recorded blow-counts, fine alluvium density may generally be described as being medium stiff to stiff, though two samples (out of 15) returned relative densities of very soft to soft. Interbedded layers of sandy silt ranging in thickness from approximately 0.5 to 2.0 feet were documented within the fine alluvium in LE-04 on the southern edge of the project area.

#### 4.1.3 Coarse Alluvium

Coarse alluvium was encountered in all borings and ranged in depth from the base of fine alluvium to the end of exploration between 16.5 and 31.5 feet bgs. Coarse alluvium was classified as the following in accordance with USCS:

- Silty Sand (SM)
- Poorly Graded Sand with Silt (SP-SM)
- Poorly Graded Gravel (GP)
- Silty Gravel (GM)
- Poorly Graded Sand (SP)
- Poorly Graded Sand with Clay (SP-SC)
- Clayey Sand (SC)

Generally, coarse alluvium was some combination of sand and gravel with few to some fines (either clay or silt) present. Flowing behavior was noted at times within the coarse alluvium based on the drilling behavior. Based on recorded blow-counts, the density of coarse alluvium ranges from medium stiff to very dense. Interbedded layers of lean clay approximately six-inches thick were documented within the coarse alluvium in LE-01.

## 4.2 Groundwater

Groundwater was encountered during the subsurface investigation in all borings at depths ranging from 8 to 17 feet bgs. Temporary monitoring wells were installed in borings LE-1 and LE-02 to measure seasonal changes in the groundwater table elevation, collect groundwater readings through design and prior to construction, and collect water samples for testing. The table below presents initial groundwater levels in the borings at the time of drilling.

Groundwater Depth						
Boring	Depth BGS (ft)					
	01/27/23	03/02/23	04/10/23	05/03/23	06/06/23	07/06/23
LE-01	17.0	19.2	18.2	18.0	15.75	15.45
LE-02	13.8	15.0	15.1	14.7	12.45	12.0
LE-03	11.5	--	--	--	--	--
LE-04	8.0	--	--	--	--	--

Groundwater should be expected to fluctuate based on precipitation, localized irrigation, water levels in nearby water bodies and irrigation ditches, site development, and seasonal variations.

## 5 LIMITATIONS

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings, geotechnical laboratory testing, information provided by the Client, engineering judgement, and our experience with similar subsurface conditions and projects. The boring logs presented in this report only depict the subsurface conditions at the actual boring locations. Subsurface conditions are typically variable, both laterally and vertically, and the nature and extent of the subsurface variations across the site may not become evident until construction. The boundaries between different soil types presented in this report are approximate, and in some cases may be more abrupt or gradational than described herein. Groundwater levels may vary with time, adjacent water source levels, precipitation, and changes to the hydrogeological conditions at or surrounding the project site.

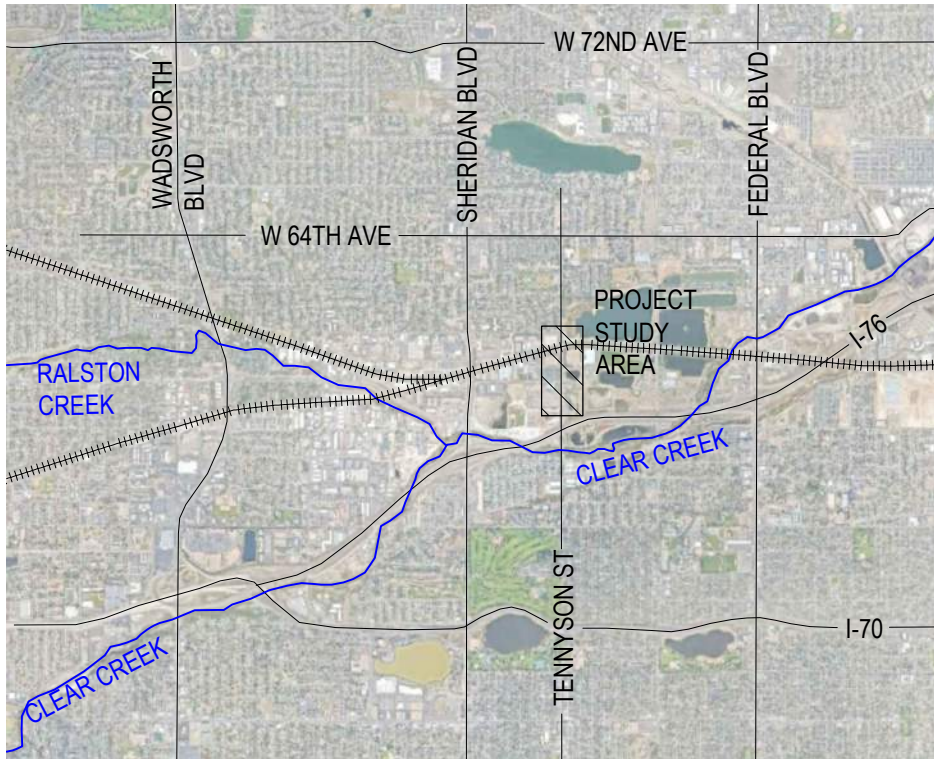
This report has been prepared exclusively for our client for design purposes for the subject project. Lithos Engineering is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects. If differing site conditions are encountered during further evaluation of the subsurface conditions by others or during construction, Lithos Engineering should be notified immediately to determine if any changes to our recommendations presented in this report are warranted.

An environmental assessment was not included in Lithos Engineering scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, Lithos Engineering recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

## 6 REFERENCES

- ASTM Standards, ASTM International, West Conshohocken, PA (2012).
- Lindvall, R.M. (1979). *Geologic map of the Arvada quadrangle, Adams, Denver, and Jefferson Counties, Colorado*, US Geological Survey, Geological Quadrangle Map GQ-1453
- U.S. EPA. 1994. *Method 200.7: Determination of Metals and Trace Elements in Water and Wastes by Inductively Coupled Plasma-Atomic Emission Spectrometry*, Revision 4.4. Cincinnati, OH
- U.S. EPA. 1994. *Method 200.8: Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectrometry*, Revision 5.4. Cincinnati, OH
- U.S. EPA. 2005. *Method 245.7 Mercury in Water by Cold Vapor Atomic Fluorescence Spectrometry*, Revision 2.0. Cincinnati, OH
- Standard Methods Committee of the American Public Health Association, American Water Works Association, and Water Environment Federation. *3500-cr chromium In: Standard Methods For the Examination of Water and Wastewater*. Lipps WC, Baxter TE, Braun-Howland E, editors. Washington DC: APHA Press.

DRAFT



LEGEND:

- BORING LOCATION
- ROADWAYS
- RIVERS AND CREEKS
- RAILROAD TRACKS

0 1 2 MILES  
SCALE

REGIONAL OVERVIEW MAP



0 1000 2000 FT  
SCALE

SITE VICINITY MAP

<p>2750 S. WADSWORTH BLVD, SUITE D-200 DENVER, COLORADO 80227 303.625.9502</p>	PROJECT TITLE	NORTH TRUNK SEWER IMPROVEMENTS - TENNYSON AND 58TH	OWNER	CITY OF ARVADA	CLIENT	KJ Kennedy Jenks	FIGURE NUMBER	<h1>FIG.1</h1>
	DRAWING TITLE	SITE VICINITY AND BORING LOCATION MAP	PROJECT NO.:	20088	DRAWN BY:	AM		
			LOCATION:	ARVADA, CO	DESIGNED BY:	JC		
			DATE:	02/09/2023	CHECKED BY:	BS		



# BORING LOG KEY

## STANDARD GEOTECHNICAL DRILLING

### Soil Classifications:

Clear Square Sieve Openings				U.S. Standard Series Sieve Sizes			
12"	3"	3/4"	4	10	40	200	
Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	
300mm	75mm	19mm	4.75mm	2.0mm	0.42mm	0.075mm	

Gradation Estimates by Field Observation	
Description	Quantity (%)
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	> 50

Relative Density or Consistency of Non-cohesive and Cohesive Soils			
Non-cohesive Soils		Cohesive Soils	
Classification	Blows per 12 in	Classification	Blows per 12 in
Very Loose	0 to 4	Very Soft	0 to 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11-30	Medium Stiff	5 to 8
		Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	>50	Hard	>30

**Color:** Sample colors are in general accordance with basic brown, red, yellow, and gray combinations

Description of Moisture	
Description	Criteria
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil below the groundwater table

Description of Odor	
Description	Criteria
No Organic Odor	Organic odor is not present
Trace Organic Odor	Mild organic odor; mixture of soil and organics
Strong Organic Odor	Prominent organic odor; sample is primarily organic

Plasticity	
Description	Criteria
Nonplastic	A $\frac{1}{8}$ " diameter thread cannot be rolled
Low	A $\frac{1}{8}$ " in diameter thread can be rolled with difficulty; a lump cannot be formed at a moisture lower than the plastic limit
Medium	A $\frac{3}{8}$ " in diameter thread can be rolled easily; a crumbly lump can be formed at a moisture lower than the plastic limit
High	A $\frac{3}{8}$ " in diameter thread can be rolled very easily; a lump can be formed at a moisture lower than the plastic limit

Cementation	
Description	Criteria
Weak	Crumbles with light finger pressure
Moderate	Crumbles with considerable finger pressure
Strong	Will not crumble with finger pressure

### Rock Descriptions:

Weathering	
Description	Criteria
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration of rock material on discontinuity surfaces.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Texture	
Description	Criteria
Very Fine Grained	Grains not individually visible to the unaided eye
Fine Grained	Grains barely visible to the unaided eye, up to $\frac{1}{16}$ " diameter
Medium Grained	Grain diameter between $\frac{1}{16}$ " and $\frac{3}{16}$ "
Coarse Grained	Grains diameter between $\frac{3}{16}$ " and $\frac{1}{4}$ "
Very Coarse Grained	Grains larger than $\frac{1}{4}$ " in diameter

Field Hardness	
Description	Criteria
Very Hard	Cannot be scratched with a knife or sharp pick.
Hard	Can be scratched with a knife or pick only with difficulty
Medium	Can be gouged $\frac{1}{16}$ " deep by firm pressure on knife or pick point
Soft	Can be grooved or gouged readily with knife or pick point
Very Soft	Can be carved with knife and scratched readily by fingernail

### Geologic Interpretation:

A **Geologic Interpretation** of encountered soil and bedrock units is provided for each specific **Visual Material Description**. Examples of geologic interpretations for soil that may be presented include: FILL, ALLUVIUM, AEOLIAN, AND GLACIAL TILL, AND RESIDUUM. Rock geologic interpretations are referenced based on a combination of field classifications and applicable geologic maps.

### Sample Graphics and Descriptions:

- California Barrel Sampler: Barrel sampler loaded with sample liners and driven to collect a relatively representative and intact specimen of soil or weak rock.
- Split-Spoon Sampler: Split-barrel sampler driven in accordance with ASTM D1586 used to provide visual material descriptions and collect a disturbed specimen.
- Shelby Tube Sampler: Thin wall tube hydraulically pushed into the subsurface to collect a representative and intact specimen of soil.
- Bulk Sample: Bulk or bagged sample taken from auger cuttings.

Continuous Sampler: A 5-foot long sampler barrel that is driven to collect a continuous 5-foot run of cohesive and non-cohesive soil.

### Groundwater Monitoring Well Graphics:

	Riser Pipe with Auger Cuttings		Well Screen with Silica Sand		Riser Pipe with Silica Sand		Riser Pipe with Bentonite Chips
	Auger Cuttings		Stick-Up Well		Flush Mounted Cap		
	First Groundwater Reading		Second Groundwater Reading		Third Groundwater Reading		

### Boring Graphics:

Below are the primary boring log graphics. Any classification combinations will result in a combination of graphics.

	Fill		Lean Clay		Silt		Fat Clay		Elastic Silt		Well Graded Gravel
	Poorly Graded Gravel		Well Graded Sand		Poorly Graded Sand		Sandstone		Claystone		Siltstone



# BORING: LE-01

Project Name: N.TSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.80495, -105.044092\*  
 Boring Elevation: 5,249.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States		INDEX DATA				Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
0						<b>PAVEMENT SECTION</b> Asphalt: 4.5-inches Base: 6.0-inches											
0.9						<b>FILL</b> Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, little fine to coarse gravel, few clay, medium dense, olive brown, moist, iron oxidation.											
2.5	5247.5		22 16 13	16		<b>FINE ALLUVIUM</b> LEAN CLAY (CL), few fine to coarse sand, trace fine gravel, stiff, olive brown, moist.											
5	5245		6 4	6		LEAN CLAY with sand (CL), little to some fine to medium sand, trace fine gravel, medium stiff, olive brown, moist.	26.1	95.7		71.4	41	23					
7.5	5242.5		3 4	10		As above except very soft, olive brown to dark blueish gray.	32.9	87.9		71.1	43	26			N/A	-0.4	
10	5240		1 1	11		LEAN CLAY (CL), few fine to coarse sand, stiff, olive brown, moist.	29.2	93.4									
12.5	5237.5		4 8	11		As above.											
13.3			1 1	11		<b>COARSE ALLUVIUM</b> Silty SAND (SM), mostly fine to medium sand, little silt, loose, olive brown to yellowish brown, moist, iron oxidation.											
15	5235		4 7	10		Poorly graded SAND with silt and gravel (SP-SM), some to mostly fine to coarse sand, some fine to coarse gravel, few silt,											
			30														

### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		Date:		Elapsed Time:		Depth to Groundwater:	
▲	01/27/23	0-days		17.0-feet			
▲							

# BORING: LE-01

Project Name: NISI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

# Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.80495, -105.044092\*  
 Boring Elevation: 5,249.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States	INDEX DATA					Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
12	5232.5	30 33		12													
17.5	5230	12 16 22		12													
20	5227.5	21 25		12			2.8	158.5	63.6	31.8	4.6						
22.5	5225	49 50		4													
25	5222.5	49 50 50		18													
27.5	5220	27 50/5"		18													
30	5217.5	49 33 27		11													

### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Date:	Groundwater Data:	Depth to Groundwater:
01/27/23	0-days	17.0-feet

# BORING: LE-01

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.80495, -105.044092\*  
 Boring Elevation: 5,249.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data						Visual Material Description						Laboratory Testing Results											
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions  Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions						In-Situ States		INDEX DATA				Strength & Compressibility				
													Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
31.5	5217.5						<b>END OF EXPLORATION</b>																
32.5																							
35	5215																						
37.5	5212.5																						
40	5210																						
42.5	5207.5																						
45	5205																						
	5202.5																						

### General Notes:

- Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:	
Date:	Depth to Groundwater:
01/27/23	17.0-feet
0-days	

# BORING: LE-02

Project Name: N.TSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.804011, -105.044089\*  
 Boring Elevation: 5,247.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States		INDEX DATA				Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
0						<b>PAVEMENT SECTION</b> Asphalt: 4.5-inches Base: 6.0-inches											
0.9						<b>FILL</b> Clayey SAND with gravel (SC), mostly fine to coarse sand, little fine gravel, little clay, medium dense, olive brown, moist.											
2.0						<b>FINE ALLUVIUM</b> Sandy LEAN CLAY (CL), some fine to coarse sand, few fine to coarse gravel, very stiff, olive to dark brown, moist. As above except mottled olive to olive brown.											
2.5	5245	11 6	18														
5.0	5242.5	6 7	10														
5.0		4 5	12			As above except mottled olive to olive brown.	18.1	104.3		53.5	35	20			N/A	0.0	
7.5	5240	5 7	10			As above except no gravel, olive gray, iron oxidation, calcite.											
10.0	5237.5	15 23	10			<b>COARSE ALLUVIUM</b> Silty GRAVEL with sand (GM), mostly fine to coarse gravel, little to some fine to coarse sand, little silt, dense, yellowish brown, moist, iron oxidation, maximum particle size 2.0-inches.	5.2	130.6									
12.5	5235	7 10	9			As above except medium dense.	12.1	117.7	56.1	25.7	18.2	NV	NP				
15.0	5232.5					Poorly graded SAND with silt and gravel (SP-SM), mostly fine to coarse sand, little to some fine to coarse gravel, few silt,											
15.0		28															

### General Notes:

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- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:	
Date: <u>01/27/23</u>	Depth to Groundwater: <u>13.8-feet</u>
Elapsed Time: <u>0-days</u>	

# BORING: LE-02

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

# Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Hollow Stem Auger (HSA)  
 Bit Type: Cutting Head  
 Casing Description: HSA  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.804011, -105.044089\*  
 Boring Elevation: 5,247.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results													
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)				Drilling Rate (min./ft.)	In-Situ States	INDEX DATA					Strength & Compressibility						
50						very dense, dark brown, wet, maximum particle size 2.0-inches.															
17.5	5230					As above except olive, maximum particle size 1.25-inches.															
20	5227.5		24 32 32	12		As above except olive, maximum particle size 1.25-inches.															
25	5225		17 28 34	17		As above except olive, maximum particle size 1.25-inches.						27.1	64.5	8.4							
27.5	5222.5		27 50/1"	6		As above except olive, maximum particle size 1.25-inches.															
30	5220					As above except dense, olive, maximum particle size 1.25-inches.															
	5217.5		15 19 15	16																	

### General Notes:

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:	
Date:	Depth to Groundwater:
01/27/23	13.8-feet
0-days	





# BORING: LE-03

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

# Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.801111, -105.043856\*  
 Boring Elevation: 5,244.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in Recovery (in) / ROD (%)	Drilling Rate (min./ft.)				In-Situ States	INDEX DATA					Strength & Compressibility				
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)	
0						<b>FINE ALLUVIUM</b> LEAN CLAY with sand (CL), little fine to coarse sand, few fine to coarse gravel, stiff, mottled dark brown to olive, moist, bark, roots, maximum particle size 1.5-inches.												
2.5	5242.5		5 7	10		As above except few fine gravel, iron oxidation, mica grains, maximum particle size 0.5-inches.												
5	5240		6 8	6		Sandy LEAN CLAY (CL), some to mostly fine to coarse sand, stiff, dark brown to olive, moist, iron oxidation, mica grains.	17.8	96.6		53.4	32	15						
7.5	5237.5		8 10	9		<b>COARSE ALLUVIUM</b> Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, some fine to coarse gravel, few clay, medium dense, olive to olive brown, moist, iron oxidation, maximum particle size 2.0-inches.	4.3	118.6	33.8	58.8	7.4							
10	5235		3 7 10	6		As above except little fine to coarse gravel, olive brown, maximum particle size 1.5-inches.												
12.5	5232.5		22 29	10		As above except wet.												
15	5230		24			Clayey SAND with gravel (SC), mostly fine to coarse sand, little clay, little fine to coarse gravel, very dense, olive to olive												

(11.5 ft.)

**General Notes:**  
 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)  
 2) The maximum particle size identified in the material description is dependent on sampler dimensions.  
 3) Additional information is provided on the Boring Log Key.  
 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		Date:	Elapsed Time:	Depth to Groundwater:
		01/27/23	0-days	11.5-feet

# BORING: LE-03

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.801111, -105.043856\*  
 Boring Elevation: 5,244.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description					Laboratory Testing Results												
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions  Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions					Groundwater Depth / Monitoring Well Configuration	In-Situ States		INDEX DATA				Strength & Compressibility			
													Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)
16.5	5227.5		32 42	12			brown, wet.															
							<b>END OF EXPLORATION</b>															

### General Notes:

- Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		
Date:	Elapsed Time:	Depth to Groundwater:
01/27/23	0-days	11.5-feet

# BORING: LE-04

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

# Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.799083, -105.043825\*  
 Boring Elevation: 5,243.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results									
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in Recovery (in) / ROD (%)	Drilling Rate (min./ft.)			Geologic Graphic	In-Situ States	INDEX DATA					Strength & Compressibility		
						Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
0	5242.5		6 7	9	<b>FINE ALLUVIUM</b> Sandy LEAN CLAY (CL), some fine to coarse sand, few fine gravel, stiff, dark brown, moist, roots.											
2.5	5240		3 3	5	As above.											
5	5237.5		2 1	12	Silty SAND (SM), mostly fine to coarse sand, little silt, olive brown, moist, iron oxidation.  As above except very loose, olive gray.											
7.5	5235		6 2 9	6	<b>FINE ALLUVIUM</b> SILT with sand (ML), little to some fine to medium sand, soft, dark gray, moist. 6' - Auger grinding indicative of gravel and cobbles.  As above except stiff. Silty SAND with gravel (SM), mostly fine to coarse sand, little fine to coarse gravel, little silt, medium dense, yellowish brown, moist. SILT (ML), stiff, dark gray, moist.	54.6	70.8			74.5	NV	NP				
10	5232.5		11 13 19	10	<b>COARSE ALLUVIUM</b> Poorly graded SAND with clay and gravel (SP-SC), mostly fine to coarse sand, some fine to coarse gravel, few clay, dense, dark olive, wet, maximum particle size 1.25-inches.					40.3	52.7	7.0				
12.5	5230		11 17 20	13	Clayey SAND with gravel (SC), mostly fine to coarse sand, some clay, little fine to coarse gravel, dense, dark olive to olive brown, wet, maximum particle size 1.25-inches.											
15	5227.5		13		As above.											

**General Notes:**

- 1) Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- 2) The maximum particle size identified in the material description is dependent on sampler dimensions.
- 3) Additional information is provided on the Boring Log Key.
- 4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:		Date:	01/27/23	Elapsed Time:	0-days	Depth to Groundwater:	8.0-feet
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# BORING: LE-04

Project Name: NTSI - Tennyson & 58th  
 Project Number: 22134  
 Client's Name: Kennedy Jenks  
 Owner's Name: City of Arvada  
 Drilling Subcontractor: Vine Laboratories  
 Lithos Representative: J. Halverson  
 Date(s) of Drilling: 01/27/23

## Drilling and Sampling Methods

Drill Make and Model: CME-75  
 Drilling Method: Solid Stem Auger (SSA)  
 Bit Type: Cutting Head  
 Casing Description: N/A  
 Hammer Weight (lbs)/Fall (in): 140/30  
 Sampler Type(s): Mod. Cal., SPT  
 Sampler Diameter(s): 2.0-inches, 1.4-inches



Boring Location: 39.799083, -105.043825\*  
 Boring Elevation: 5,243.0-feet\*  
 Notes: \*Location and Elevation approximate.

Sampling Data					Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results										
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / ROD (%)			Drilling Rate (min./ft.)	Geologic Graphic	In-Situ States	INDEX DATA					Strength & Compressibility		
							Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psi)	Swell Pressure (psf)	Swell Percent (%)
16.5	5243.0		35	18													
END OF EXPLORATION																	

### General Notes:

- Soil classifications are in general accordance with ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)
- The maximum particle size identified in the material description is dependent on sampler dimensions.
- Additional information is provided on the Boring Log Key.
- Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:	
Date:	Depth to Groundwater:
01/27/23	8.0-feet
0-days	



GEOTECHNICAL LABORATORY TESTING RESULTS													
Sample Identification		In-Place States		Material Classification and Index Testing						Stress Strain Behavior		USCS <sup>1</sup>	Description
Boring	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Particle Size Distribution (%)			Atterberg Limits (%)			One-Dimensional Consolidation/Swell			
				Gravel Content	Sand Content	Fines Content	Liquid Limit	Plastic Limit	Plasticity Index	Swell Percent (%) <sup>2</sup>	Swell Pressure (psf)		
LE-01	5.0	26.1	95.7			71.4	41	18	23			CL	LEAN CLAY with sand
LE-01	7.5	32.9	87.9			71.1	43	17	26	-0.4	N/A	CL	LEAN CLAY with sand
LE-01	10.0	29.2	93.4									CL	LEAN CLAY
LE-01	15.0			40.4	49.6	10.0	NV	NP	NP			SP-SM	poorly graded SAND with silt and gravel
LE-01	20.0	2.8	158.5	63.6	31.8	4.6						GP	poorly graded GRAVEL with sand
LE-02	5.0	18.1	104.3			53.5	35	15	20	0.0	N/A	CL	sandy LEAN CLAY
LE-02	10.0	5.2	130.6									GM	silty GRAVEL with sand
LE-02	12.5	12.1	117.7	56.1	25.7	18.2	NV	NP	NP			GM	silty GRAVEL with sand
LE-02	20.0			27.1	64.5	8.4						SP-SM	poorly graded SAND with silt and gravel
LE-03	5.0	17.8	96.6			53.4	32	17	15			CL	sandy LEAN CLAY
LE-03	7.5	4.3	118.6	33.8	58.8	7.4						SP-SC	poorly graded SAND with clay and gravel
LE-04	5.0	54.6	70.8			74.5	NV	NP	NP			ML	SILT with sand
LE-04	10.0			40.3	52.7	7.0						SP-SC	poorly graded SAND with clay and gravel

<sup>1</sup>Where Atterberg Limits and Fines Content testing was not performed, USCS classifications visually determined in the field during the subsurface investigation

<sup>2</sup>Swell percent as measured under an inundation pressure of 500 psf

**MOISTURE CONTENT & DENSITY DETERMINATION**

PROJECT: 58th and Tennyson JOB NO. 23-0029

TESTED BY A. Godat DATE 2/7/2023 CLIENT JOB NO.: 22134

LAB NO.	11775	11776	11777	11779	11780	11781
Boring No.	LE-01	LE-01	LE-01	LE-01	LE-02	LE-02
Depth, ft.	5'	7.5'	10'	20'	5'	10'
Diameter, in.	1.931	1.923	1.909	1.923	1.947	1.947
Length, in.	4.011	4.091	3.393	3.012	4.172	2.943
Wet Soil + Tare, gm.	380.5	372.6	316.0	382.7	410.2	324.4
Tare, gm.	8.2	8.1	8.0	8.1	8.2	8.0
Wet Soil, gm.	372.3	364.5	308.0	374.6	402.0	316.4
Volumn, cu. ft.	0.006798	0.006876	0.005620	0.005062	0.007188	0.005071
<b>Wet Density, pcf</b>	<b>120.6</b>	<b>116.8</b>	<b>120.7</b>	<b>163.0</b>	<b>123.2</b>	<b>137.4</b>
Cup No.	40	15	51	59	MOE	32
Cup Weight, gm	8.2	8.1	8.0	8.1	8.2	8.0
Wet Soil + Cup, gm.	380.5	301.6	316.0	382.7	331.7	324.4
Dry Soil + Cup, gm.	303.4	229.0	246.4	372.5	282.2	308.7
Water, gm.	77.1	72.6	69.6	10.2	49.5	15.7
Dry Soil, gm.	295.2	220.9	238.4	364.4	274.0	300.7
<b>Moisture Content, %</b>	<b>26.1</b>	<b>32.9</b>	<b>29.2</b>	<b>2.8</b>	<b>18.1</b>	<b>5.2</b>
<b>Dry Density, pcf</b>	<b>95.7</b>	<b>87.9</b>	<b>93.4</b>	<b>158.5</b>	<b>104.3</b>	<b>130.6</b>

LAB NO.	11782	11784	11785	11786
Boring No.	LE-02	LE-03	LE-03	LE-04
Depth, ft.	12.5'	5'	7.5'	5'
Diameter, in.	1.887	1.875	1.921	1.875
Length, in.	3.990	4.203	3.023	4.014
Wet Soil + Tare, gm.	394.7	355.1	292.4	326.9
Tare, gm.	8.1	8.2	7.9	8.0
Wet Soil, gm.	386.6	346.9	284.5	318.9
Volumn, cu. ft.	0.006457	0.006716	0.005070	0.006414
<b>Wet Density, pcf</b>	<b>131.9</b>	<b>113.8</b>	<b>123.6</b>	<b>109.5</b>
Cup No.	58	33	HBO	7
Cup Weight, gm.	8.1	8.2	7.9	8.0
Wet Soil + Cup, gm.	394.7	355.1	292.4	326.9
Dry Soil + Cup, gm.	353.1	302.8	280.8	214.3
Water, gm.	41.6	52.3	11.6	112.6
Dry Soil, gm.	345.0	294.6	272.9	206.3
<b>Moisture Content, %</b>	<b>12.1</b>	<b>17.8</b>	<b>4.3</b>	<b>54.6</b>
<b>Dry Density, pcf</b>	<b>117.7</b>	<b>96.6</b>	<b>118.6</b>	<b>70.8</b>

\* 11782 - approx. 1/2 of the liner was granular; dimensions are approximate

**Martinez Associates**

14025 W. 66th Avenue  
 Arvada, Colorado 80004  
 Phone: (303) 459-2216  
 Fax: (303) 482-2230



**One Dimensional Swell/Consolidation (ASTM D 4546)**

(Denver Area Swell/Consolidation Test)

Client Project No.: 22134 Proj. Name: 58th and Tennyson Sampled By: J. Halverson  
 Martinez Job No.: 23-0029 Lab Tech: R.S. Kay Test Date: 2/10/23 Sample Date: 2/7/23  
 Sample ID: 11780 Reviewed By: K. Runner  
 Sample Location: LE-02 Brass Liner @ 5'  
 Soil Description: \_\_\_\_\_  
 USCS: \_\_\_\_\_

**Sample Data:**

Ring No:	F	Dish No:	MOE
Ring Mass (g):	237.9	Dish Mass (g):	8.2
Sample Height (in):	0.75	Swell Machine #:	6
Pre-test Sample		Post-test Sample	
Ring + Sample (g):	314.2	Ring + Sample (g):	313.9
Dish wt:	8.2	Dish wt:	8.2
Wet wt (g):	331.7	Wet wt (g):	83.8
Dry wt (g):	282.2	Dry wt (g):	71.0

**Results:**

Pre-test Sample		Post-test Sample	
Moisture Content:	18.1%	Moisture Content:	20.4%
Wet Density (pcf):	131.7	Wet Density (pcf):	135.0
Dry Density (pcf):	111.5	Dry Density (pcf):	112.1

**Swell/Consolidation**

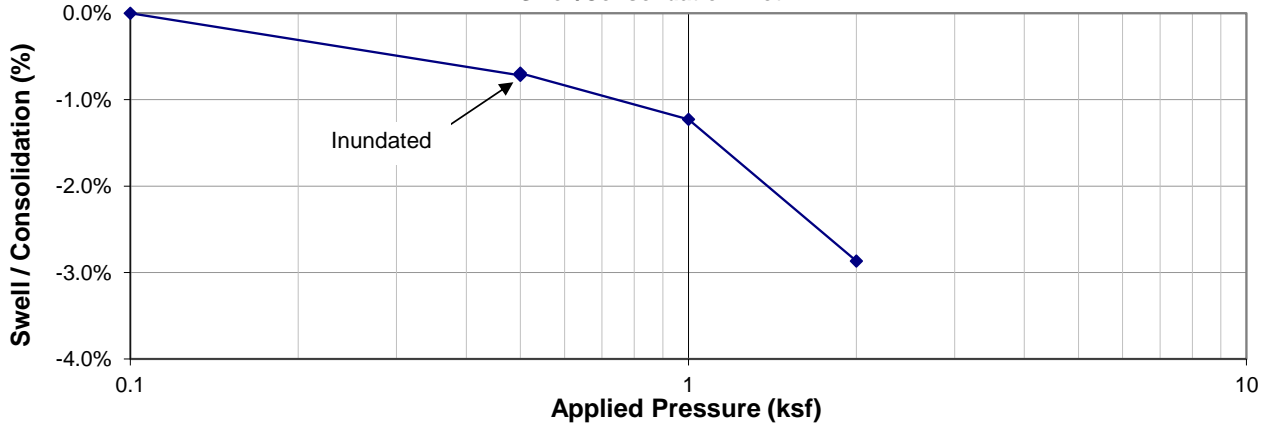
Load (ksf):	0.1	0.5	Add Water	0.5	1	2		
Correction (x 10-4):	0	19		19	39	76		
Dial Reading (x 10-4):	3301	3228		3230	3170	3010		
Swell/Consolidation %:	0.0%	-0.7%		-0.7%	-1.2%	-2.9%		

**Results:**

Swell Upon Wetting @  
 500 psf: **0.0%**  
 Swell Pressure (psf): **N/A**

Tested By: R. S. Kay  
 Checked By: K. Runner

**Swell/Consolidation Plot**



**Martinez Associates**

14025 W. 66th Avenue  
 Arvada, Colorado 80004  
 Phone: (303) 459-2216  
 Fax: (303) 482-2230



**One Dimensional Swell/Consolidation (ASTM D 4546)**

(Denver Area Swell/Consolidation Test)

Client Project No.: 22134	Proj. Name: 58th and Tennyson	Sampled By: J. Halverson
Martinez Job No.: 23-0029	Lab Tech: R.S. Kay	Test Date: 2/10/23
Sample ID: 11776		Sample Date: 2/7/23
Sample Location: LE-01 Brass Liner @ 7.5'		Reviewed By: K. Runner
Soil Description:		
USCS:		

**Sample Data:**

Ring No:	D	Dish No:	15
Ring Mass (g):	236.7	Dish Mass (g):	8.1
Sample Height (in):	0.75	Swell Machine #:	4
Pre-test Sample		Post-test Sample	
Ring + Sample (g):	306.2	Ring + Sample (g):	303.5
Dish wt:	8.1	Dish wt:	8.1
Wet wt (g):	301.6	Wet wt (g):	73.9
Dry wt (g):	229.0	Dry wt (g):	59.8

**Results:**

Pre-test Sample		Post-test Sample	
Moisture Content:	32.9%	Moisture Content:	27.3%
Wet Density (pcf):	119.9	Wet Density (pcf):	128.2
Dry Density (pcf):	90.3	Dry Density (pcf):	100.7

**Swell/Consolidation**

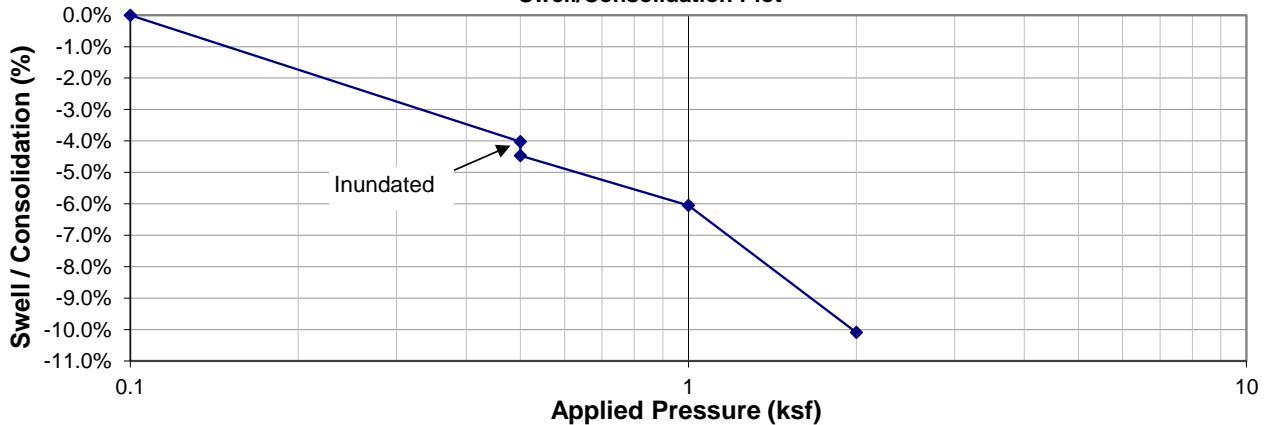
Load (ksf):	0.1	0.5	Add Water	0.5	1	2		
Correction (x 10-4):	0	37		37	74	110		
Dial Reading (x 10-4):	4580	4241		4208	4052	3713		
Swell/Consolidation %:	0.0%	-4.0%		-4.5%	-6.1%	-10.1%		

**Results:**

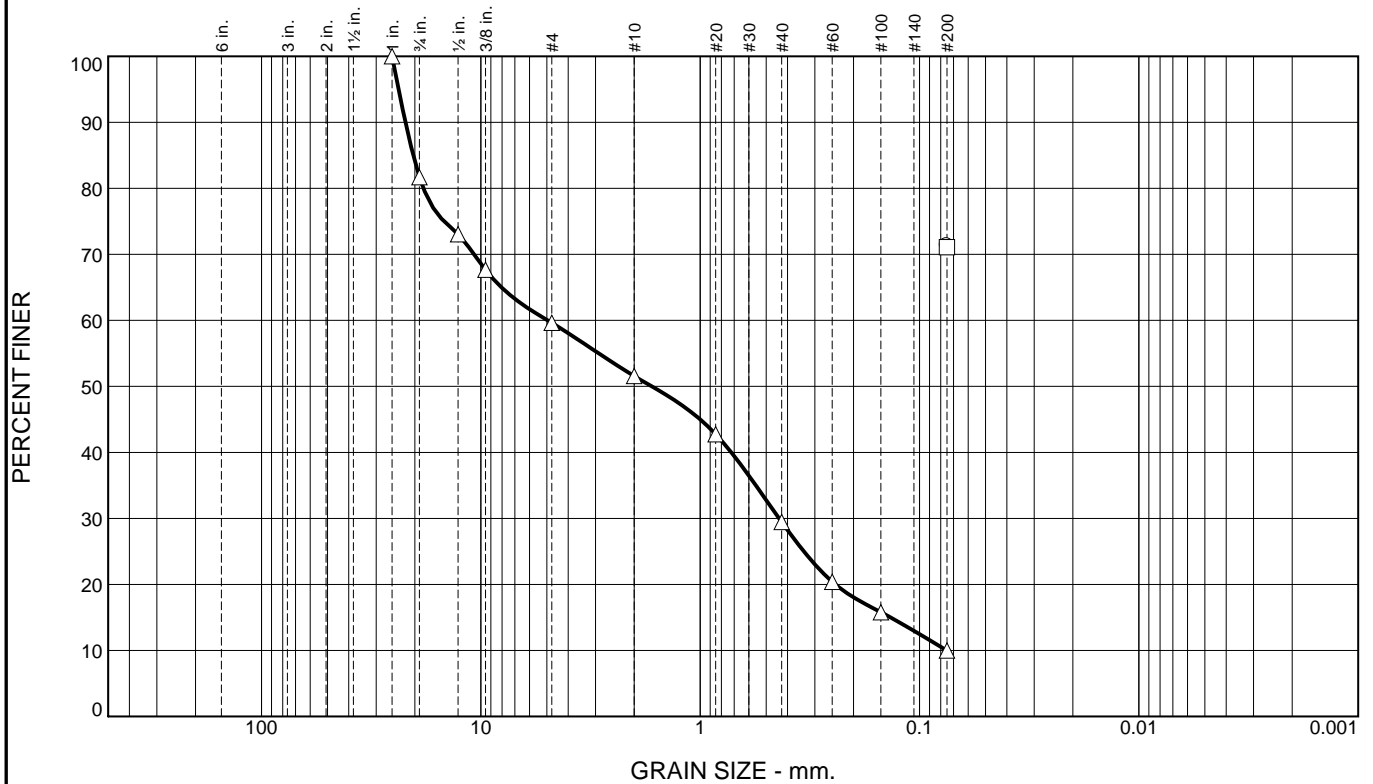
Settlement Upon Wetting @  
 500 psf: **-0.4%**  
 Swell Pressure (psf): **N/A**

Tested By: R. S. Kay  
 Checked By: K. Runner

**Swell/Consolidation Plot**



# Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							41	18	23
□							43	17	26
△	0.0	40.4	49.6	10.0		SP-SM	NV	NP	NP

SIEVE inches size	PERCENT FINER		
	○	□	△
1"			100.0
3/4"			81.7
1/2"			73.0
3/8"			67.7
GRAIN SIZE			
D60			4.9551
D30			0.4366
D10			0.0751
COEFFICIENTS			
C <sub>c</sub>			0.51
C <sub>u</sub>			65.96

SIEVE number size	PERCENT FINER		
	○	□	△
#4			59.6
#10			51.6
#20			42.7
#40			29.5
#60			20.4
#100			15.8
#200	71.4	71.1	10.0

**Material Description**

○

□

△ poorly graded sand with silt and gravel

**REMARKS:**

○ Natural Moisture Content: 26.1%

□ Natural Moisture Content: 32.9%

△

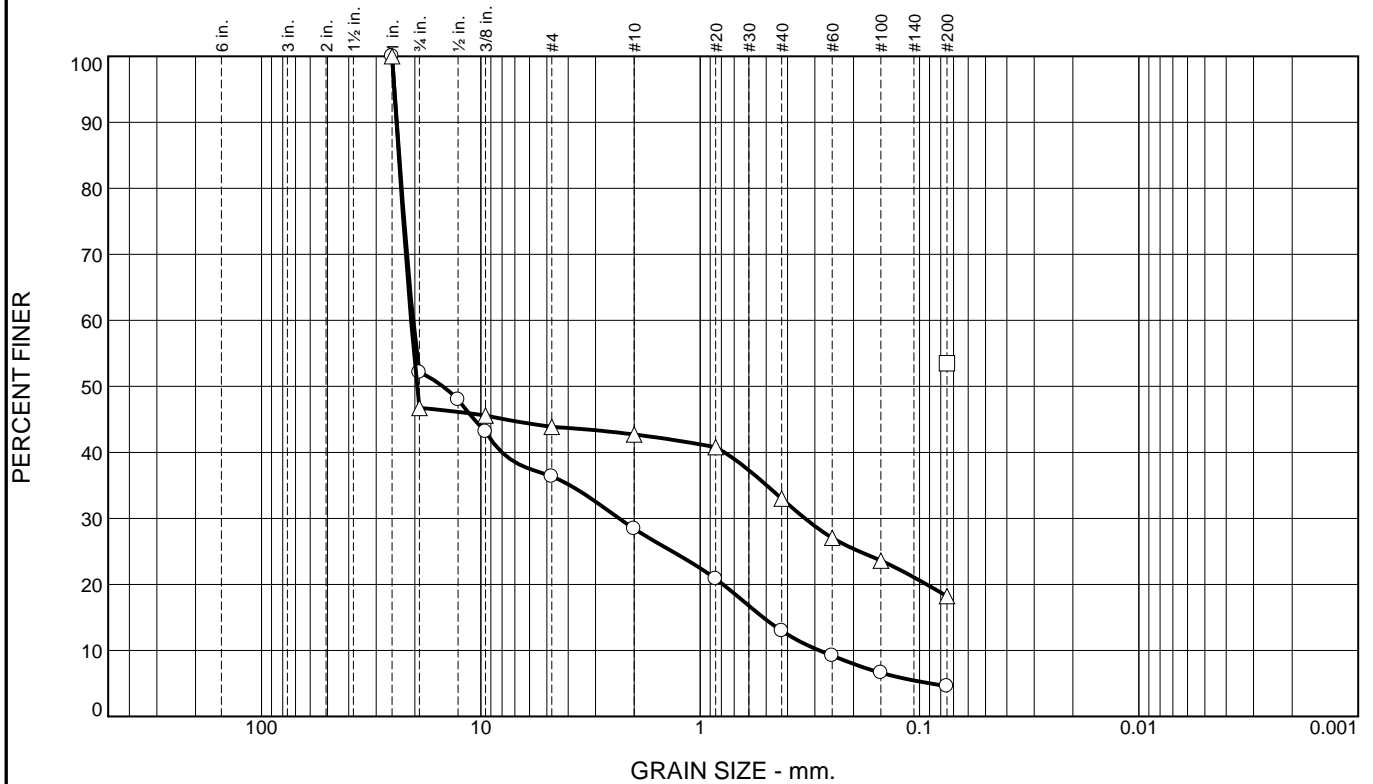
○ Location: LE-01 Brass Liner      Depth: 5'      Sample Number: 11775  
 □ Location: LE-01 Brass Liner      Depth: 7.5'      Sample Number: 11776  
 △ Location: LE-01 Bag      Depth: 15'      Sample Number: 11778

	Client: Lithos Engineering Project: 58th and Tennyson Lithos Project Number: 22134 Project No.: 23-0029
--	--

Figure



# Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○	0.0	63.6	31.8	4.6		GP			
□							35	15	20
△	0.0	56.1	25.7	18.2		GM	NV	NP	NP

SIEVE inches size	PERCENT FINER		
	○	□	△
1"	100.0		100.0
3/4"	52.1		46.7
1/2"	48.0		
3/8"	43.1		45.6
GRAIN SIZE			
D60	20.3722		20.8082
D30	2.3418		0.3329
D10	0.2866		
COEFFICIENTS			
Cc	0.94		
Cu	71.08		

SIEVE number size	PERCENT FINER		
	○	□	△
#4	36.4		43.9
#10	28.4		42.7
#20	20.8		40.8
#40	13.0		33.0
#60	9.2		27.0
#100	6.6		23.6
#200	4.6	53.5	18.2

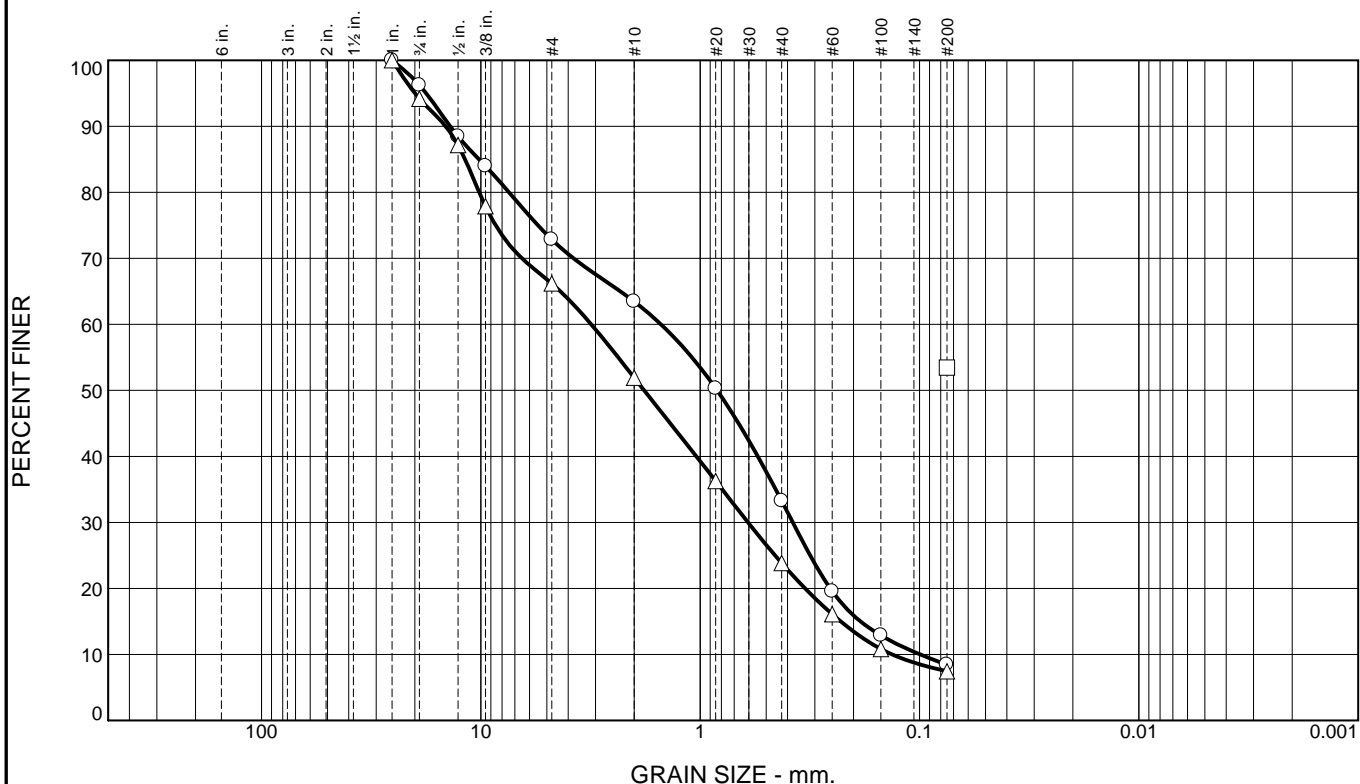
**Material Description**  
 ○ poorly graded gravel with sand  
 □  
 △ silty gravel with sand

**REMARKS:**  
 ○ Natural Moisture Content: 2.8%  
 □ Natural Moisture Content: 18.1%  
 △ Natural Moisture Content: 12.1%

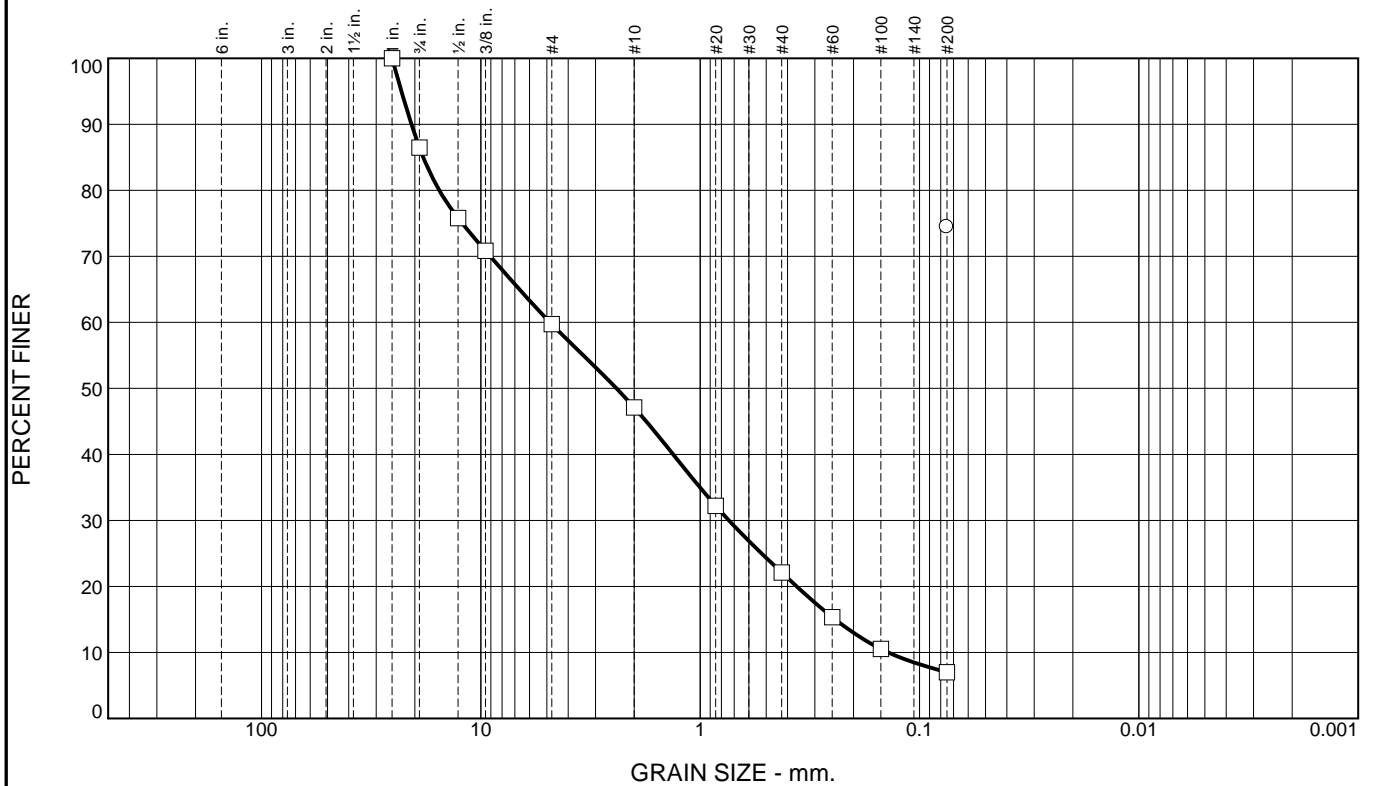
○ Location: LE-01 Brass Liner      Depth: 20'      Sample Number: 11779  
 □ Location: LE-02 Brass Liner      Depth: 5'      Sample Number: 11780  
 △ Location: LE-02 Brass Liner      Depth: 12.5'      Sample Number: 11782

	Client: Lithos Engineering Project: 58th and Tennyson Lithos Project Number: 22134 Project No.: 23-0029
--	--

# Particle Size Distribution Report



# Particle Size Distribution Report



	+3"	% GRAVEL	% SAND	% SILT	% CLAY	USCS	LL	PL	PI
○							NV	NP	NP
□	0.0	40.3	52.7	7.0					

SIEVE inches size	PERCENT FINER	
	○	□
1"		100.0
3/4"		86.5
1/2"		75.8
3/8"		70.8
GRAIN SIZE		
D60		4.8370
D30		0.7401
D10		0.1389
COEFFICIENTS		
Cc		0.82
Cu		34.82

SIEVE number size	PERCENT FINER	
	○	□
#4		59.7
#10		47.1
#20		32.2
#40		22.1
#60		15.3
#100		10.5
#200	74.5	7.0

**Material Description**

○

□

**REMARKS:**

○ Natural Moisture Content: 54.6%

□

○ Location: LE-04 Brass Liner      Depth: 5'      Sample Number: 11786  
 □ Location: LE-04 Bag      Depth: 10'      Sample Number: 11787

	Client: Lithos Engineering Project: 58th and Tennyson Lithos Project Number: 22134 Project No.: 23-0029
--	--

Figure

## **APPENDIX D**

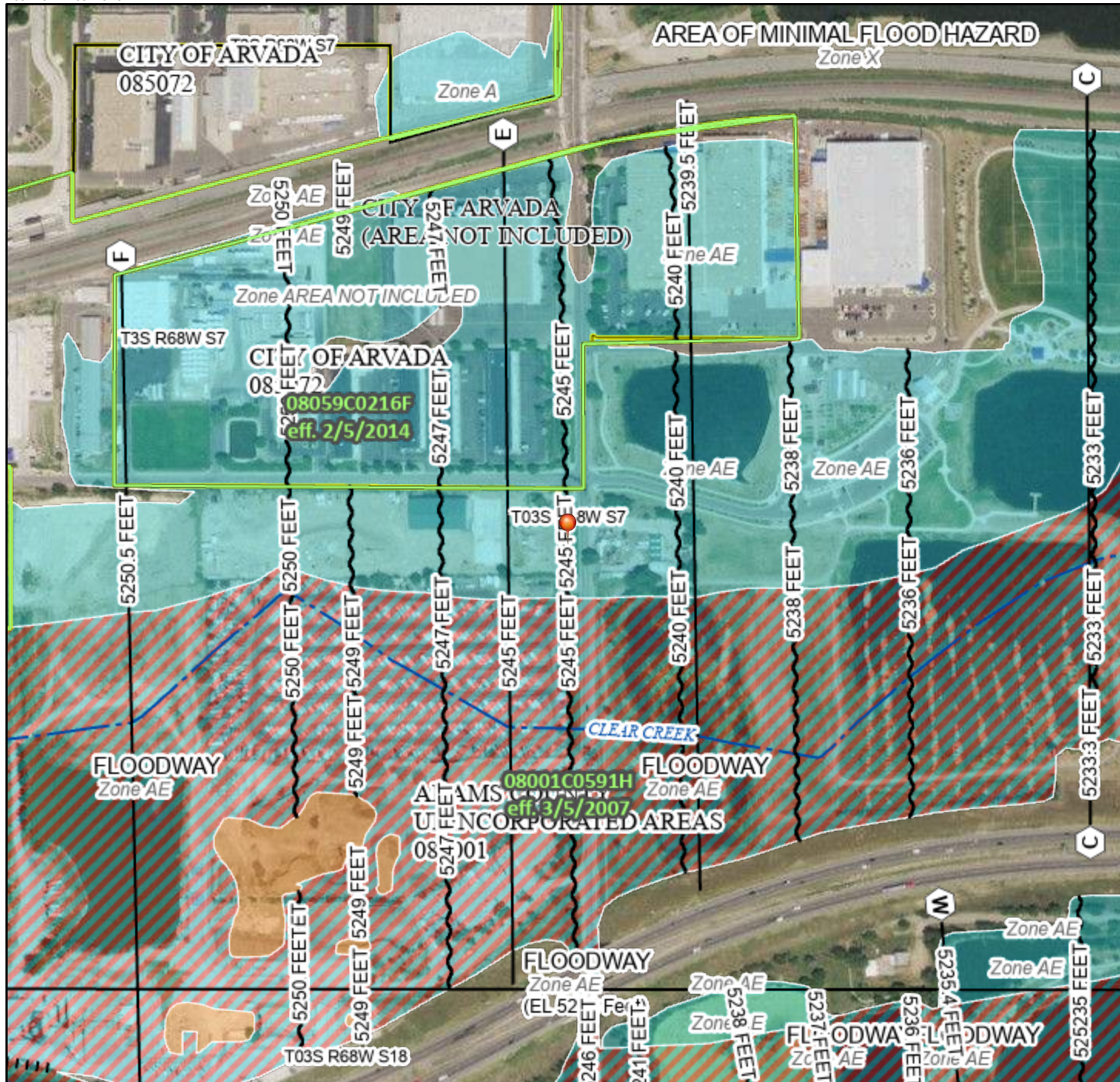
### **NATIONAL FLOOD HAZARD LAYER – FIRMette**



# National Flood Hazard Layer FIRMMette



105°2'57"W 39°48'19"N



## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

- |                                    |  |   |
|------------------------------------|--|---|
| <b>SPECIAL FLOOD HAZARD AREAS</b>  |  | Without Base Flood Elevation (BFE)<br>Zone A, V, A99  |
|                                    |  | With BFE or Depth Zone AE, AO, AH, VE, AR   |
|                                    |  | Regulatory Floodway   |
| <b>OTHER AREAS OF FLOOD HAZARD</b> |  | 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X |
|                                    |  | Future Conditions 1% Annual Chance Flood Hazard Zone X  |
|                                    |  | Area with Reduced Flood Risk due to Levee. See Notes. Zone X  |
|                                    |  | Area with Flood Risk due to Levee Zone D  |
| <b>OTHER AREAS</b>                 |  | NO SCREEN Area of Minimal Flood Hazard Zone X   |
|                                    |  | Effective LOMRs   |
|                                    |  | Area of Undetermined Flood Hazard Zone D  |
| <b>GENERAL STRUCTURES</b>          |  | Channel, Culvert, or Storm Sewer  |
|                                    |  | Levee, Dike, or Floodwall   |
| <b>OTHER FEATURES</b>              |  | 20.2 Cross Sections with 1% Annual Chance   |
|                                    |  | 17.5 Water Surface Elevation  |
|                                    |  | Coastal Transect  |
|                                    |  | Base Flood Elevation Line (BFE)   |
|                                    |  | Limit of Study  |
|                                    |  | Jurisdiction Boundary   |
|                                    |  | Coastal Transect Baseline   |
|                                    |  | Profile Baseline  |
|                                    |  | Hydrographic Feature  |
|                                    |  | Digital Data Available  |
|                                    |  | No Digital Data Available   |
|                                    |  | Unmapped  |

**MAP PANELS**

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/16/2023 at 4:24 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

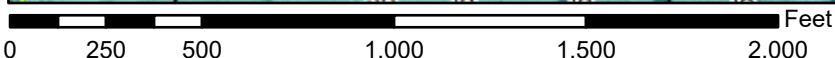
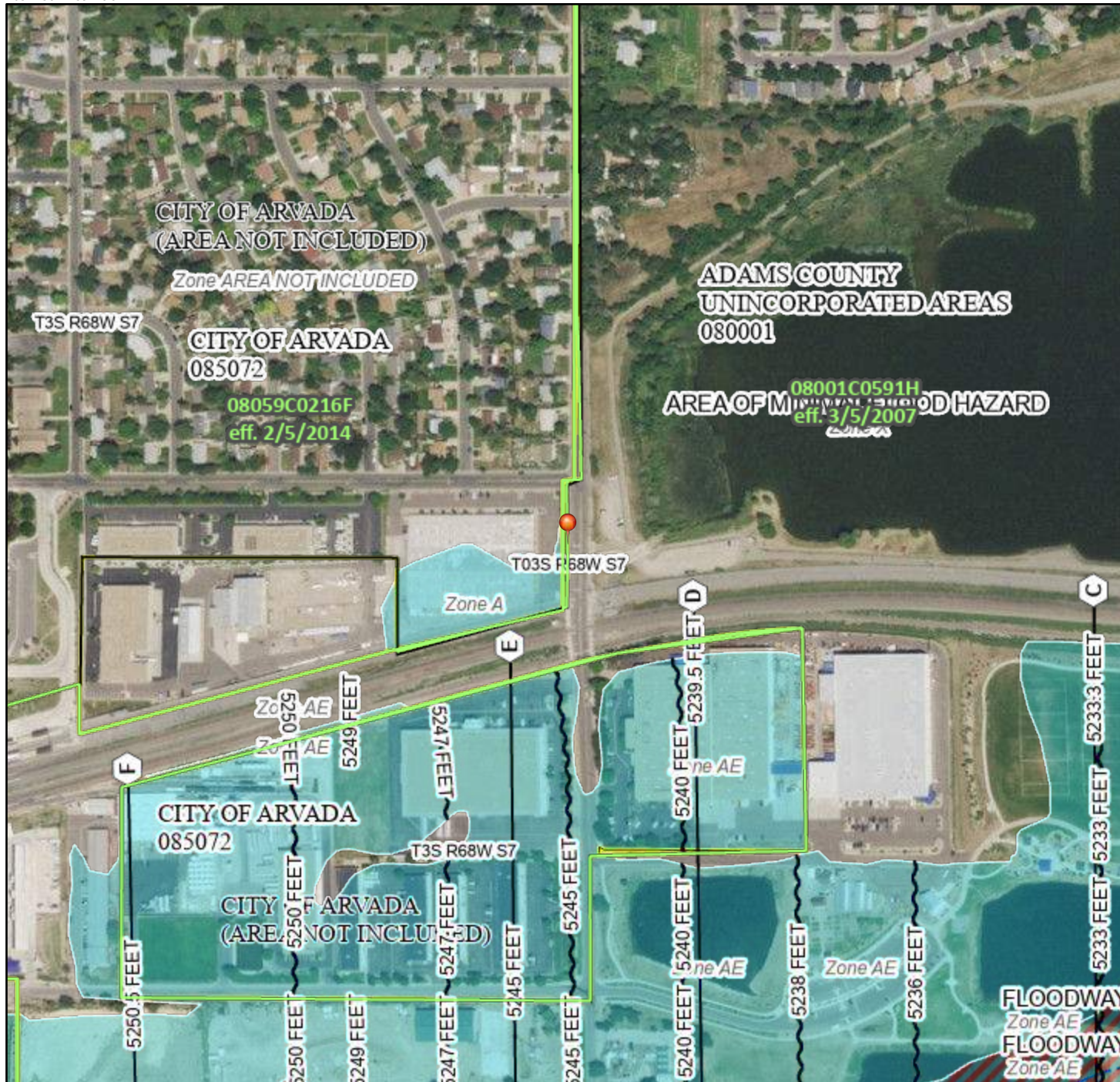
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



# National Flood Hazard Layer FIRMette



105°2'58"W 39°48'32"N



1:6,000 105°2'20"W 39°48'5"N

Basemap Imagery Source: USGS National Map 2023

## Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS	Without Base Flood Elevation (BFE) Zone A, V, A99	With BFE or Depth Zone AE, AO, AH, VE, AR	Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD	0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile Zone X	Future Conditions 1% Annual Chance Flood Hazard Zone X	Area with Reduced Flood Risk due to Levee. See Notes. Zone X	Area with Flood Risk due to Levee Zone D

OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard Zone X	Effective LOMRs	Area of Undetermined Flood Hazard Zone D

GENERAL STRUCTURES	Channel, Culvert, or Storm Sewer	Levee, Dike, or Floodwall

OTHER FEATURES	Cross Sections with 1% Annual Chance Water Surface Elevation	Coastal Transect	Base Flood Elevation Line (BFE)	Limit of Study	Jurisdiction Boundary	Coastal Transect Baseline	Profile Baseline	Hydrographic Feature

MAP PANELS	Digital Data Available	No Digital Data Available	Unmapped



The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 8/16/2023 at 4:25 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

**APPENDIX E**  
**INSPECTION FORMS**

# Inspection Report

Permit Inspection Details	
Project Name	
Permit Number	
Inspection Date	
Inspection Time	
Inspector	
Inspection Type	
Results Of Inspection	

### Definition of Results for Inspection

Passing: All checklist items are adequately controlled. All BMPs are rated as *Not Needed* or *Working*.

Compliance Advisory: If at least one of the checklist items is not adequately controlled or if any BMPs are rated as *Maintenance Required*, *Install new or alternate BMP* or *Immediate Action Required*, a compliance advisory is issued and a follow-up inspection will be conducted within seven days to verify the checklist items or BMP(s) were corrected. If all items are corrected, the inspection result will be changed to Passing.

Notice of Non-compliance: Will be issued if the items indicated in the Compliance Advisory are still not corrected during the subsequent 30 day inspection. These Notices negatively affect the compliance record of the site.

Notice of Violation / Stop Work Order: Will be issued if the items in the Compliance Advisory are still not corrected during a follow up inspection of the subsequent 30 day inspection. If the severity of noncompliance demonstrates additional sanctions are necessary, building permits and/or inspections are withheld or a stop work order is posted until the items are corrected.

Inspection Checklist	
Permit on site?	
Current SWMP on site?	
SWMP reviewed during inspection?	
Completed Inspection reports on site?	
Vehicle maintenance/fueling controlled?	
Stockpiled building materials controlled?	
Dewatering activities onsite?	
Stockpiled soils controlled?	
Soils stabilized in inactive work areas?	
Offsite soil tracking?	
Onsite street sweeping needed?	
Evidence of pollutants in major outlets?	
Concrete washout controlled?	
Portable restroom controlled?	
Results Reviewed with onsite rep?	



## **Appendix B**

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Adams County Development Application  
Adams County 60% Comments/Responses



# **Adams County Development Application**

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**Application Type:**

<input checked="" type="checkbox"/> Conceptual Review	<input type="checkbox"/> Preliminary PUD	<input type="checkbox"/> Temporary Use
<input type="checkbox"/> Subdivision, Preliminary	<input type="checkbox"/> Final PUD	<input type="checkbox"/> Variance
<input type="checkbox"/> Subdivision, Final	<input type="checkbox"/> Rezone	<input type="checkbox"/> Conditional Use
<input type="checkbox"/> Plat Correction/ Vacation	<input type="checkbox"/> Special Use	<input checked="" type="checkbox"/> Other: IGA

**PROJECT NAME:** Arvada North Trunk Sewer Improvements Project

**APPLICANT**

Name(s): Kris Gardner Phone #: 720-898-7647  
Address: 8101 Ralston Rd.  
City, State, Zip: Arvada, CO 80001  
2nd Phone #: Email: kgardner@arvada.org

**OWNER**

Name(s): Sharon Israel Phone #: 720.898.7761  
Address: 8101 Ralston Rd.  
City, State, Zip: Arvada, CO 80001  
2nd Phone #: Email: sisrael@arvada.org

**TECHNICAL REPRESENTATIVE (Consultant, Engineer, Surveyor, Architect, etc.)**

Name: Brad Floretine Phone #: 720-779-1006  
Address: 215 Union Blvd. Suite 500  
City, State, Zip: Lakewood, CO 80228  
2nd Phone #: Email: bradfloretin@kennedyjenks.com

**DESCRIPTION OF SITE**

Address:

City, State, Zip:

Area (acres or square feet):

Tax Assessor Parcel Number:

Existing Zoning:

Existing Land Use:

Proposed Land Use:

I hereby certify that I am making this application as owner of the above described property or acting under the authority of the owner (attached authorization, if not owner). I am familiar with all pertinent requirements, procedures, and fees of the County. I understand that the Application Review Fee is non-refundable. All statements made on this form and additional application materials are true to the best of my knowledge and belief.

Name:

Date:

Owner's Printed Name

Name:

Sharon Israel

Owner's Signature

## **Adams County 60% Comments/Responses**

---

May 15<sup>th</sup>, 2024

Mark McDonald  
Adams County Public Works (County)

Subject: Arvada North Trunk Sewer (NTS) – ADCO Comments 60% Design – Revision 1  
KJ Job No. 2246059

Dear Mark:

Kennedy/Jenks (KJ) is providing the following responses to the County's comments on the 60% design alignment for the Arvada NTS project. KJ responses will be in *blue text*.

1. The County will accept the proposed Alignment #1 with the metering pit on the west side of the roadway and the bypass line (pipe and manholes) on the west side of the metering pit (as shown in the plans). The existing drainage sway will be realigned (offset) farther west of the new sanitary sewer system. (The County does not agree with Alignment #2 because it crosses diagonally under the road; the County prefers the sanitary line stay parallel to the road.)

*Alignment #1 was selected as the preferred alignment due to existing utility conflicts and to avoid utility conflicts in the future. The alignment has also been modified to bypass the meter vault on the east side to avoid conflict with the existing drainage swale. Please see the attached updated design plans showing the new meter vault location and bypass alignment.*

2. The County does not have any special requirements for the details and construction of the realigned drainage sway. Public Works will review and comment on the proposed details and specifications designed by Kennedy Jenks and provided in later progress documents.

*Plans and details are being prepared in accordance to City of Arvada and CDOT standards for Adams County's review.*

3. Placing the bypass line on the west side of the metering pit and offsetting the drainage sway farther west falls outside of the existing County right of way. Land acquisition will be needed from two (2) parcels.
  - a. The County requests that the land be acquired as Permanent Right of Way from the LOC No. 2 LLC parcel. It is understood that the land acquisition from CDOT will be by a license agreement.

*The updated trunk sewer alignment has been modified and the proposed meter vault location and bypass is now located inside existing right-of-way. CDOT property acquisition for extension of the ROW is not required for this project.*

- b. The County understands that all land will be acquired by the City of Arvada and then transferred to Adams County.



*The updated trunk sewer alignment has been modified and the proposed meter vault location and bypass is now located inside existing right-of-way. CDOT property acquisition for extension of the ROW is not required for this project.*

- c. The County requests that the new west ROW line be a distance of 54.00' from the estimated centerline of future roadway shown in the NTS plans at the property line between the CDOT and LOC No.2 LLC parcels. This will put the new west ROW line just outside of the existing private fence.

*The updated alignment is now 100% within existing right-of-way. CDOT property acquisition for extension of the ROW is not required for this project.*

- i. The reason for this width of ROW is the County has made the NTS project aware that we intend to replace the drainage sway (open channel) with a new buried storm sewer system with our Tennyson St Improvement project in the near future. The County's standard ROW for a minor collector road section is 80', with 40' on each side of the roadway centerline. The proposed bypass line at the metering pit is offset approximately 13' west of the main sanitary sewer line. If the County's future storm sewer line (which could be 48" diameter pipe or a larger hydraulic area) is behind the future west sidewalk and an adequate lateral distance from the sanitary sewer line, then the storm sewer alignment will need to be offset west a similar distance as the bypass line in the vicinity of the metering pit.

*Realigning the meter vault bypass line to the east keeps the alignment of the existing storm swale intact for a future stormwater pipeline within ROW.*

- ii. The County asked if the bypass line around the west side of the metering pit was really necessary. Kennedy Jenks indicated they would ask the City about the bypass. If the bypass line was eliminated from the design, then it might be possible to reduce the width of the land acquisition. It appears some land will still need to be acquired to realign the drainage sway around the metering pit.

*The bypass line is a requirement of Metro Water Recovery.*

- iii. After further consideration since the Friday, 7/14, meeting, the County also requests that the City please extend the north end of the land acquisition all the way to the property line between the LOC No. 2 LLC and OSI parcels.

*The updated alignment is now 100% within existing right-of-way. CDOT property acquisition for extension of the ROW is not required for this project.*

Separate from the subject of the metering pit and bypass alignment, the County also discussed the impact the NTS project might have all along the existing drainage sway. Stormwater drainage between 58<sup>th</sup> Ave and I-76 is not good. The County is wondering if any improvements to the drainageway could be achieved as a direct or indirect result of the NTS project with trenching occurring beside or in the sway to varying degrees. Please let the County know the following:

*Per City Staff: The City of Arvada has identified a trouble point in its sanitary sewer system and is working on construction plans to prevent a pipe failure and/or sanitary sewer overflow. This is the primary goal of this project. It is understood that the City will replace any stormwater infrastructure damaged or removed during construction. ROW acquisition, drainage analysis, and additional scope changes may cause delays to the project putting the City sewer system at a higher risk of failure causing an environmental and public health incident.*

4. Does the NTS project have topographic survey data to share – elevations, contours, bottom profile, etc. – of the drainage sway and driveway access culverts between 58<sup>th</sup> Ave and I-76?

*Yes, the City has topographic survey in this area, which includes elevations of the flow line of the ditch and the top of the berm on either side. Additional survey points west of the swale were not included in scope of work.*

5. How and where will the construction work to remove the old and place the new sanitary pipes affect:
  - a. the existing drainage sway (grading and shape of side slope(s) and bottom)?

*The intent of this project is to return all areas of the impacted storm swale to pre-construction conditions. The plan is to include existing contours, spot elevations, and the flow line of the ditch in the design plans so the Contractor can match pre-construction conditions.*

- b. the existing access culverts for the four (4) driveways between 58<sup>th</sup> Ave and I-76?

*The Contractor plans on replacing the existing culverts up to Station 9+00. The intent is to replace culverts in kind to match pre-construction conditions.*

We appreciate the opportunity to work with Adams County on this project. If you have any questions, or require additional information, please call me at 720-779-0998.

Sincerely,

Travis Stevens, P.E.  
KENNEDY/JENKS CONSULTANTS

## **Appendix C**

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Sign-in Sheet

Maps Displayed at Neighborhood Meeting

Berkeley Sanitation Email Correspondence

## **Sign-in Sheet**

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# SIGN IN SHEET

NAME

EMAIL

Arthur Teter

Laure Teter

Juanita Garcia

Arthur Garcia

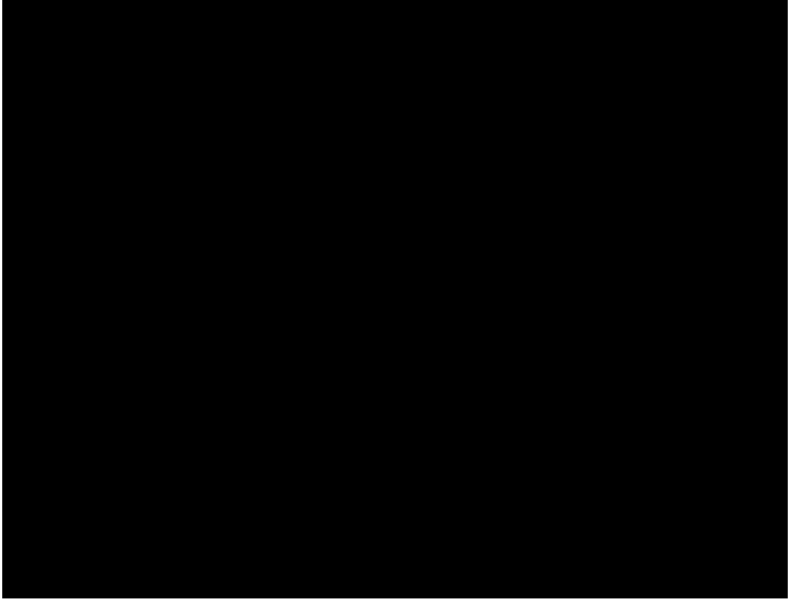
Edward Kajko

~~SUZUKI WAKITAHARA~~

JUSTIN LANGE

Wayne & Jeanette Wawock

Pat Erickson





# COMMENT CARD

NAME

Juanita Garcia

PHONE



ADDRESS

4274 W 61st Place

Crystal Lakes

Today 4-23-24, Crestview water cleaned out the sewer line. We had gurgling in our house. Possibly our sewer line. Is this safe?

# COMMENT CARD

NAME

JUSTIN LANGE

PHONE



ADDRESS

4730 W. 63rd AVE

ARVADA, CO 80003

There will be significant traffic increased on 63rd Avenue b/w TENNYSON & WOLFF. THERE NEEDS TO BE "LOCAL TRAFFIC ONLY" SIGNS PREVENTING PEOPLE FRUSTERATED WITH THE ROAD CLOSURE "ONELANE" FROM SPEEDING AROUND THE NEIGHBORHOOD.

\* PLEASE PUT IN SPEED BUMPS AROUND TENNYSON KNOXLS PARK PEOPLE SPEED FREQUENTLY ON 63rd AND ON WOLFF\*

# COMMENT CARD

NAME

Pat Erickson

PHONE



ADDRESS

6210 Tennyson St.  
Arvada, CO 80003

Interested in the North  
side of 60th + Tennyson St.

## **Maps Displayed at Neighborhood Meeting**

---





JIM BAKER  
RESERVOIR

SHW 76

RR TRACKS

TENNYSON ST.

W. 61st PL.

W. 60th AVE.

W. 58th AVE.



NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SCALE NTS  
JOB NO 2246059\*00  
DATE JAN 2024





W. 61st PL.

JIM BAKER  
RESERVOIR

W. 60th AVE.

RR TRACKS

TENNYSON ST.

W. 58th AVE.

SHW 76



NORTH TRUNK SEWER IMPROVEMENTS  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11



SCALE NTS  
JOB NO 2246059\*00  
DATE JAN 2024



## **Berkeley Sanitation Email Correspondence**

---



Amber Brooks &lt;abrooks@arvada.org&gt;

---

**RE: Tennyson Street Sewer Line Replacement Project**

2 messages

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**Amber Brooks** <abrooks@arvada.org>

Fri, Apr 26, 2024 at 9:38 AM

To: berkeleywater@gmail.com

Cc: Mary Stahl &lt;mstahl@arvada.org&gt;, Kris Gardner &lt;kgardner@arvada.org&gt;, Katie Patterson &lt;kpatterson@arvada.org&gt;

Good morning Ms. Whitehair,

It was lovely meeting you on Tuesday at the informational meeting. Thank you for taking the time to discuss your concerns with us. I believe we had a chance to talk through most of them, but I wanted to follow up with our responses below as well. I did my best to respond to your comments you submitted at the meeting, but please feel free to reach out via email or phone if you have any follow up questions or if I missed anything.

1. Have you done a recent traffic study between 61st and I-76 recently? Did you also do one on 58th Avenue off of Tennyson?
  - As part of any construction, traffic control plans will be provided by the contractor and reviewed by the City's Traffic Engineering department. The City does not conduct traffic studies for any pipe project, including sewer line projects. The goal of this project is to upgrade aging sanitary sewer infrastructure, and all traffic configurations that will be disrupted as part of construction will be replaced as is.
2. Are you going to be considerate about businesses and their employees so they can get to and from their job on time without being stacked behind other vehicles because there is only one option to get in and out?
  - The contractor will be utilizing a phased approach to construction. No entrances/exits will be fully blocked at any time. In other words, at least one lane of entry/exit will be maintained at all times to the safest extent possible.
  - As with any construction project, some delays can be expected and folks should plan accordingly. Single-lane traffic can result in minor delays, typically only a few minutes. One directional traffic will be maintained through the project.
3. Do you realize this is one of the worst streets for you to block since you can only get out on the north and south side of Tennyson or on 58th to Ralston Road and Sheridan? There are no other east to west streets on Tennyson.
  - At this time, the criticality of the sewer line replacement does make the project a priority to ensure we can continue to provide reliable wastewater services to our community. While disruptions from construction may be unavoidable, the contractor will utilize best practice for the safety of their crews and the traveling public to minimize disruptions through their traffic control plans.
4. Are you going to work with CDOT to fix the stop light at Sheridan and Ralston since it does not have a left turn lane signal and only lets three or four vehicles out at a time? Traffic already backs up around the curve at 58th Avenue with a mix of semis and regular vehicles. It is going to be nightmare if that is the only way out.
  - This project is specific to the City's utility system to replace the sanitary sewer underneath Tennyson Ave. No traffic signals/configurations will be changed as a result of this project. This type of work would be out of the scope of the project.
5. If you close the railroad tracks, are you aware that when you divert traffic to 60th Avenue at 8 am, that you will have vehicles backed up from Sheridan to Tennyson? That is what happened to me on the 9th of April.
  - Noted. A full road closure at the railroad crossing is required to provide safe working conditions while tunneling underneath the railroads for pipe installation. Every effort will be made to communicate the closure beforehand using the contractor's traffic control plan including relevant signage and detours.
6. Berkeley's maintenance people need to respond to emergency calls and if you block Tennyson south of 58th, they will not be able to respond as quickly depending on what exit you make us take.
  - Noted. As mentioned above, traffic control plans will be designed with safety of the working crews and the traveling public as priority. With phased construction, only portions of Tennyson will be affected by traffic control at a time during the 10-month duration of the project. Meaning traffic will not be affected for emergency crews for all 10 months. Prior to any lane closures that would affect the Berkeley WSD facility, notifications will be provided by the City/Contractor.
7. Why is it taking 10 months to put in a sewer main in approximately eight blocks of road?
  - This project is complicated and includes not only the installation of approximately 3,600 feet of sanitary sewer, but also the installation of a new Metro Water metering vault, the safe abandonment of existing, aged sanitary sewer, and the replacement of pressurized 8-inch waterline. The majority of this process will be completed by open trenches, but at the railroad crossings the contractor will be installing sanitary sewer pipe via tunneling/trenchless methods. The latter takes time and precision to ensure that the pipe is installed at line and grade and with no damage to existing utilities.

8. Are you putting in curb and gutter as well?
  - We will be replacing any curb and gutter affected by the project as is, or upgrading to current ADA-compliant crosswalk ramps. We are not doing general roadway improvements beyond existing conditions.
  - Through a grant with Adams County, the City is coordinating a separate project to provide some bike lane and sidewalk improvements. More information about that project is available at [ArvadaCO.gov/Tennyson-Street](https://ArvadaCO.gov/Tennyson-Street).
9. Are you widening the road? If so, have you acquired all of the right of way needed?
  - The City is not widening the road as part of this project. The City will be working within the existing right-of-way
10. I didn't think that UP could close the tracks for very long without getting a fine. How is Arvada and Adams County able to do that?
  - The three railroad companies are requiring trenchless means for installation which minimizes impacts on their operations. At this time, there are no plans to close the tracks for the railroad companies' use, but there will be a road closure for this portion of the work.
11. Why would water be shut off if you are working on the sewer main?
  - Part of the project requires that an existing 8-inch waterline be relocated to accommodate the upsized sanitary sewer. During this time, brief lapses of service may occur, and anyone affected by planned outages will be notified.

The following are in response to the comments/questions you noted during the meeting:

1. To answer your question regarding bypass work performed by the contractor, BT Construction will be qualified to bypass where necessary.
2. Every utility marked within the vicinity of the proposed construction will be test holed with a vac truck prior to the completion of design to minimize any unplanned encounters with existing utilities.

Thank you again for your time and consideration. Have a great weekend,

---

**Amber Brooks** (*she/her*)  
Civil Engineer - Utilities

(720) 665 - 4404  
[abrooks@arvada.org](mailto:abrooks@arvada.org)



---

**Berkeley Water District** <berkeleywater@gmail.com>

Fri, Apr 26, 2024 at 10:10 AM

To: Amber Brooks <abrooks@arvada.org>

Cc: Mary Stahl <mstahl@arvada.org>, Kris Gardner <kgardner@arvada.org>, Katie Patterson <kpatterson@arvada.org>

Amber:

It was a pleasure to meet you and your team as well. This was a very detailed response so I wanted to thank you and your team for the time it took to answer my questions.

I will forward this to my Board since this will have a major impact on their travels as well (especially monthly Board meetings). My staff also appreciates your response.

I hope all of you have a wonderful weekend.

Regards  
Sharon

[Quoted text hidden]

## **Appendix D**

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Sanitary Sewer Master Plan Executive Summary  
Sanitary Sewer Master Plan Selected Modeling Results



# **Sanitary Sewer Master Plan Executive Summary**

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# Model Update

Sanitary Sewer Master Plan

*City of Arvada Colorado*

December, 2022

TM 7

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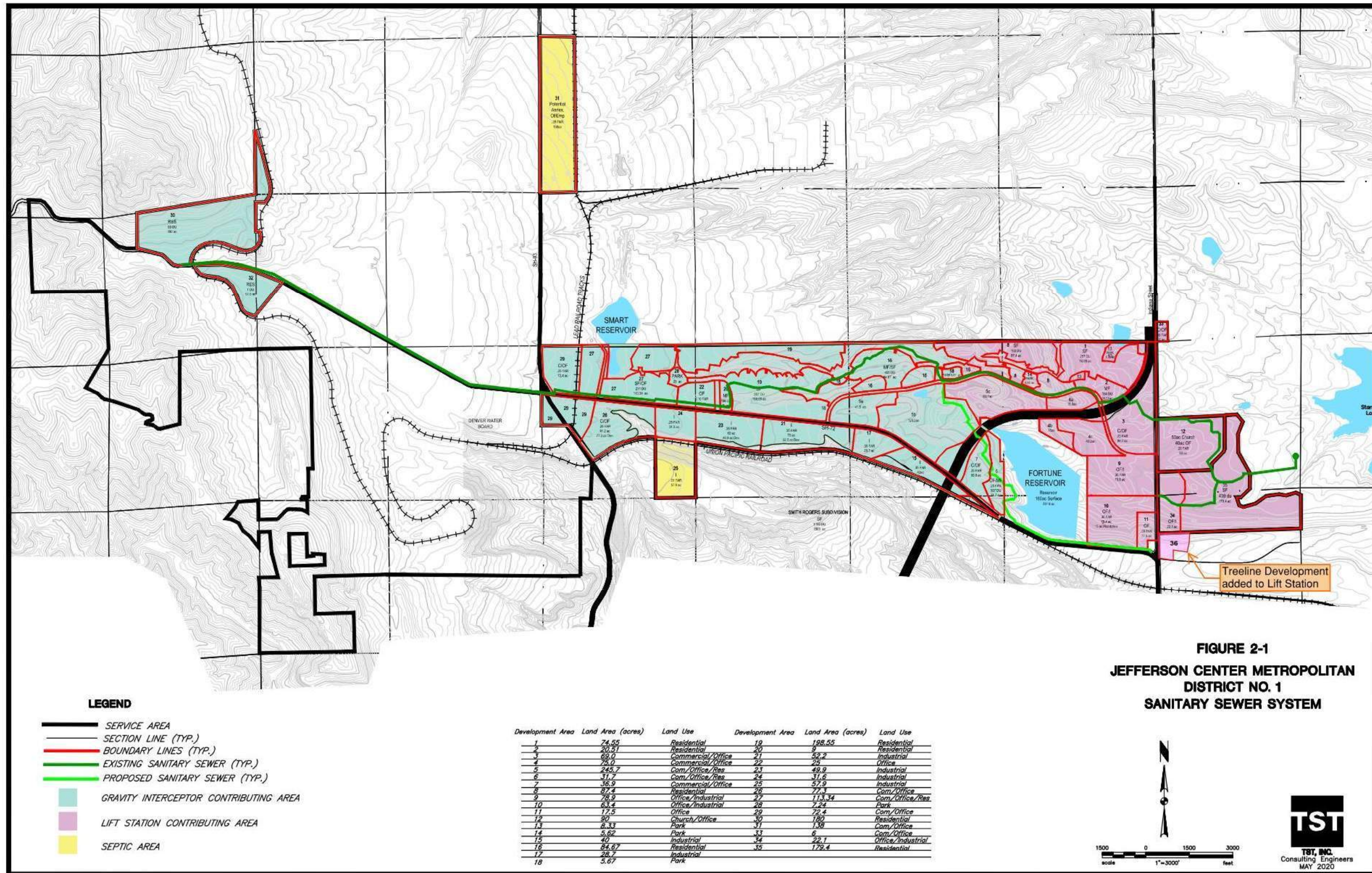
# 1 Introduction

The City of Arvada (City) has contracted HDR Engineering, Inc. to update the original sewer system master plan. Since the most recent master plan effort, the City has updated flow projections to provide a sensitivity analysis evaluating potential impacts of comprehensive plan changes for the Jefferson Center Metropolitan District (JCMD) located at the north-west side of the City along the North Trunk. Figure 1 shows a map of the JCMD development.

The previous land use analysis, flow projections and other flow components remained intact for the rest of the system and the same 5-, 10- and 25-year design storms were used for the analysis. The City's criteria of 0.75 d/D was used to identify capacity limited areas and improvement projects. Finally, the Alkire lift station was updated with new pump curves. Refer to Future Flow Analysis TM 4 for detailed information on future flow projections and the Level of Service TM 2 for selected design storms details and design criteria.



Figure 1. JCMD Development





## 2 JCMD Development

The City provided updated Base Sanitary Flow (BSF) for the JCMD development that represents the reasonable upper limit for parcels that have potential for change in use. These changes in use would require a comprehensive plan modification and the flows were provided with the intention to perform a sensitivity analysis on pipe size through the North Trunk Line. Attachment A shows the original data received. Two different flow projections were provided, 85 g/c/d and 100 g/c/d. As directed by the City, HDR used flow projections based on 100 g/c/d, which was consistent with the Master Plan.

The updated data compared to the original master plan, contained an extra development parcel, parcel 36 located at the south-east side of the JCMD development at the corner of Indiana Street and Highway 72. To calculate sewershed areas for the JCMD development parcels, previous areas provided by the developer were used with the exception of the new added parcel 36. To calculate area for parcel 36 a polygon was created in GIS and area was calculated spatially. Table 1 shows a comparison of Base Sanitary Flow and sewershed area between the original and updated projections in the model. The updated loading has approximately 1,160 gpm of additional BSF and sewershed areas were reduced by approximately 43 acres, areas remained similar to each other.

During the original master plan effort an incremental analysis was used to load base sanitary flow and sewershed area. As mentioned in the Future Flow Analysis TM4, the developer provided completed development and ultimate buildout estimated to happen in 2030. Since a portion of the JCMD development has been in construction over the past years, projected flow for each parcel was evaluated individually based on the RDII already assumed during wet weather flow calibration. Based on pipelines that were already constructed, an estimate was made for the contributing areas for the existing system calibration. An incremental acreage was added to the existing system to match total ultimate acreages. During the updated master plan, instead of using an incremental approach, the existing sewershed area and BSF were removed from the model, and the total existing and future BSF and sewershed area were allocated together during future conditions.

**Table 1. BSF and Sewershed Area Comparison**

Type	Parcel ID	Original Master Plan Area (Acres)	Updated Master Plan Area (Acres)	Original Master Plan Completed Loading (gpm)	Original Master Plan Loading 2030 (gpm)	Original Master Plan Total Loading (gpm)	Updated Total Loading (gpm)
Lift Station	1	74.6	74.6	77.9	0.2	78.1	62.3
Lift Station	2	20.5	20.5	26.6	9.9	36.5	37.1
Lift Station	3	69.0	69.0	19.6	23.3	42.9	38.3
Lift Station	8	87.4	87.4	14.2	14.4	28.6	46.8
Lift Station	9	78.9	78.9	0.0	54.8	54.8	265.1
Lift Station	10	63.4	63.4	0.0	44.0	44.0	53.1
Lift Station	11	17.5	17.5	0.0	12.2	12.2	10.6
Lift Station	12	90.0	90.0	39.1	45.7	84.9	70.0
Lift Station	33	6.0	6.0	4.2	0.0	4.2	4.2
Lift Station	34	22.1	22.1	11.2	4.2	15.3	20.7
Lift Station	35	179.4	179.4	102.9	0.0	102.9	103.2
Lift Station	4a	19.8	19.8	0.0	15.6	15.6	13.8
Lift Station	4c	40.2	40.2	0.0	27.9	27.9	15.6
Lift Station	16 - 5%	4.2	4.2	3.2	0.0	3.2	5.1
Lift Station	5c	84.0	84.0	0.0	35.8	35.8	46.1
Lift Station	4b	15.0	15.0	0.0	52.9	52.9	52.6
Lift Station	36		15.2				10.7



Type	Parcel ID	Original Master Plan Area (Acres)	Updated Master Plan Area (Acres)	Original Master Plan Completed Loading (gpm)	Original Master Plan Loading 2030 (gpm)	Original Master Plan Total Loading (gpm)	Updated Total Loading (gpm)
Gravity Main	5a	41.5	41.5	11.4	17.4	28.8	18.0
Gravity Main	5b	120.2	120.2	0.0	106.7	106.7	144.8
Gravity Main	6	31.7	31.7	0.0	133.1	133.1	82.8
Gravity Main	7 <sup>2</sup>	36.9	36.9	2.6	23.1	25.6	67.2
Gravity Main	7a	33.2	33.2	0.0	23.1	23.1	64.6
Gravity Main	7b	3.7	3.7	2.6	0.0	2.6	2.6
Gravity Main	15	40.0	40.0	0.0	27.8	27.8	72.2
Gravity Main	16 - 95%	80.5	80.5	59.1	15.0	74.1	74.1
Gravity Main	17	28.7	28.7	0.0	19.9	19.9	52.6
Gravity Main	19	198.6	198.6	60.5	25.2	85.7	150.1
Gravity Main	20	9.0	9.0	7.9	6.5	14.4	15.0
Gravity Main	21	52.2	52.2	0.0	36.3	36.3	95.7

Type	Parcel ID	Original Master Plan Area (Acres)	Updated Master Plan Area (Acres)	Original Master Plan Completed Loading (gpm)	Original Master Plan Loading 2030 (gpm)	Original Master Plan Total Loading (gpm)	Updated Total Loading (gpm)
Gravity Main	22	25.0	25.0	17.4	0.0	17.4	17.4
Gravity Main	23	49.9	49.9	0.0	34.7	34.7	91.5
Gravity Main	24	31.6	31.6	0.0	21.9	21.9	57.9
Gravity Main	25	57.9	0.0	0.0	0.0	0.0	0.0
Gravity Main	26	77.3	77.3	0.0	53.7	53.7	53.7
Gravity Main	27	113.3	113.3	36.4	31.3	67.7	130.9
Gravity Main	29	72.4	72.4	0.0	50.3	50.3	132.8
Gravity Main	30	180.0	180.0	0.0	20.6	20.6	20.6
Gravity Main	31 - Annexation <sup>1</sup>	138.0	0.0	0.0	0.0	0.0	0.0
Gravity Main	32	57.5	57.5	0.2	0.0	0.2	11.5
<b>Total</b>			2133.4				2144.0

<sup>1</sup> Parcel 31-annexation was assumed to be in septic at the direction of the City in the previous and updated analysis but it is shown in the table for clarification.

<sup>2</sup> Parcel 7 loading and area is the sum of parcel 7a and parcel 7b.

### 3 Model Update

The City provided updated pump curves for the Alkire lift station. Table 2 shows the updated pump curve used for future conditions in the model.

**Table 2. Alkire Lift Station Pump Curve**

Head (ft)	Flow (gpm)
126	1,750
140	1,550
170	1,170
186	900
194	700
210	362

### 4 Model Results and Improvements

Once the model had the updated loading, it was run for the 5-, 10- and 25-year design storms. The previous model was used as the basis for the updated future conditions. To model the impact in the sewer system due to the updated loading, BSF, BI and Unit hydrographs were loaded as described in the Future Flow Analysis TM4, section 4.2.

As shown in Figure 2, Figure 3, and Figure 4, surcharging increased along the gravity main connecting the north-west side of the city to the south side of the Alkire lift station. This is due to the increase in flow in this area. Table 3 shows a comparison in peak flow during dry-weather flow conditions between the original and updated analysis.

Previous pipe size improvements were developed during the most recent master plan. Those improvements were used for the updated loading results. Improvement results stayed consistent across the system with the exception of NT2 and NT7 improvement areas. For NT2 there was a short segment of pipe at the end of the improvement that had to be upsized to a 27-inch. For NT7, there were seven pipes that needed further upsizing, to 36-inch. Figure 5 shows all improvement areas in the system including the upsized 27-inch in NT2 and 36-inch in NT7. Table 4 shows a comparison of the improvement scenarios maximum flow and d/D results between the updated and original master plan. Refer to Future System Evaluation TM5 for a detail description of previous improvements.



**Table 3. Peak Dry-Weather Flow Comparison**

Area	Original Master Plan Max Flow (gpm)	Updated Master Plan Flow (gpm)
NT1	665	1,245
NT2	3,309	4,776
NT3	3,490	4,920
NT4	3,326	3,986
NT5	3,621	4,299
NT6	3,982	4,660
NT7	5,181	5,890
NT8	5,914	6,296
NT10	6,523	6,848

**Table 4. Future 25-year Storm Improvement Maximum Flow and d/D Results Comparison**

Improvement Project	Original Master Plan Improvement Diameter (in)	Original Master Plan Improvement Max Flow (gpm)	Original Master Plan Improvement Max d/D	Updated Master Plan Max Flow with Original Improvements (gpm)	Updated Master Plan d/D with Original Improvements	Updated Master Plan Diameter (in)	Updated Master with Improvements d/D
NT2	24	6,269.32	0.75	6,945.14	0.80	24, 27	0.74
NT3	27	6,577.85	0.54	7,233.67	0.58	27	0.58
NT4	27	6,986.35	0.67	7,622.03	0.71	27	0.71
NT5	27	7,442.80	0.69	8,311.46	0.73	27	0.73
NT6	27	7,966.24	0.71	9,081.20	0.77	27	0.77
NT7	30, 42	11,259.06	0.76	12,463.34	0.84	30,36,42	0.77
NT8	36, 42	11,783.79	0.70	12,735.98	0.74	36,42	0.73
NT10	42, 48	12,568.67	0.72	13,442.92	0.75	42,48	0.75



Figure 2. Future Conditions 5-year Storm

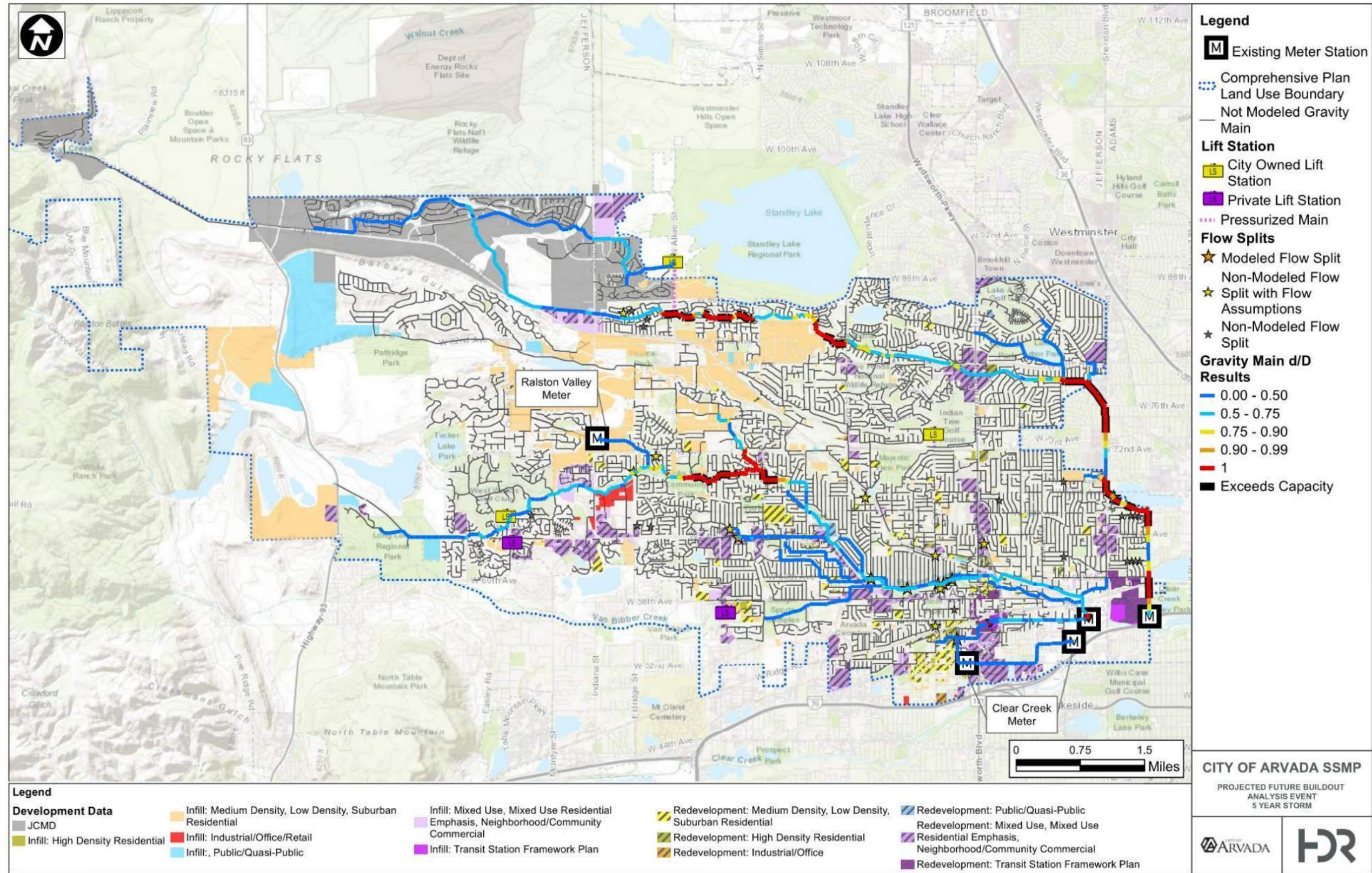




Figure 3. Future Conditions 10-year Storm

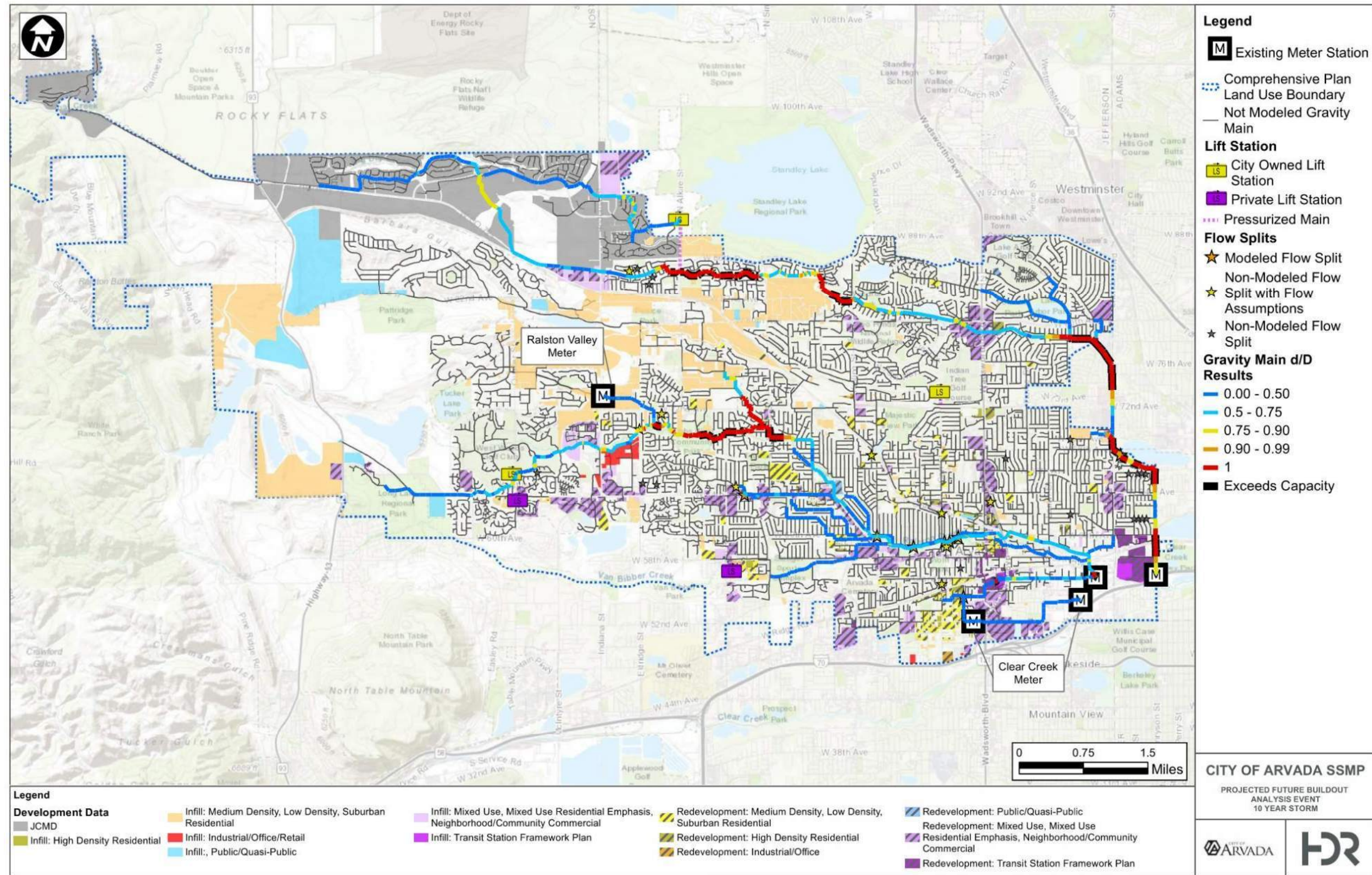




Figure 4. Future Conditions 25-year Storm

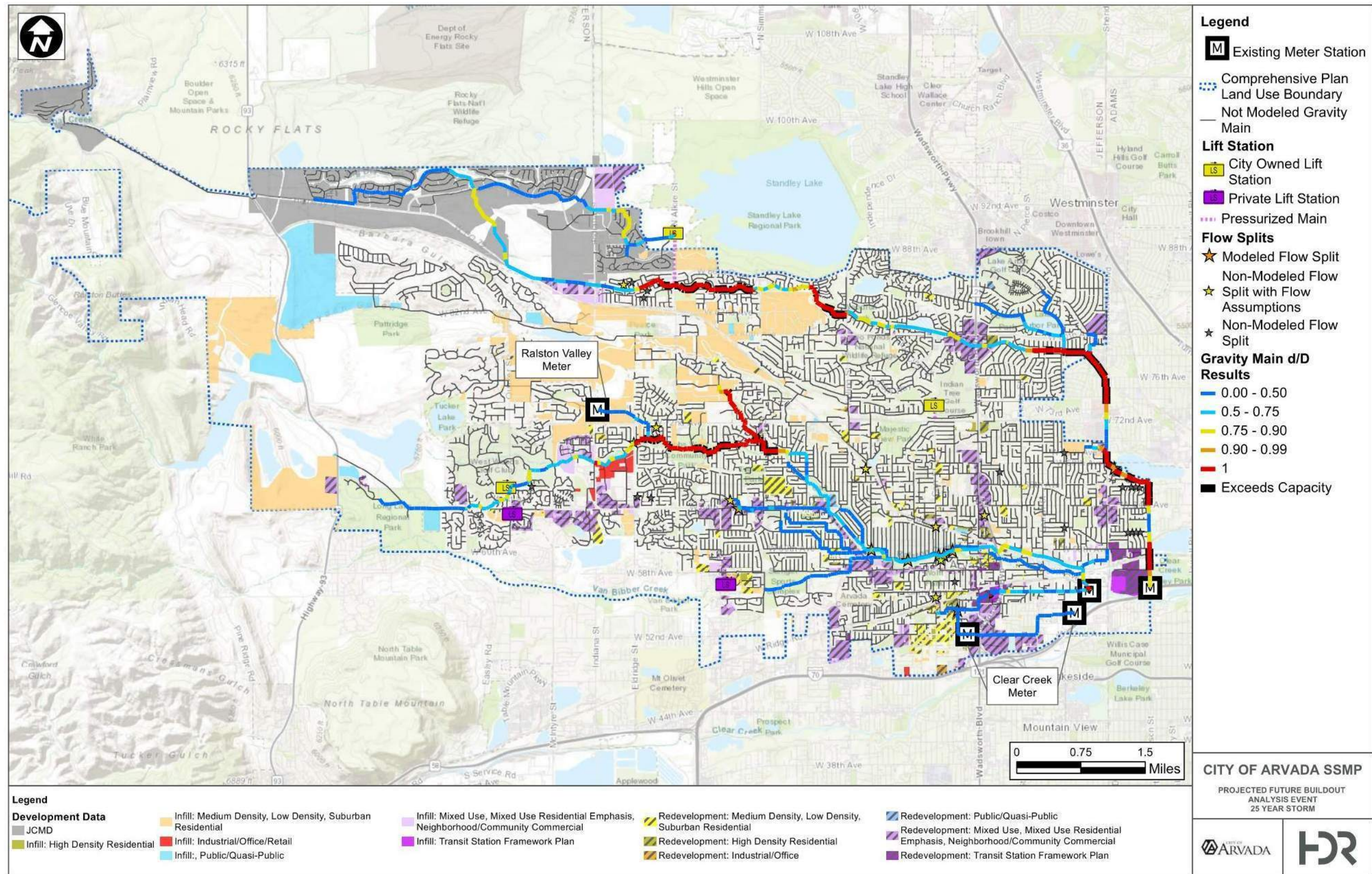
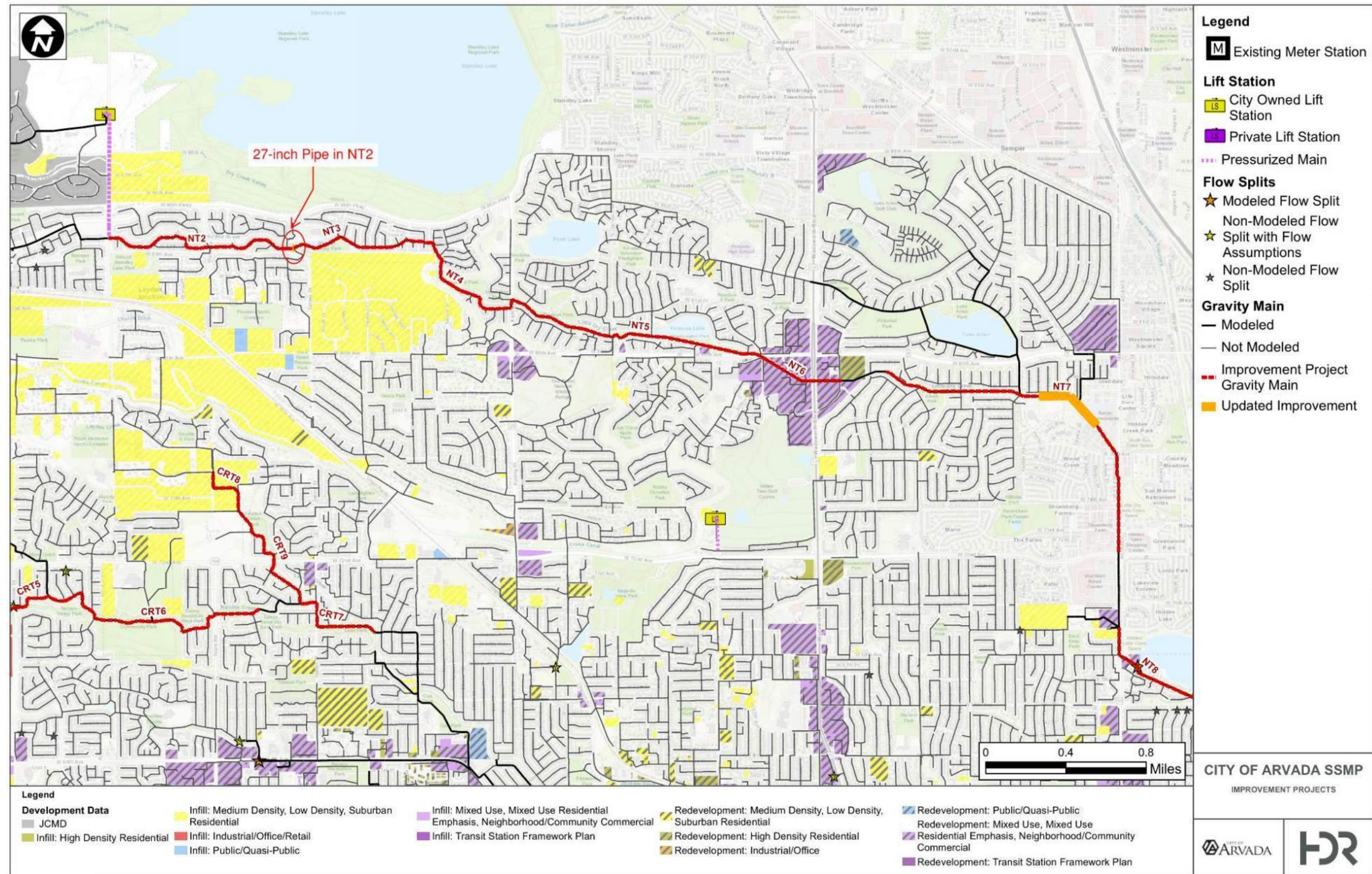




Figure 5. Improvement Areas





## 5 Summary

This TM summarizes how updated loading from the JCMD development was implemented into the model and how it impacted the system results. After the City provided updated data for the JCMD development area, the same approach used during future flow analysis was applied in order to bring updated loading. The Alkire lift station had improved pump curves also provided by the City. Base sanitary flows were considerable higher in the updated values, for this reason, there was an increased in surcharging pipes along the north trunk. After applying previous improvement sizes to the system based on the future 25-year storm results, model results achieved a  $d/D$  of 0.75 except for improvement area NT2 and NT7 along the north trunk. One short segment in NT2 was further upsized and seven pipe segments already upsized in NT7 during the previous analysis were further upsized in order to reach design criteria.

Appendices

Appendix A – JCMD Loading Provided by the City

Lift Station Contributing Area City of Arvada Revised Flow Projections June 2022 Memo (100 g/c/d)					
Development Area	Single Family Residences	Multi-Family Residences	Commercial Acres	SFE	Avg Daily Flow (gpd)
1	272			272	89,760.00
2	97	75	6.373	162	53,383.00
3			55.16	167	55,160.00
4a			19.8	60	19,800.00
4b		379		230	75,800.00
4c			22.4	68	22,400.00
5c	201			201	66,330.00
8	204			204	67,320.00
9		1584	65.012	1,157	381,812.00
10			76.423	232	76,423.00
11			15.277	46	15,277.00
12	158	110	26.616	305	100,756.00
5% of 16		37		22	7,400.00
33			6	18	6,000.00
34	50		13.353	90	29,853.00
35	308	132	20.621	450	148,661.00
36		77		47	15,400.00
	<b>1,290</b>	<b>2,394</b>	<b>327</b>	<b>3,732</b>	<b>1,231,535.00</b>
			<i>Assume 10%</i>	I/I	123,153.50
				PF	2.86
				Peak Flow (mgd)	<b>3.88</b>
				Peak Flow (gpm)	<b>2,694.65</b>

Gravity Contributing Area City of Arvada Revised Flow Projections June 2022 Memo (100 g/c/d)					
Development Area	Single Family Residences	Multi-Family Residences	Commercial Acres	SFE	Avg Daily Flow (gpd)
5a			25.888	78	25,888.00
5b	544	120	5	632	208,520.00
6		557	7.9	362	119,300.00
7a		450	3	282	93,000.00
7b			3.7	11	3,700.00
15		520		315	104,000.00
16 - 95%	264	98		323	106,720.00
17	229.6			230	75,768.00
19	655			655	216,150.00
20		108		65	21,600.00
21	417.6			418	137,808.00
22			25	76	25,000.00
23	399.2			399	131,736.00
24	252.8			253	83,424.00
25				0	0.00
26			77.3	234	77,300.00
27	571			571	188,430.00
29	579.6			580	191,268.00
30	90			90	29,700.00
31 - Annexation				0	0.00
32	50			50	16,500.00
	<b>4,053</b>	<b>1,853</b>	<b>148</b>	<b>5,624</b>	<b>1,855,812.00</b>
			<i>Assume 10%</i>	I/I	185,581.20
				PF	2.69
				Peak Flow (mgd)	<b>5.48</b>
				Peak Flow (gpm)	<b>3,806.55</b>



# **Sanitary Sewer Master Plan Selected Modeling Results**

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**A.1.10 North Trunk Area 10**

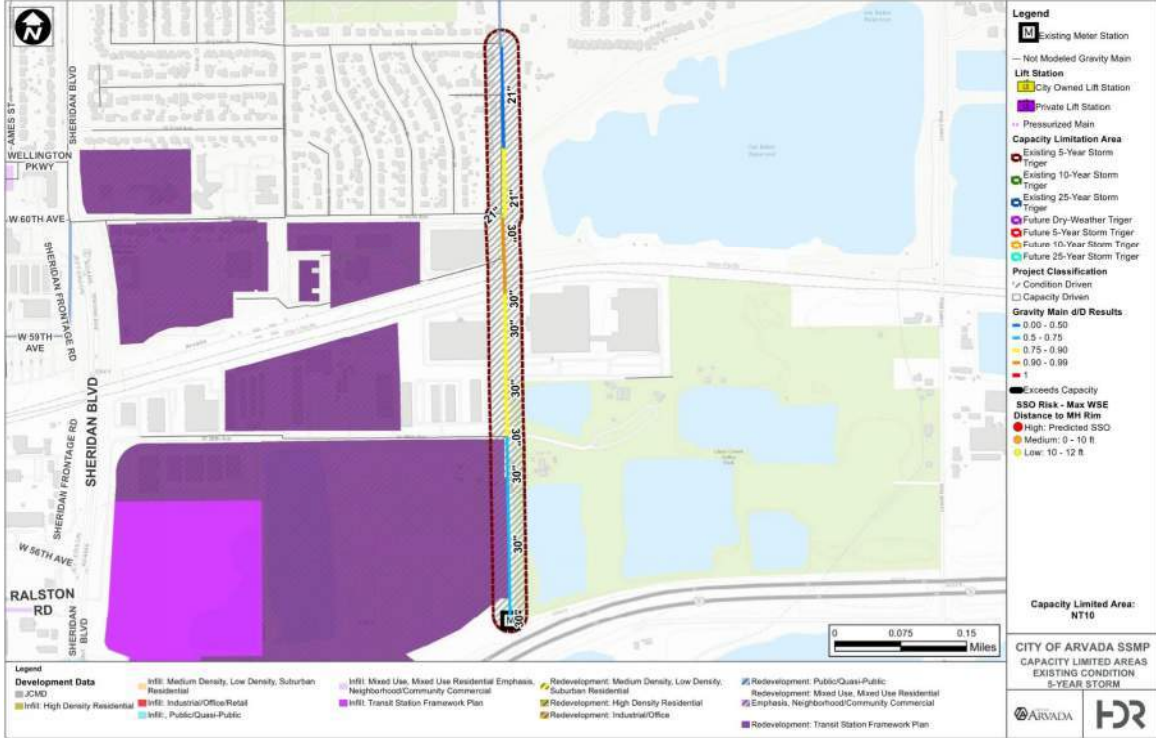
<b>Capacity Limited Area:</b>	The NT10 (North Trunk area 10) capacity limited area is located along the North Trunk extending from the intersection of West 61st Place and Tennyson Street to the north side of I-76 at Tennyson Street where the system connects to the Metro Water Reclamation utilities.
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**Capacity-Limited Area Profile ID Map**

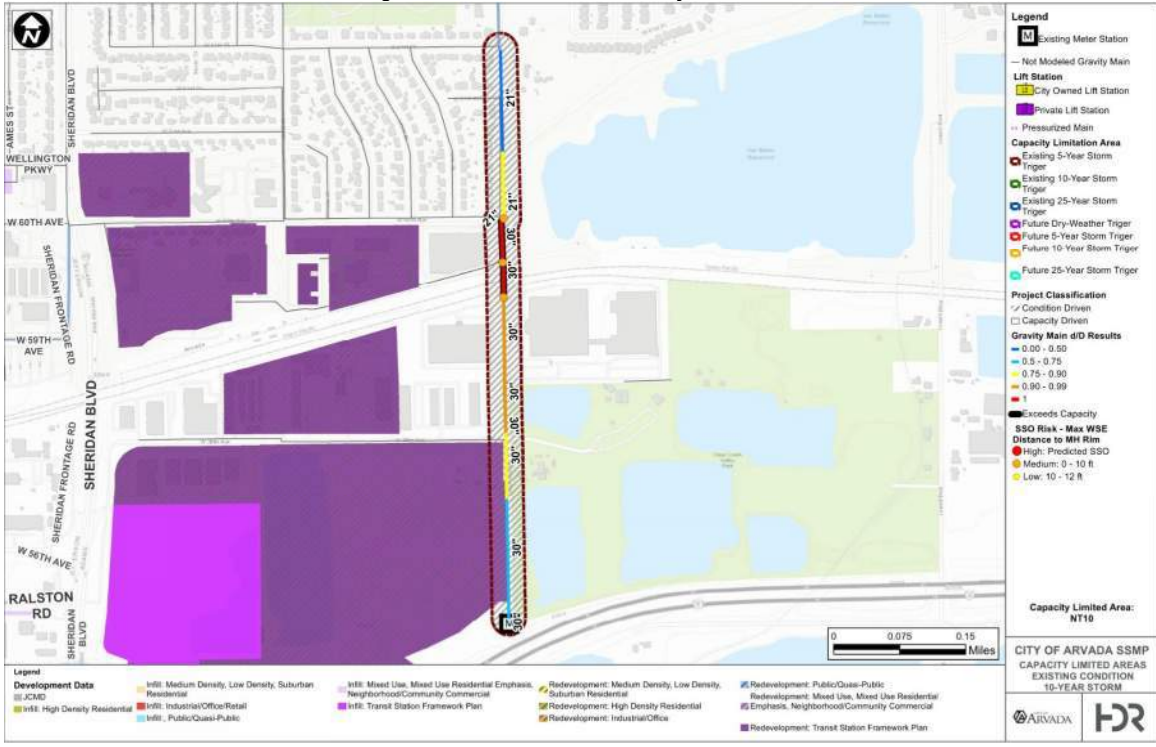


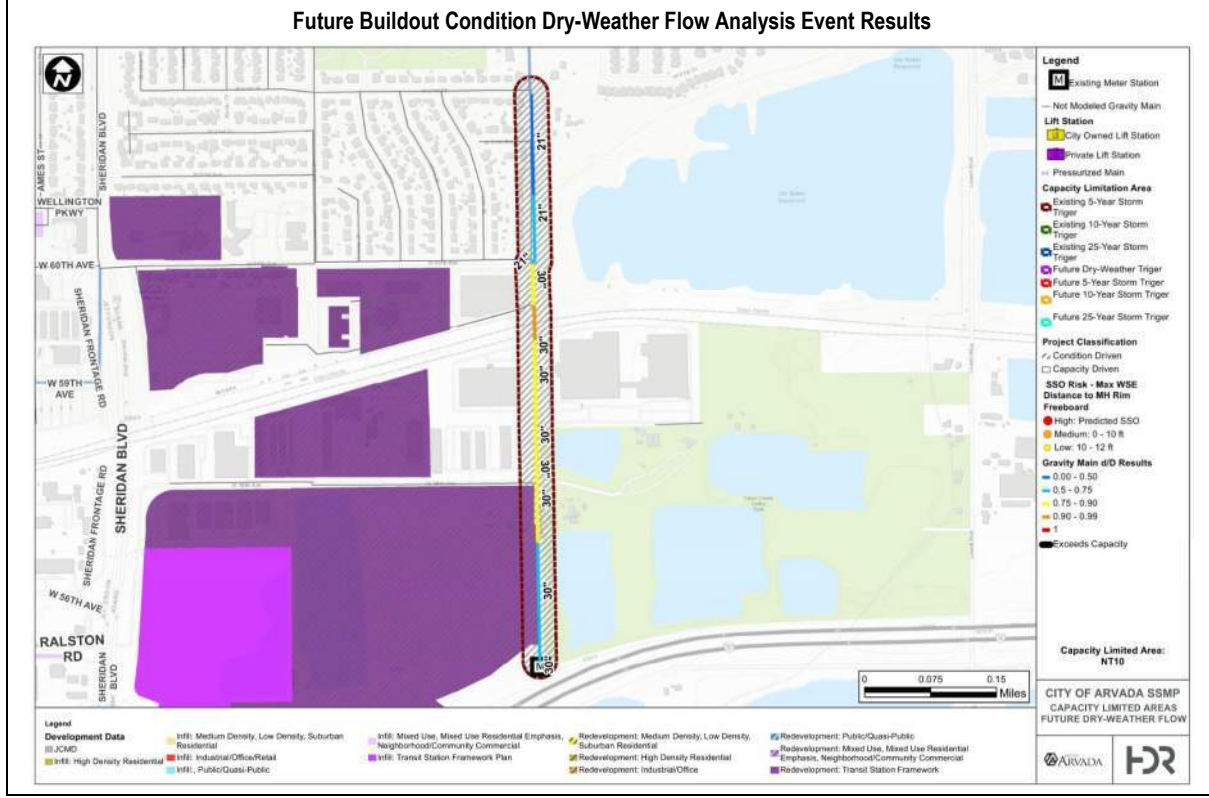
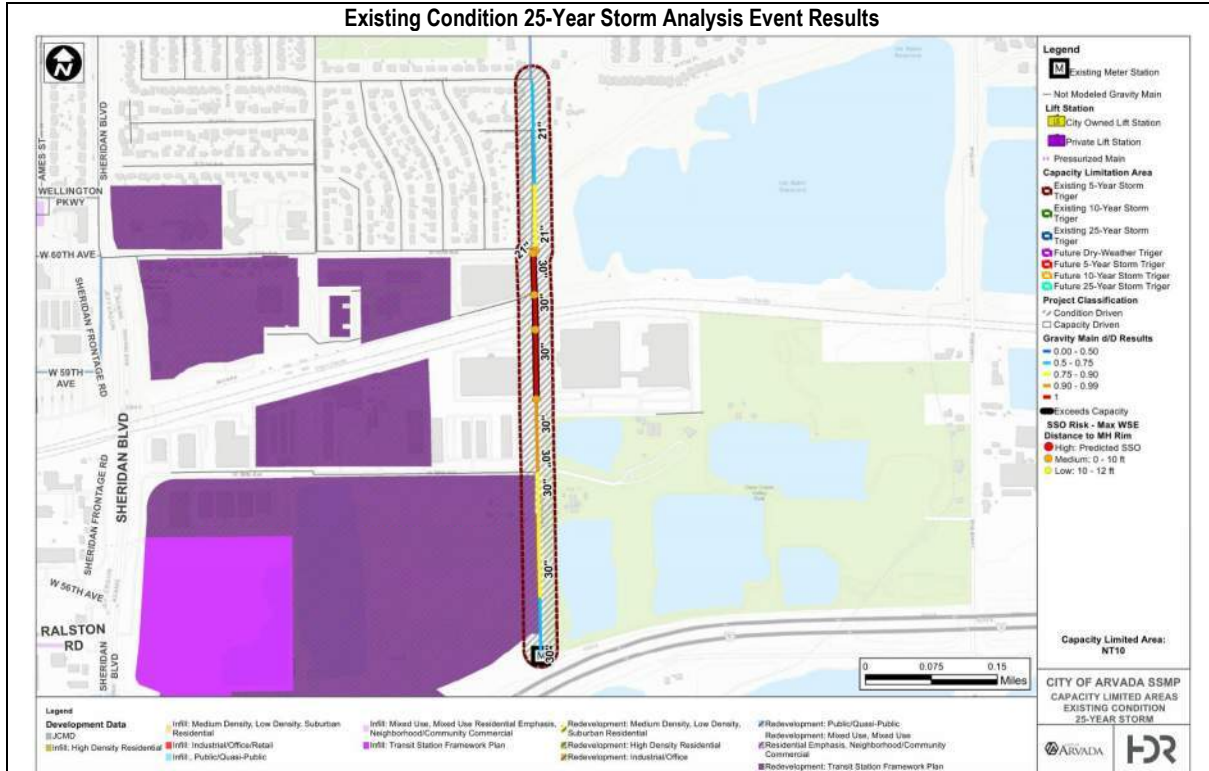
### Capacity Limited Area Location Results Map

#### Existing Condition 5-Year Storm Analysis Event Results

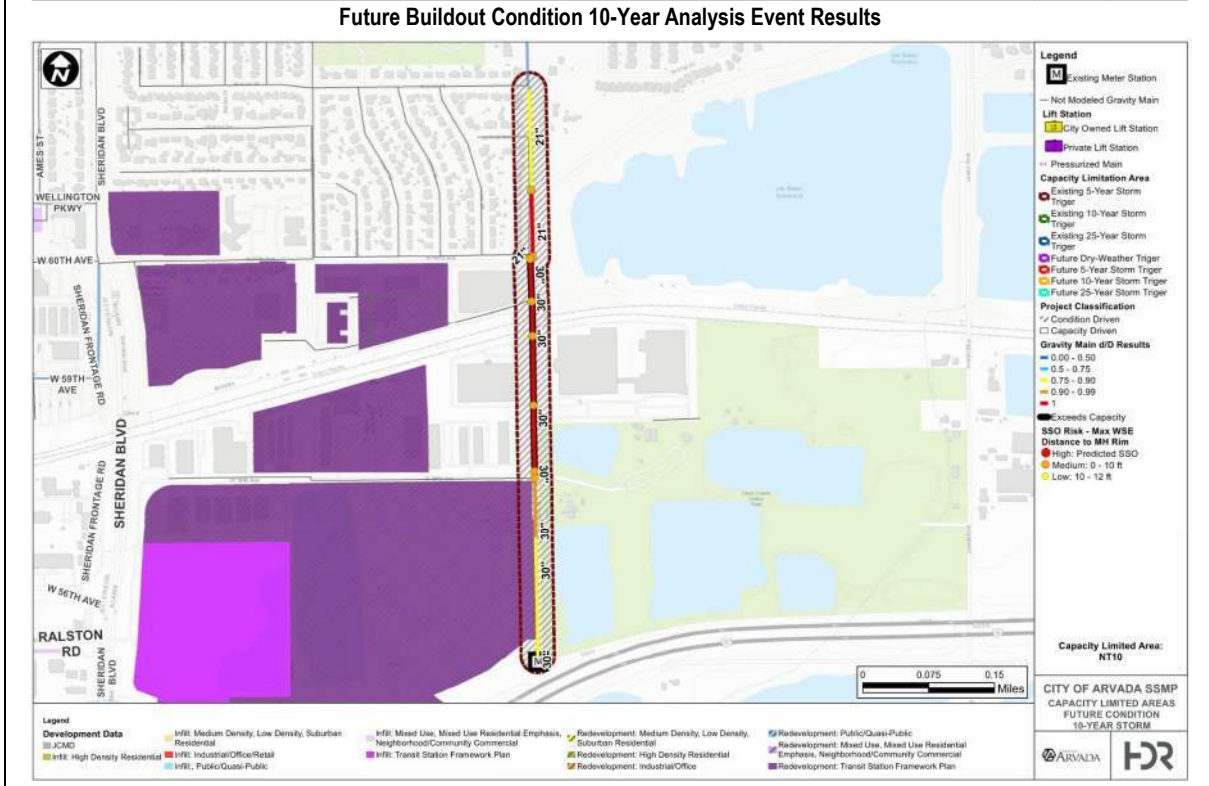
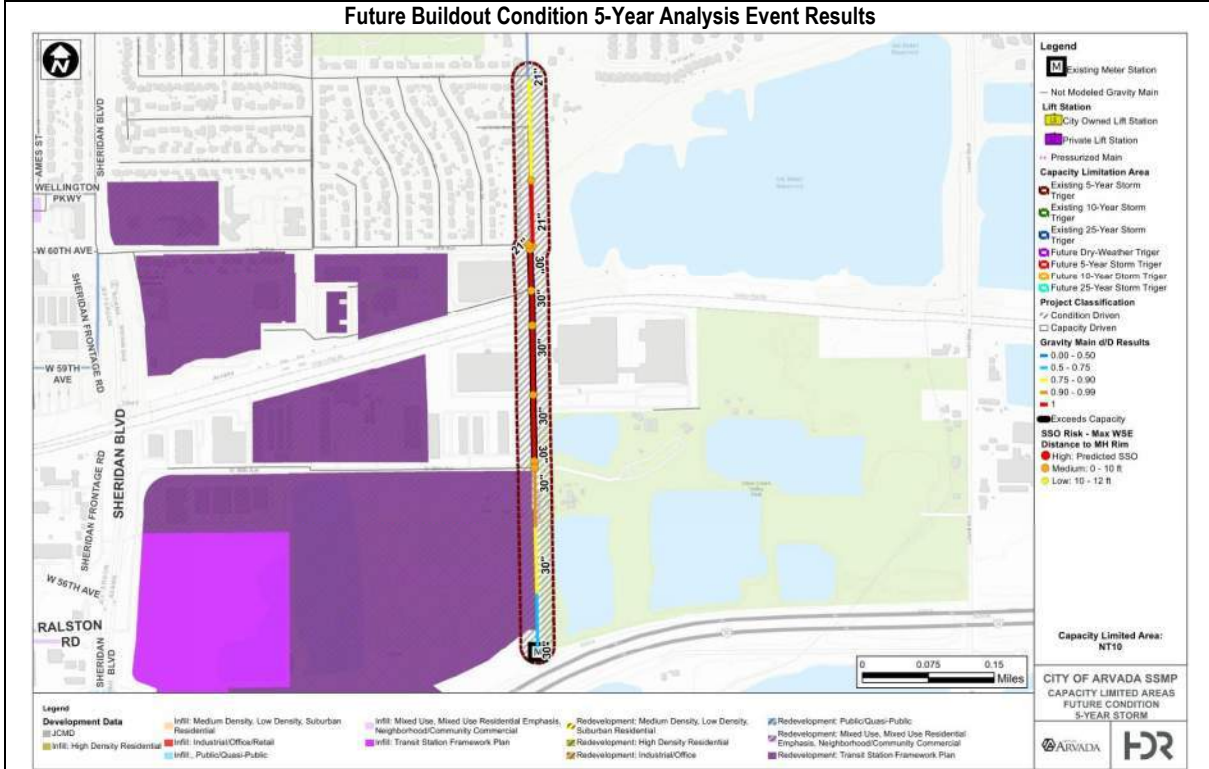


#### Existing Condition 10-Year Storm Analysis Event Results

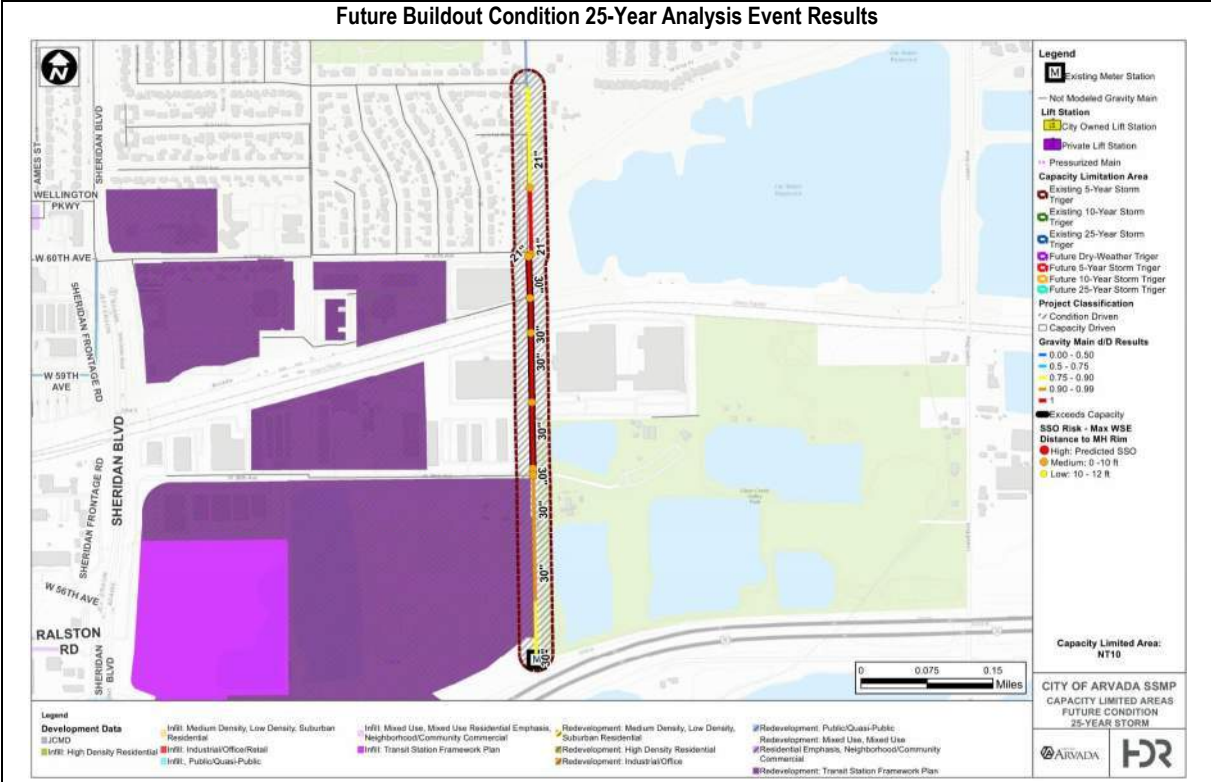






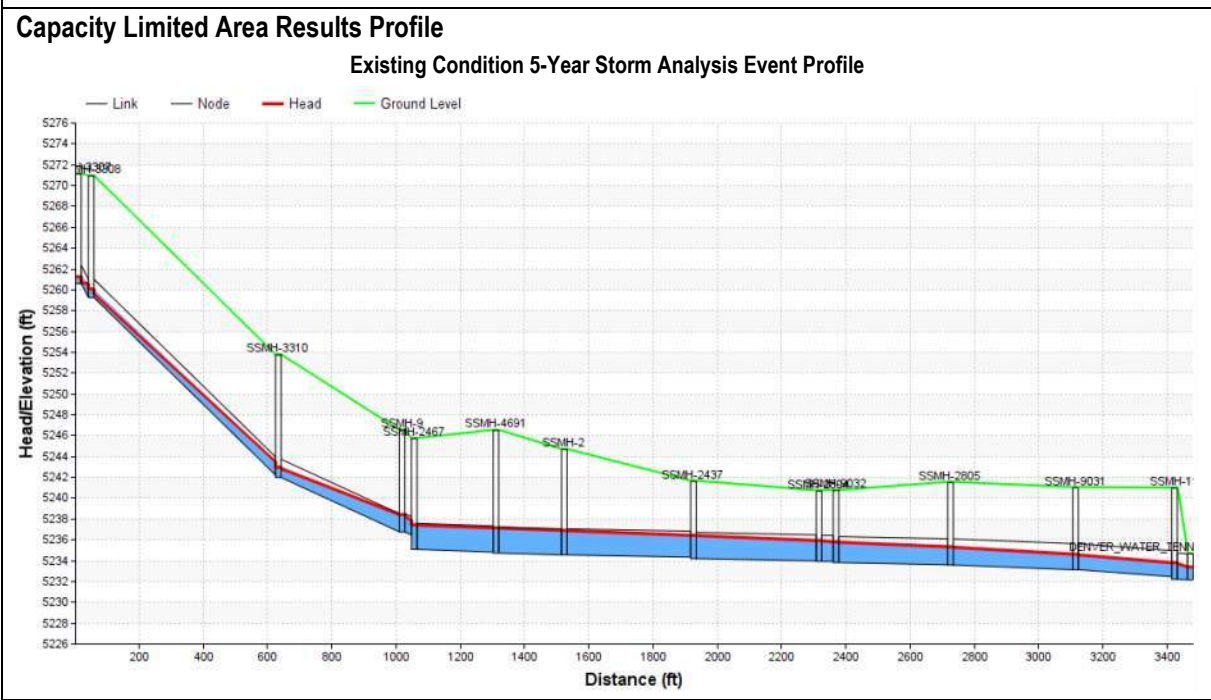


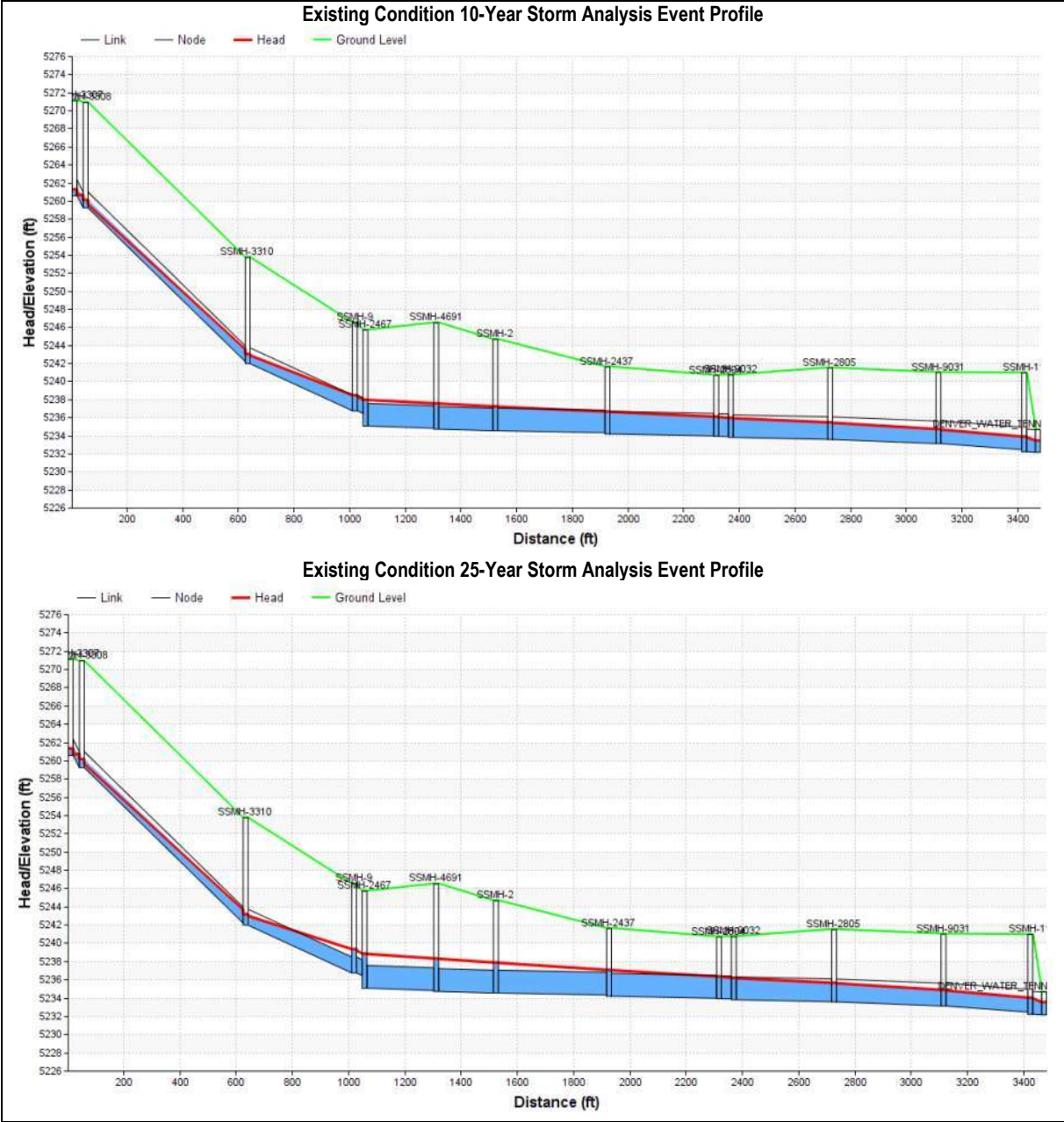
Future Buildout Condition 25-Year Analysis Event Results



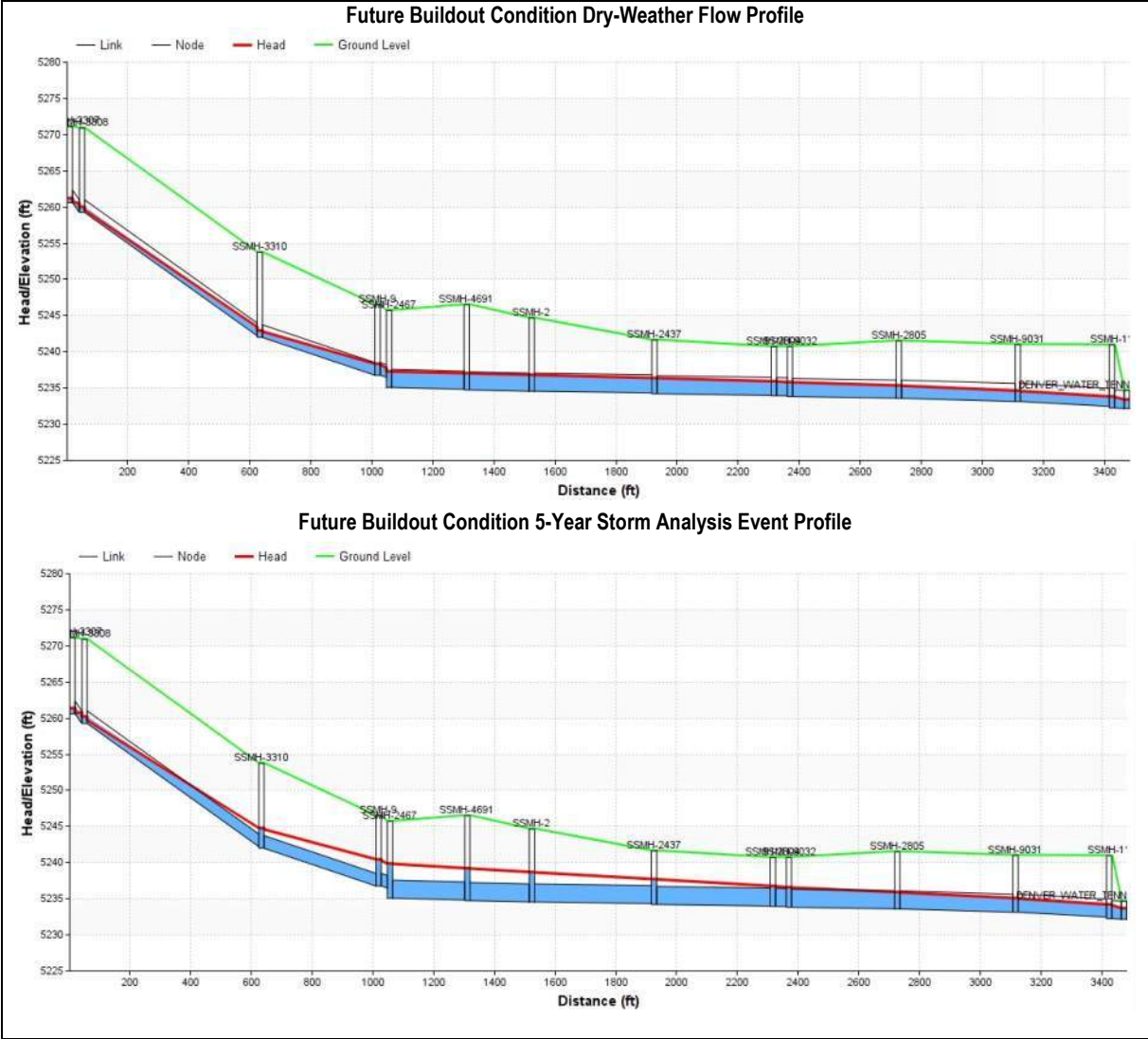
Capacity Limited Area Results Profile

Existing Condition 5-Year Storm Analysis Event Profile

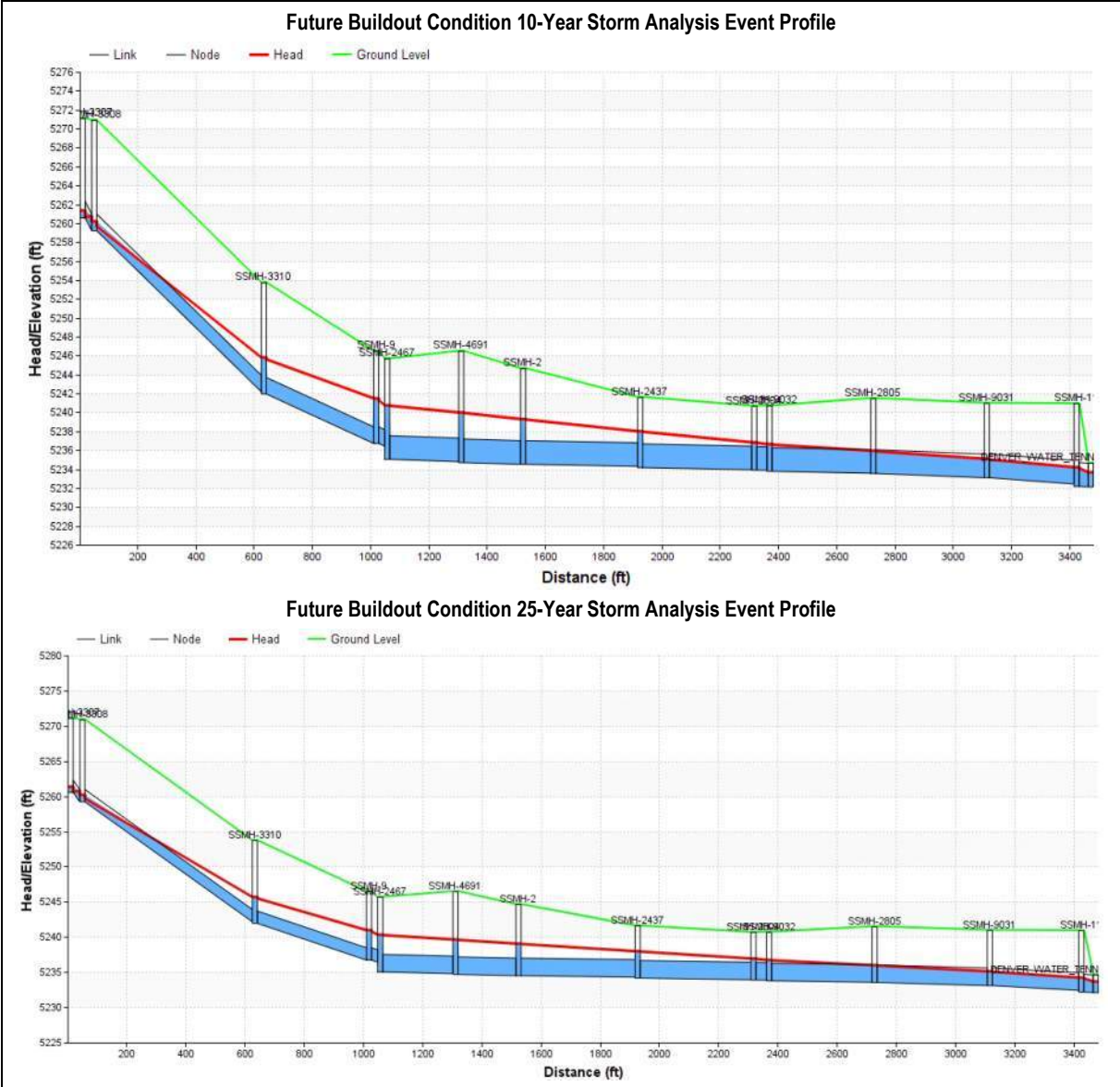














**Technical Data:**

- This area consists of 11 pipes and 3,423 ft. of sewer
- This area consists of pipes 21-inches to 30-inches in diameter
  - Material(s): VCP, CPP and PVC
  - Install Date: 1963-2019
- Limiting pipe capacity
  - Full flow capacity: 4,223 gpm
  - Design capacity (0.75 d/D): 3,862 gpm

**Peak flow summary:**

	5-Year Storm Existing Condition	10-Year Storm Existing Condition	25-Year Storm Existing Condition
Peak Wet Weather Flow (gpm)	6,023	6,798	7,758
Average DWF (gpm)	1,931		
	5-Year Storm Future Condition	10-Year Storm Future Condition	25-Year Storm Future Condition
Peak Wet Weather Flow (gpm)	8,938	9,122	9,383
Average DWF (gpm)	4,437		

**Capacity limitation Summary:**

	5-Year Storm Existing Condition	10-Year Storm Existing Condition	25-Year Storm Existing Condition
Pipe Length Exceeds Capacity (ft)	0	465	879
Pipe Length Under Backwater Conditions (ft)	0	0	22
Pipe Length Exceeds Criteria (ft)	1,737	2,102	2,502
	5-Year Storm Future Condition	10-Year Storm Future Condition	25-Year Storm Future Condition
Pipe Length Exceeds Capacity (ft)	1,319	1,319	1,319
Pipe Length Under Backwater Conditions (ft)	418	418	418
Pipe Length Exceeds Criteria (ft)	3,110	3,423	3,423

**Sanitary Sewer Service Connections: Y**

**SSO Risk – Number of manholes in risk category:**

Scenario / SSO Risk	Low risk	Moderate risk	High Risk / Projected SSO
Criteria (Distance from Max WSE to MH Rim (ft))	10 to 12	0 to 10	0
Existing Condition 5-Year Storm	0	0	0
Existing Condition 10-Year Storm	0	3	0
Existing Condition 25-Year Storm	0	5	0
Future Condition 5-Year Storm	0	8	0
Future Condition 10-Year Storm	0	8	0
Future Condition 25-Year Storm	0	8	0

## **Appendix E**

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Schedule for Design

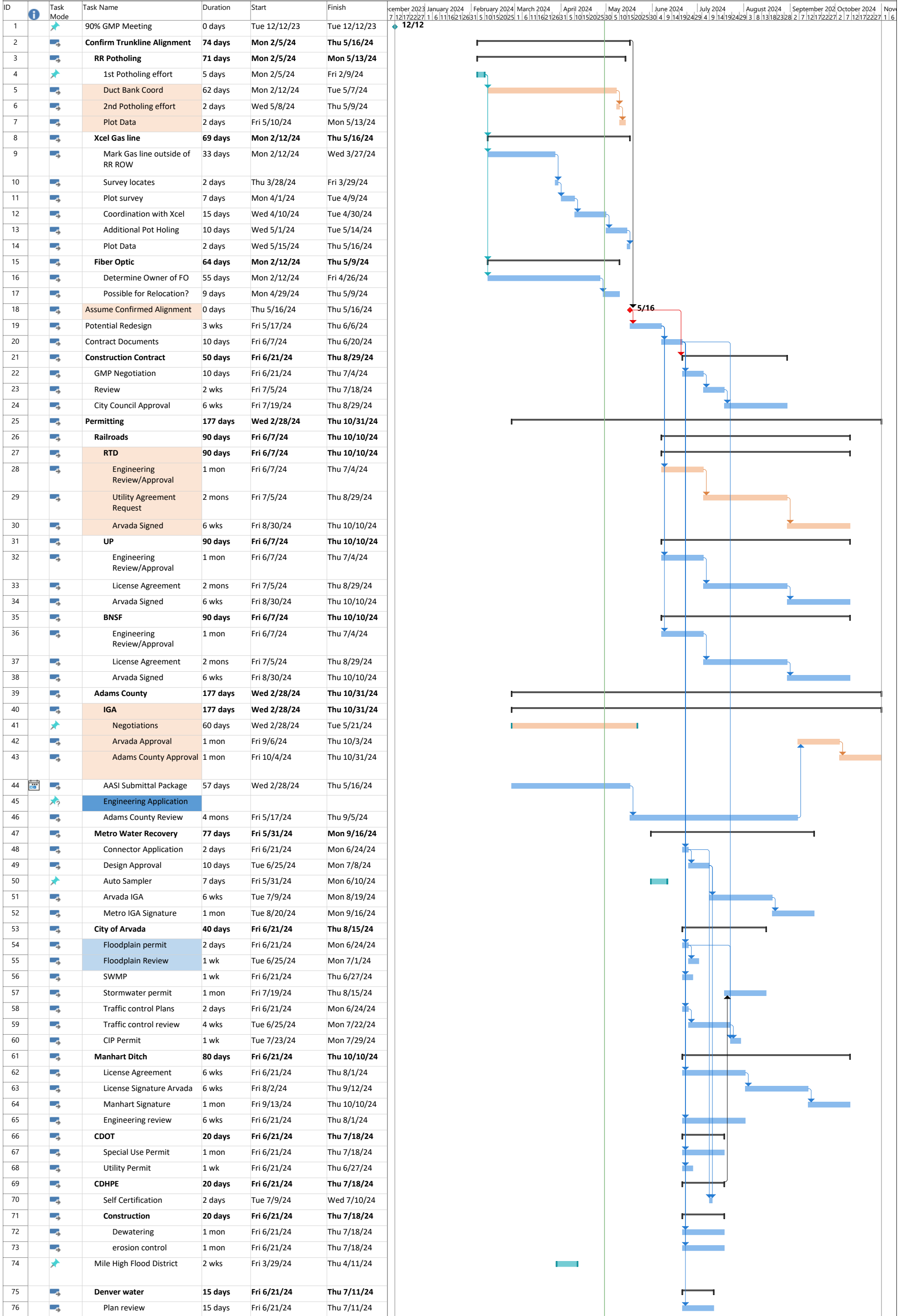
Schedule for Construction

## **Schedule for Design**

---



Kennedy Jenks - Arvada NTS  
Figure 1: Detailed Schedule  
4/3/2024



Project: Arvada NTS schedule  
Date: Tue 4/30/24

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

## **Schedule for Construction**

---

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names	23																											
								Half 1, 2024							Half 2, 2024							Half 1, 2025							Half 2, 2025						
								S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S			
1		<b>Arvada North Tennyson Sewer Replacement - NTSI</b>	<b>285 days</b>	<b>Mon 7/1/24</b>	<b>Fri 8/1/25</b>																														
2		Submittals	15 days	Mon 7/1/24	Fri 7/19/24																														
3		Procurement	30 days	Mon 7/22/24	Fri 8/30/24	2																													
4		Tunnel Design / Monitoring Plan Development	45 days	Mon 9/2/24	Fri 11/1/24	3																													
5		Work Plan Submittal	30 days	Mon 11/4/24	Fri 12/13/24	4																													
6		Mobilization	5 days	Mon 12/16/24	Fri 12/20/24	5																													
7		Open Cut Sanitary Sewer Replacement/Installation	150 days	Mon 12/23/24	Fri 7/18/25	6																													
8		Tunnel Underneath Railroad Tracks	45 days	Mon 3/3/25	Fri 5/2/25	6FS+50 days																													
9		Roadway Restoration Work	30 days	Mon 6/23/25	Fri 8/1/25	7FS-20 days																													

Project: Arvada NTS - BTC Preli  
Date: Tue 5/7/24

Task		Project Summary		Manual Task		Start-only		Deadline	
Split		Inactive Task		Duration-only		Finish-only		Progress	
Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress	
Summary		Inactive Summary		Manual Summary		External Milestone			

## **Appendix F**

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USGS National Wetlands Inventory  
Critical Habitat for Threatened & Endangered Species  
Terrestrial & Aquatic Plant Life



# **USGS National Wetlands Inventory**

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May 7, 2024

**Wetlands**

- Estuarine and Marine Deepwater
- Freshwater Emergent Wetland
- Freshwater Forested/Shrub Wetland
- Estuarine and Marine Wetland
- Freshwater Pond
- Lake
- Other
- Riverine

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

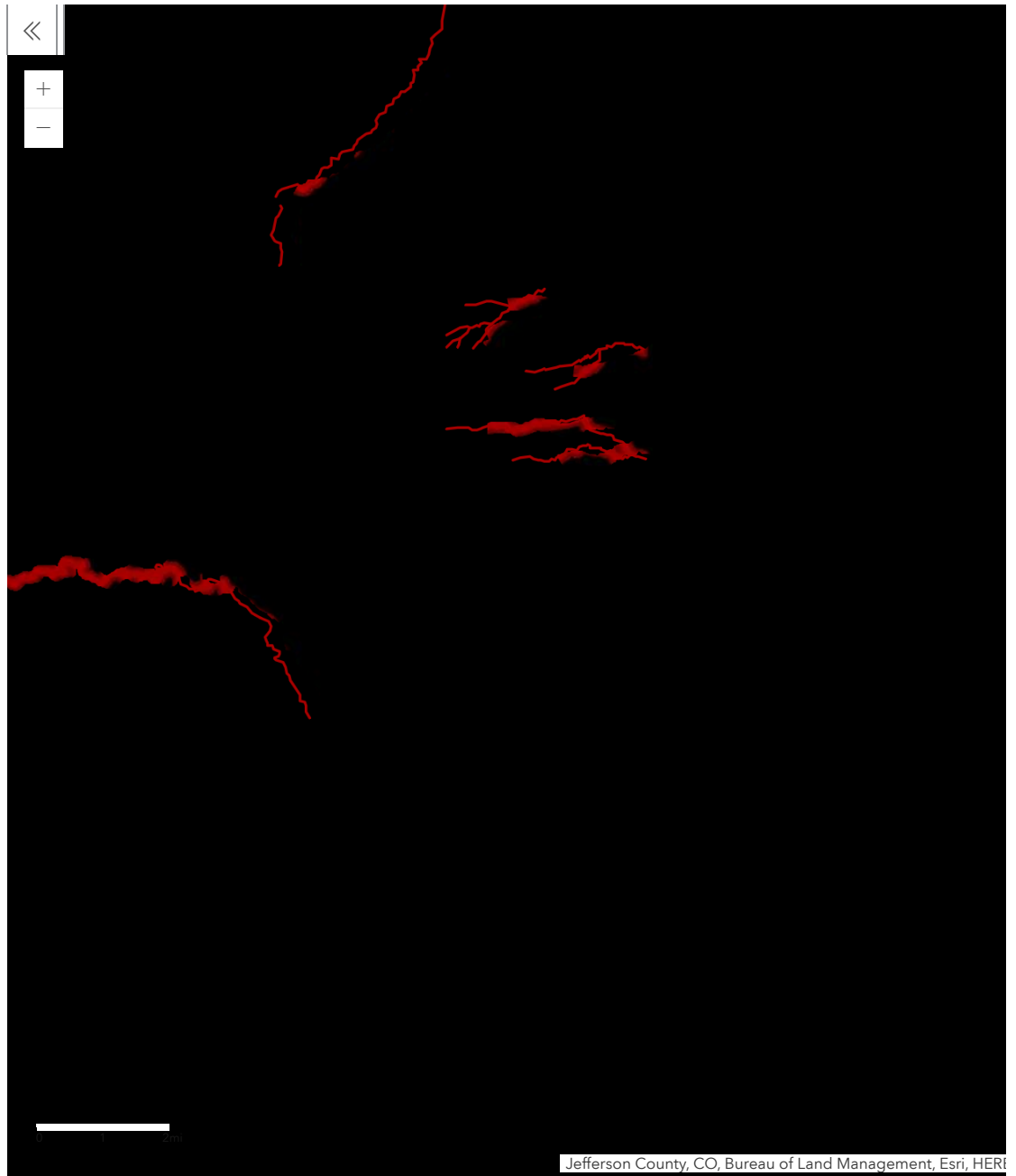
# **Critical Habitat for Threatened & Endangered Species**

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Details

Critical Habitat for Threatened & Endangered Species [USFWS]

Welcome to the [US Fish & Wildlife Service's](#) map of Threatened and Endangered Species with Critical Habitat designation across the United States. You are about to use an online mapper that displays designated critical habitat spatial information. It is important to understand that the designated critical habitat displayed in this mapper **DOES NOT** represent all of the critical habitat designated by the U.S. Fish & Wildlife Service. Only digitized critical habitat submitted into this system is available. This means that there is additional designated critical habitat that is not displayed in this mapper. If you require critical habitat spatial data not available here, please contact the lead [FWS Region](#) for that species.





## **Terrestrial & Aquatic Plant Life**

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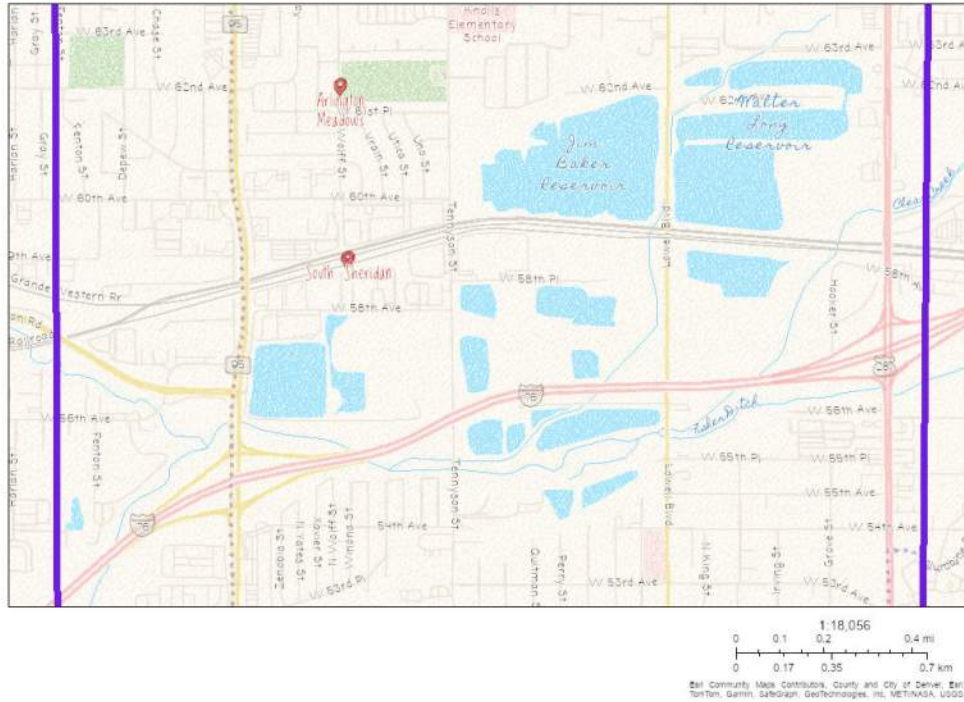


# Critical Habitat Report

## Area of Interest (AOI) Information

Area : 29,969.67 km<sup>2</sup>

May 8 2024 13:33:46 Mountain Daylight Time



## Summary

Name	Count	Area(km <sup>2</sup> )	Length(m)
All Critical Habitat Polyline	0	N/A	0
All Critical Habitat Polygon	0	0	N/A

## **Appendix G**

---

Email from Mr. Fonda Apostolopoulos

Email from Mr. Brian Mead

CDPHE Site Application Approval



## **Email from Mr. Fonda Apostolopoulos**

---

**From:** [Apostolopoulos - CDPHE, Fonda](#)  
**To:** [Erica Wirski](#)  
**Cc:** [Travis Stevens](#); [Brad Florentin](#)  
**Subject:** Re: CDPHE Covenant and Institutional Control Site Enquiry  
**Date:** Thursday, April 18, 2024 11:58:18 AM  
**Attachments:** [image001.png](#)  
[image002.png](#)

---

Erica,

Since you will be working in an area outside of the environmental covenant, the state has no authority to review your work plans.

As reiterated in your email, the area in question is surrounded by landfills and there is a high probability that you will encounter landfill waste. Appropriate documentation and disposal to an approved licensed landfill will be required if solid waste/landfill material is unearthed as part of this project. Also due to methane in the area, adequate ventilation of the excavation may be required.

Fonda

On Thu, Apr 18, 2024 at 11:39 AM Erica Wirski <[EricaWirski@kennedyjenks.com](mailto:EricaWirski@kennedyjenks.com)> wrote:

Hello Fonda,

Thank you for returning my call. I understand that, given that we are not directly on the covenant site, we do not require CDPHE approval or review of our plans.

As a courtesy, you made the following comments:

- There are several landfills in the area and that soil on our site is likely not suitable for reuse and may need to be disposed of off-site at an appropriate facility.
  - We had a limited subsurface investigation performed for this purpose that recommended off-site disposal of soils on the south end of our project. We also have requirements written into our specifications that native soil may only be used for certain applications if it meets the specified criteria.
- Methane may be present and that we may want to test for methane as we dig and keep fans in case of methane exposure from a health and safety perspective to those working on the project.
  - Noted- we will relay this information to the contractor.

Can you please confirm that no approval is required from CDPHE regarding the covenant site?

Thank you,



**Erica Wirski** | Staff Engineer

215 Union Boulevard, Suite 500

Lakewood, CO 80228

Direct: [720-744-2221](tel:720-744-2221)

Teams: [EricaWirski@kennedyjenks.com](mailto:EricaWirski@kennedyjenks.com)

[Kennedyjenks.com](https://www.kennedyjenks.com)

---

**From:** Erica Wirski  
**Sent:** Wednesday, April 17, 2024 4:51 PM  
**To:** [fonda.apostolopoulos@state.co.us](mailto:fonda.apostolopoulos@state.co.us)

**Cc:** Travis Stevens <[TravisStevens@kennedyjenks.com](mailto:TravisStevens@kennedyjenks.com)>; Brad Florentin <[BradFlorentin@kennedyjenks.com](mailto:BradFlorentin@kennedyjenks.com)>  
**Subject:** CDPHE Covenant and Institutional Control Site Enquiry

Hello Fonda,

I am following up on my voicemail regarding the CDPHE covenant/environmental use restriction site off of Tennyson St. in the City of Arvada.

API Investments LLC II

Institutional Control ID RSNOT00075

We are working on a sanitary sewer upgrades project on Tennyson extending between I-76 and West 61<sup>st</sup> place. All of the work being done is occurring within the street right of way. None of the work involves a change in land use nor does it involve any structures for human occupancy. See screenshot below of covenant site (pink outline) and our pipeline location (gold outline).

Can you please confirm that we can proceed with the design as planned or let us know if there are any considerations that must be made for this site?

Thank you,



**Erica Wirski** | Staff Engineer

215 Union Boulevard, Suite 500

Lakewood, CO 80228

Direct: [720-744-2221](tel:720-744-2221)

Teams: [EricaWirski@kennedyjenks.com](mailto:EricaWirski@kennedyjenks.com)

[KennedyJenks.com](http://KennedyJenks.com)



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Mr. Fonda Apostolopoulos, P.E.  
Colorado Department of Public Health and Environment  
4300 Cherry Creek Drive South  
Denver, CO 80246

303-692-3411

[Fonda.Apostolopoulos@State.co.us](mailto:Fonda.Apostolopoulos@State.co.us)

## **Email from Mr. Brian Mead**

---

**From:** [Brian Mead](#)  
**To:** [Erica Wirski](#)  
**Cc:** [Travis Stevens](#); [Brad Florentin](#)  
**Subject:** RE: ACHD Sanitary System in Floodplain Regs - Arvada North Trunk Sewer Project  
**Date:** Thursday, April 18, 2024 1:45:26 PM  
**Attachments:** [image001.png](#)  
[image002.jpg](#)  
[image003.jpg](#)

---

Good Afternoon Erica,

It was nice speaking with you this afternoon. As we discussed over the phone, your project does not involve an onsite wastewater treatment system, so section 11.1 of the O-22 regulation does not apply to this sewer line project. As far as sewer systems in a floodplain that are not part of an onsite wastewater treatment system, we advise that you check the local building, plumbing, and receiving wastewater treatment plant codes for any further requirements. Most of these requirements will be receive thru the land use referral process. Occasionally, there are other FEMA requirements for sewer lines encroaching on floodplains. You are correct in your reasoning that Adams County Health Department does not have any specific requirements for this type of project consisting of a municipal sewer trunkline.

Please let me know if you have any further questions regarding this project.

Have A great Rest Of The Week,

### **Brian Mead**

Environmental Health Water Program Supervisor

ADAMS COUNTY, COLORADO

7190 Colorado Blvd, Commerce City, CO 80022

O: 720.322.4610 | Main: | [bmead@adcogov.org](mailto:bmead@adcogov.org)

[www.adamscountyhealthdepartment.org](http://www.adamscountyhealthdepartment.org)

*To responsibly serve the Adams County community with integrity and innovation*

*Please note: I am off every other friday*

---

**From:** Erica Wirski <EricaWirski@kennedyjenks.com>  
**Sent:** Thursday, April 18, 2024 1:31 PM  
**To:** Brian Mead <BMead@adcogov.org>  
**Cc:** Travis Stevens <TravisStevens@kennedyjenks.com>; Brad Florentin

<BradFlorentin@kennedyjenks.com>

**Subject:** ACHD Sanitary System in Floodplain Regs - Arvada North Trunk Sewer Project

You don't often get email from [ericawirski@kennedyjenks.com](mailto:ericawirski@kennedyjenks.com). [Learn why this is important](#)

Please be cautious: This email was sent from outside Adams County

Hi Brian,

Following up on our call just now:

I am reaching out regarding Adams County Health Department regulations for sanitary systems in a floodplain. Our project generally involves upgrading an existing sanitary sewer trunkline in Tennyson Street extending from W. 61<sup>st</sup> Place and tying in with Metro Water Recovery just north of I-76. Tennyson St. right of way is shared with Adams County. As a part of approval from the County, a preliminary review of our design was performed. We were given the following comments from the environmental review:

***Adams County Health Department (ACHD) has requirements for sewer systems in the floodplain. It would follow that bulk sewer piping would require the same or greater regulation based on the quantity and capacity of wastewater flow. ACHD and FEMA requirements must be determined and followed for this proposed project, and documentation provided for Adams County review.***

***According to ACHD Regulation O-22, Section 11.11 Floodplains: A. A new, expanded, or repair/replacement OWTS installed in a 100-year floodplain must meet or exceed the requirements of the FEMA and the local emergency agency. Repairs of an existing system must meet the requirements as feasible. The system as approved must be designed to minimize or eliminate infiltration of floodwaters into the system and discharge from the system into floodwaters. B. A new or expanded OWTS must not be installed in a floodway designated in a 100-year floodplain where a conforming OWTS outside the floodway can be installed. For any new OWTS or system repair that may affect the floodway delineation, appropriate procedures must be followed including revision of the floodway designation, if necessary. The regulation can be found here: <https://adamscountyhealthdepartment.org/septic-rules-and-regulations>***

These regulations appear to apply only to onsite wastewater treatment systems-we are not designing an OWTS and my understanding is that these regulations do not apply. Can you please confirm that ACHD regulations apply only to OWTS and no further action is needed from us? Or, if that is not the case, please let us know what steps we need to take to acquire ACHD approval. I have attached our design for your review in case it is needed.

Thank you!



**Erica Wirski** | Staff Engineer

215 Union Boulevard, Suite 500

Lakewood, CO 80228

Direct: [720-744-2221](tel:720-744-2221)

Teams: [EricaWirski@kennedyjenks.com](mailto:EricaWirski@kennedyjenks.com)



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# **CDPHE Site Application Approval**

---



January 30, 2024

Matt Amidei  
City of Arvada  
8101 Ralston Rd  
Arvada, CO 80002

Subject: Interceptor Certification Acknowledgement  
Regulation 22 Site Location Approval No.: ES Case No. ES.23.SA.07885  
North Trunk Line Sanitary Sewer Improvements  
Associated Colorado Discharge Permit System (CDPS) No. CO0026638 (Receiving Entity: Metro Water Recovery Robert W. Hite Wastewater Treatment Facility)  
Jefferson County

Dear Matt Amidei:

The Water Quality Control Division (Division) received notification from the City of Arvada in an Engineering Report dated May 30, 2023 and a letter from Metro Water Recovery (Receiving Entity) dated July 31, 2023 stating that the North Trunk Line Sanitary Sewer Improvements meets the requirements of *Site Location and Design Regulations for Domestic Wastewater Treatment Works, 5 CCR 1002-22* (Regulation 22), has the capacity to carry the projected flows from the applicable service area, and is consistent with the presiding Regional Water Quality Management Plan.

The Division acknowledges receipt of the notification and certification of the said interceptor in accordance with Section 22.8 of Regulation 22.

Based upon the application information, the design is limited to the following:

1. The City of Arvada will replace portions of the North Trunk Sanitary Sewer Interceptor within three (3) locations T2S, S69W; T3S, S69W; and T3S, S68W, Jefferson County to expand capacity for future population growth and increased storm loading. The replacement of the interceptor segments will be phased and is planned for the sections listed below:

NTL-2 Interceptor Segment

- Project area: W 86<sup>th</sup> Parkway to West 84<sup>th</sup> Place and Simms Street
- Interceptor upgrade of approximately 5,468 lineal feet of 24-inch PVC.
- Replacing all associated manholes.
- 24-inch Interceptor hydraulic design capacity: 7,476 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL-3 Interceptor Segment

- Project area: West side of Michael Northey Park to the east side of the intersection of W 84<sup>th</sup> Avenue and Parfet Court
- Interceptor upgrade of approximately 2,334 lineal feet of 27-inch PVC.
- Replacing all associated manholes.
- 27-inch Interceptor hydraulic design capacity: 12,863 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL-4 Phase 2 Interceptor Segment

- Project area: Intersection of Newcombe Street (W 84<sup>th</sup> Ave) and Oak Street to the east side of MacArthur Park along Kipling Street
- Interceptor upgrade of approximately 5,908 lineal feet of 27-inch PVC.
- Replacing all associated manholes.
- 27-inch Interceptor hydraulic design capacity: 7,317 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.



NTL 5 Interceptor Segment

- Project area: South of the Little Dry Creek from Johnson Street to south of the intersection of W 81<sup>st</sup> Avenue and Club Crest Drive
- Interceptor upgrade of approximately 5,808 lineal feet of 27-inch PVC.
- Replacing all associated manholes.
- 27-inch Interceptor hydraulic design capacity: 7,960 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 6 Interceptor Segment

- Project area: South-east side of Meadowglen Park to Vance Drive south of the Little Dry Creek
- Interceptor upgrade of approximately 2,677 lineal feet of 27-inch PVC.
- Replacing all associated manholes.
- 27-inch Interceptor hydraulic design capacity: 7,864 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 7A Interceptor Segment

- Project area: South side of the Little Dry Creek between W 79<sup>th</sup> Drive and W 78<sup>th</sup> Place to the Little Dry Creek open space
- Interceptor upgrade of approximately 6,099 lineal feet of 30-inch PVC.
- Replacing all associated manholes.
- 30-inch Interceptor hydraulic design capacity: 11,583 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 7B Interceptor Segment

- Project area: Little Dry Creek open space to the intersection of W 72<sup>nd</sup> Avenue and Sheridan Boulevard
- Interceptor upgrade of approximately 3,534 lineal feet of 42-inch PVC.
- Replacing all associated manholes.
- 42-inch Interceptor hydraulic design capacity: 10,812 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 8A Interceptor Segment

- Project area: North side of the intersection of Sheridan Boulevard and W 69<sup>th</sup> Avenue
- Interceptor upgrade of approximately 13 lineal feet of 36-inch PVC.
- Replacing all associated manholes.
- 36-inch Interceptor hydraulic design capacity: 65,305 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 8B Interceptor Segment

- Project area: North side of the intersection of Sheridan Boulevard and W 69<sup>th</sup> Avenue to the intersection of Tennyson Street and W 64<sup>th</sup> Avenue
- Interceptor upgrade of approximately 5,665 lineal feet of 42-inch PVC.
- Replacing all associated manholes.
- 42-inch Interceptor hydraulic design capacity: 8,342 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 10A Interceptor Segment

- Project area: Intersection of Tennyson Street and W 61<sup>st</sup> Place to the north side of the Union Pacific train tracks
- Interceptor upgrade of approximately 1,305 lineal feet of 42-inch PVC.
- Replacing all associated manholes.
- 42-inch Interceptor hydraulic design capacity: 13,184 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

NTL 10B Interceptor Segment



- Project area: North side of the Union Pacific train tracks to the north side of I-76 at Tennyson Street where the system connects to the Denver water utilities
- Interceptor upgrade of approximately 2,176 lineal feet of 48-inch PVC.
- Replacing all associated manholes.
- 48-inch Interceptor hydraulic design capacity: 13,524 gpm (peak instantaneous flow) at a maximum depth/diameter ratio of 0.75 and a maximum Manning's roughness coefficient of 0.011.

This acknowledgement does not constitute approval for construction. For interceptors that certify under Section 22.8(2) and in accordance with Regulation 22, Section 22.13(1), the applicant must then submit a self-certification to the Division that states the basis of design and final plans and specifications conform to the acknowledged conditions and all applicable sections of the *State of Colorado Design Criteria for Domestic Wastewater Treatment Works, WPC-DR-1*. Following receipt of the Division's acceptance of the self-certification, the applicant may commence construction of the project.

This certification acknowledgement will expire on July 30, 2025. If construction has not commenced by this date, the acknowledgment will expire and submittal of a new site location application may be required. Construction is defined as entering into a contract for the erection or physical placement of materials, equipment, piping, earthwork or buildings which are to be a part of a domestic wastewater treatment works. In cases where the applicant elects to use in-house work forces, construction shall be considered to begin when any actions are initiated towards the previous activities.

In accordance with Regulation 22, Section 22.4(12), this certification acknowledgement is subject to appeal pursuant to the State Administrative Procedures Act.

This acknowledgement does not relieve the applicant/owner from compliance with all local, state, and federal regulations prior to construction nor from responsibility for proper engineering, construction, and operation of the treatment works.

The Engineering Section is interested in gaining feedback about your experience during the engineering review process. We would appreciate your time to complete a Quality-of-Service Survey regarding your experience during the engineering review process leading up to issuance of this decision letter. The Engineering Section will use your responses and comments to identify strengths, target areas for improvement, and evaluate process improvements to better serve your needs. Please take a moment to fill out our survey [here](#).

If you should have any questions, please contact Ian Sutton by phone at 303-692-6430 or by email at [ian.sutton@state.co.us](mailto:ian.sutton@state.co.us)

Sincerely,

**Tyson Ingels**  
Digitally signed by Tyson Ingels  
Date: 2024.01.30 10:56:56  
-07'00'

Tyson Ingels, P.E.  
Engineering Section Manager  
Water Quality Control Division  
Colorado Department of Public Health and Environment

cc: Sharon Israel, City of Arvada  
William Conway, Metro Water Recovery  
Emily Wong, WQCD Engineering Review Unit Manager

## **Appendix H**

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Figures of Existing & Proposed Pipeline

# **Figures of Existing & Proposed Pipeline**

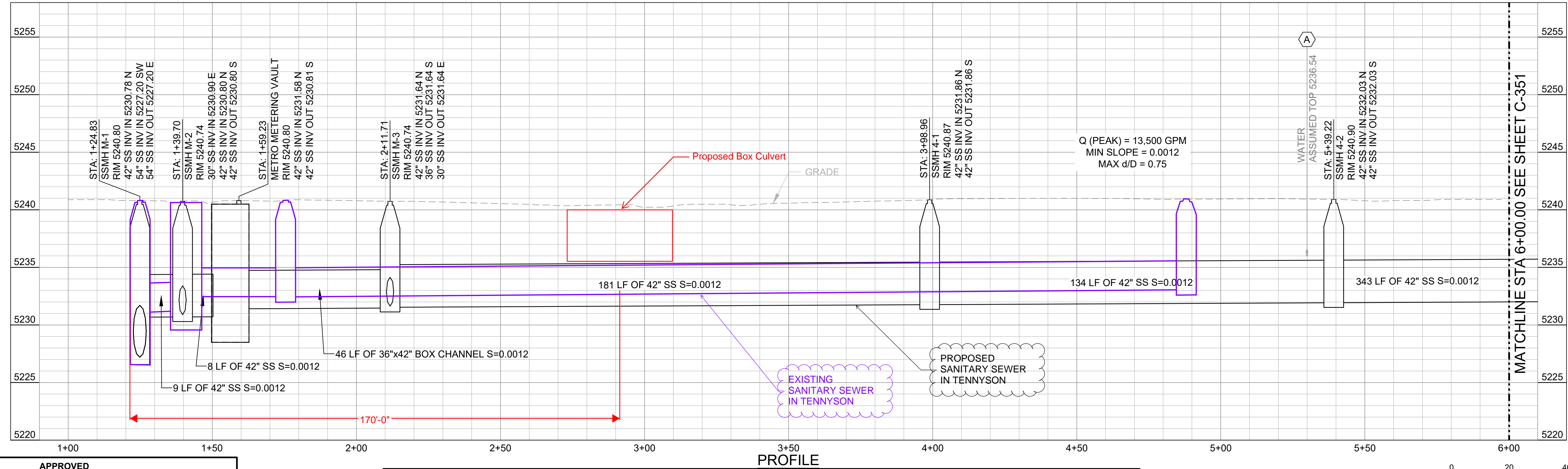
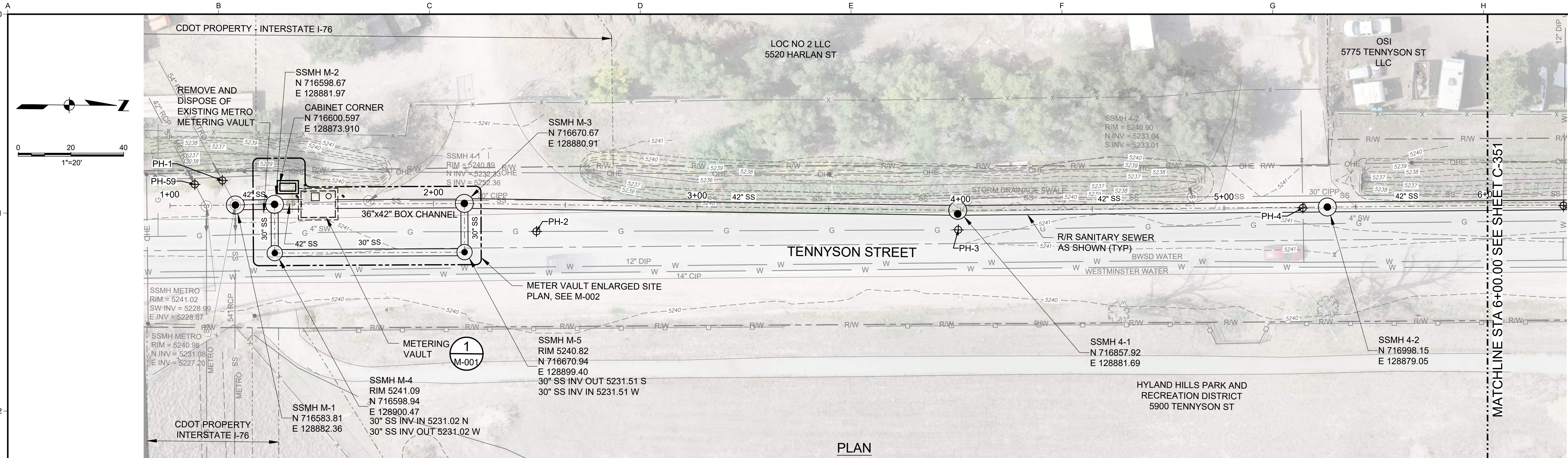
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User: BRYANT BEHNKE

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**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

**SHEET KEYNOTES**

A. POTENTIAL UTILITY CONFLICT. CONTRACTOR SHALL FOLLOW THE APPROPRIATE UTILITY CROSSING DETAILS PROVIDED ON SHEET C-003 AND COORDINATE WITH THE UTILITY OWNER FOR RELOCATION OR ENCASEMENT AS NEEDED FOR VERTICAL CROSSINGS.

**SHEET KEYNOTES (CONT.)**

B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.

**JAN 2024 - INTERIM 100%**

NOT FOR CONSTRUCTION

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NO	REVISION	DATE	BY

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
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DATE  
JAN 2024

SHEET  
11 OF 52

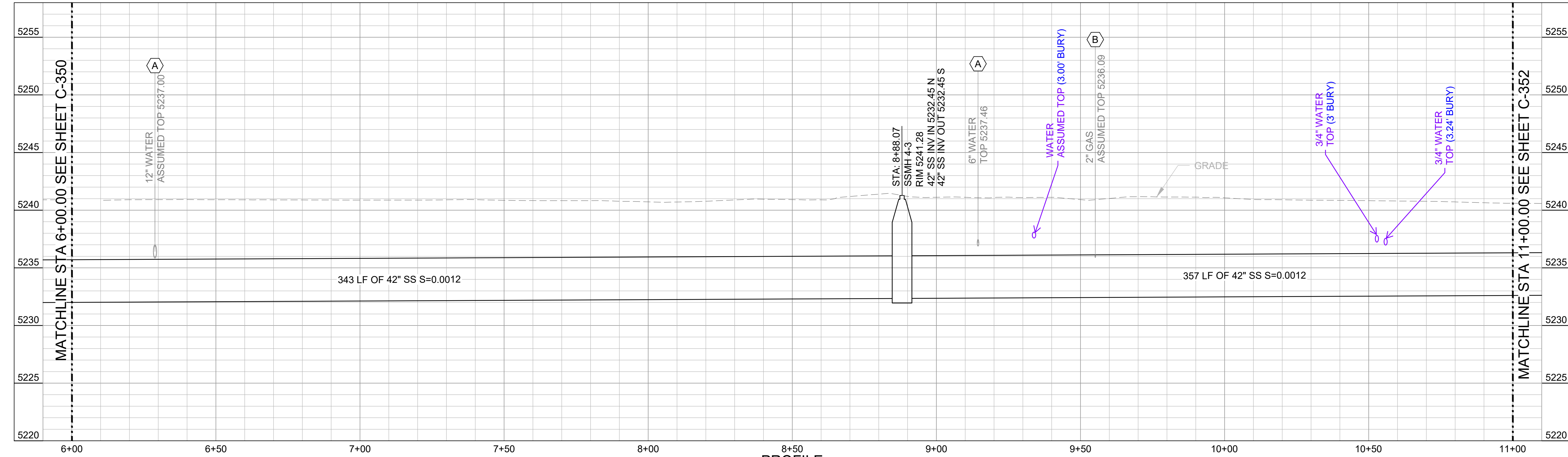
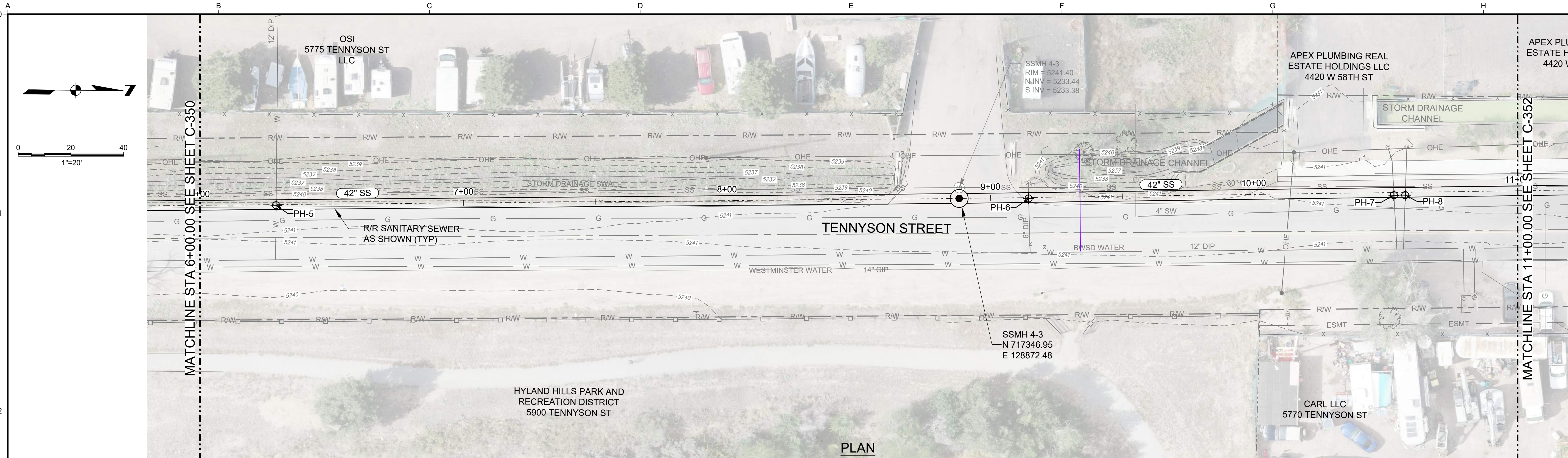
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User: BRYANT BEHNKE

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**APPROVED**  
City of Arvada, Colorado

CITY ENGINEER \_\_\_\_\_ DATE \_\_\_\_\_ JOB NUMBER \_\_\_\_\_

REVIEW IS FOR GENERAL COMPLIANCE WITH THE CITY OF ARVADA "ENGINEERING CODE OF STANDARDS AND SPECIFICATIONS FOR THE DESIGN AND CONSTRUCTION OF PUBLIC IMPROVEMENTS", LATEST EDITION. SOLE RESPONSIBILITY FOR COMPLETENESS AND/OR ACCURACY OF THESE DOCUMENTS SHALL REMAIN WITH THE REGISTERED PROFESSIONAL ENGINEER SEALING THESE PLANS, IF APPLICABLE. THE CITY DOES NOT ACCEPT LIABILITY FOR FACILITIES DESIGNED BY OTHERS.

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**SHEET KEYNOTES (CONT.)**

B. FOR POTENTIAL GAS AND ELECTRIC UTILITY CONFLICTS, CONTRACTOR SHALL COORDINATE WITH THE UTILITY OWNER FOR ALL REQUIRED GAS AND ELECTRICAL LINE RELOCATIONS AHEAD OF CONSTRUCTION.

**JAN 2024 - INTERIM 100%**

NOT FOR CONSTRUCTION

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NO	REVISION	DATE	BY

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**CITY OF ARVADA**

**NORTH TRUNK SEWER IMPROVEMENTS**  
NT10 TENNYSON AND 58TH - COA PROJECT #22-SR-11

**Kennedy Jenks**

**PLAN AND PROFILE**  
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JOB NO 2246059\*00

DATE JAN 2024

SHEET 12 OF 52

**C-351**



**AN INTERGOVERNMENTAL AGREEMENT BETWEEN THE CITY OF ARVADA AND ADAMS COUNTY FOR ARVADA'S NORTH TRUNK SEWER IMPROVEMENT PROJECT SECTION 10 (NT10)**

Formatted: All caps

Deleted: [Name of Project]

THIS INTERGOVERNMENTAL AGREEMENT ("IGA") is entered into this \_\_\_\_ day of \_\_\_\_\_, 2024, by and between the CITY OF ARVADA, a Colorado home rule municipal corporation, ("Arvada") located at 8101 Ralston Road, Arvada, Colorado 80002, and the BOARD OF COUNTY COMMISSIONERS OF ADAMS COUNTY, a body politic organized under and existing by virtue of the laws of the State of Colorado ("County") located at 4430 South Adams County Parkway, 5th Floor, Suite C5000A, Brighton, Colorado 80601, which may collectively be referred to herein as the "Parties."

Deleted: 2022

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Deleted: 9500 Civic Center Drive

Deleted: 80229

WHEREAS, Arvada is a home rule municipal corporation, established pursuant to the constitution and statutes of Colorado, and which operates a municipal domestic water system; and

Deleted: municipality

WHEREAS, Arvada is responsible for providing sewer services within its service area and has the authority to establish, construct, operate, and maintain works and facilities within and outside of its boundaries; and

WHEREAS, Arvada plans to construct a 42-inch sanitary sewer to replace, in place, the existing 30-inch sanitary sewer and associated maintenance holes (the "Project"); and

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WHEREAS, the Project is necessary for the health, safety, and welfare of the residents of Arvada; and

WHEREAS, a portion of the Project will be sited and constructed between W 61<sup>st</sup> Pl and Highway 76 on Tennyson St., in Adams County a portion of which will be within unincorporated areas of the County; and

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WHEREAS, the County has been delegated power to supervise matters of "state interest" by the Colorado General Assembly as set forth in C.R.S. § 24-65.1-101, et seq; and

WHEREAS, the County has adopted regulations governing areas and activities of state interest, Chapter 6 of the Adams County Development Standards and Regulations (the "County Regulations"), which include under Designated Areas and Activities of State interest the site selection and construction of major facilities of a public utility and major extensions of existing domestic water and wastewater treatment systems; and

WHEREAS, pursuant to Section 6-16 of the Regulations, in lieu of a permit application and review under the Regulations, the County may elect to negotiate an IGA with any political subdivision of the state as defined by C.R.S. § 29-1-202(1) to obtain the right to construct the Project within the unincorporated portions of Adams County; and

WHEREAS, the Parties are also authorized pursuant to Article XIV, Section 18 of the Colorado Constitution and Sections 29-1-201, et seq., and 29-20-105 of the Colorado Revised Statutes to cooperate or contract with any political subdivision of the State to provide any function, service, or facility lawfully authorized to each of the cooperating or contracting units; and

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WHEREAS, Arvada is diligently working in a cooperative manner with the County and with interests along the proposed Project alignment to address concerns they may have with the siting and construction of the Project; and

**Commented [CF1]:** Information on this piece will have to be updated as neighborhood meetings, etc happen.

WHEREAS, Arvada has requested, and the County has consented to, the utilization of the provisions of Section 6-16 of the Regulations, with Parties finding that an IGA is the most efficient and effective manner in which to proceed; and

WHEREAS, pursuant to Section 6-16 of the County Regulations, upon approval of this IGA, all requirements of the County Regulations shall be deemed satisfied and an AASI Permit shall be issued upon the satisfaction of the conditions set forth therein.

NOW, THEREFORE, for valuable consideration the receipt of which, and the adequacy and sufficiency of which, are hereby acknowledged by the Parties and in consideration of the mutual covenants and agreements herein contained, it is hereby agreed as follows:

1. **Submittal Requirements.** Arvada acknowledges that in order for the County to be able to evaluate fairly and thoroughly the potential impact of the Project upon the County, satisfaction of the submittal requirements identified in Chapter 6 of the County Regulations for AASI is required. Accordingly, Arvada has undertaken or will undertake the following:

a. **Notice of the Project.** Arvada provided notice in compliance with the notice requirements of Section 6-07-02-12 of the Regulations.

b. **Neighborhood/Scoping Meeting.** Arvada conducted a Neighborhood/Scoping Meeting in compliance with Section 6-07-02-12 of the Regulations. A copy of the mailing list and a meeting summary is included as [Please include Exhibit with Meeting Summary]

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c. **Referral Agencies.** County mailed referral packets to outside agencies as determined by the Community and Economic Development Department in accordance with Section 6-07-02-12 of the Regulations. Arvada has adequately responded to all referral agency comments received by the County, and copies of the responses are included as [Please Included Responses to referral agency comments as an Exhibit]

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d. **Submittal Requirements.** Arvada submitted all materials required by Sections 6-07-02 and 6-08-01 of the Regulations unless waived or modified by County's Community and Economic Development Director or designee. Arvada's submitted materials have been found to be complete. The Submittal Report attached hereto as Exhibit A.

**Commented [CF2]:** We usually see the Submittal Report (Application Materials) As Exhibit A.

e. **Mitigation of Concerns.** Arvada has been diligent in its efforts to identify and address citizen concerns, including efforts to identify the least disruptive Project alignment, and to avoid or mitigate Project impacts upon the well-being of County's citizenry, its natural resources and its environment. In particular, Arvada has agreed to the following:

**Commented [CF3]:** This section to be filled out once the neighborhood scoping meeting happens and referral comments are received. The following (a-c) are examples.

a. Arvada has contacted each of the landowners in unincorporated Adams County upon whose property Project construction activities will occur in order

to identify their concerns and take appropriate steps, where possible, to satisfactorily address those concerns; and

b. Arvada will not deprive any landowner of access to their property as a consequence of Project construction activities; and

c. Arvada will take reasonable measures to minimize damage to crops during the construction of the Project and, where such damage occurs, to promptly restore the property and fully compensate the landowner for crop losses.

f. **County Regulatory Conditions.** Arvada has specifically addressed Project impacts upon those attributes identified in the Regulations in a manner determined satisfactory by the County.

2. **Approval Criteria.** Subject to the conditions identified herein, the County has determined that the Project, as proposed, meets the General Approval Criteria and Additional Approval Criteria found in Sections 6-17-01 and 6-17-02-01, respectively, of the Regulations.

3. **County Benefits.** The County has determined that the benefits accruing to the County and its citizens from the Project outweigh the losses of any resources within unincorporated areas of Adams County or the loss of opportunities to develop such resources. In reaching this conclusion, the County has requested, and Arvada has specifically agreed, that in addition to the inherent benefits to residents and businesses in Adams County afforded by the Project as designed, Arvada will undertake the following:

4. **Financial Guarantee.** The County has determined that Arvada is not required to file a guarantee of financial security for the Project pursuant to Section 6-18 of the Regulations.

5. **Coordination between the County and Arvada.** Arvada further agrees to coordinate with the County regarding the following:

a. Arvada will utilize its best efforts to coordinate its overall construction schedule with any infrastructure construction contemplated and scheduled by the County so as to minimize the disruption of the County construction efforts.

b. ~~The County agrees that it shall not allow the development and design of its roadways to cause~~ Arvada to relocate its Project due to inadequate or excessive cover.

c. Arvada shall obtain all necessary County permits to construct the Project. Arvada shall submit to the County its construction plans for review by the County.

6. Arvada and the County will coordinate on permitting, monitoring, inspecting and approving activities required for construction of the Project including, but not limited to, stormwater (MS4) permit compliance, traffic management plans, and pavement inspections.

7. **Permit Issued.** The County hereby issues an AASI Permit for Arvada to access, install, construct, enlarge, use, operate, maintain, replace, repair, reconstruct, improve, relocate, inspect, survey, test and remove, at any time, and from time to time as may be useful to, or required by Arvada, the Project within the unincorporated areas of Adams County.

**Commented [CF4]:** To be filled out as application is reviewed.

**Commented [CF5]:** In some cases we waive the requirement of financial security. It will depend on the project and the need for any stormwater controls, etc.

**Commented [JM6R5]:** Christine, will this be waived for this project?

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**Deleted:** However; if such County construction project design results in excessive or inadequate cover over the Project, Arvada, agrees that it will take all necessary actions to protect, modify, or relocate the Project, at its sole cost and expense.

**Deleted:** <#>Should a new location within County's road ROW or on County-owned property be needed for Arvada's Project, due to the relocation for a County construction project, a new location within County's road ROW or on County-owned property will be provided by County.¶

**Deleted:** The respective staffs of the County and Arvada are authorized to enter into letter agreements, where... appropriate and required, to formalize such appropriate and required, to formalize such coordination and delegation of responsibilities and authority as deemed appropriate by staff.

**Deleted:** appropriate and required, to formalize such coordination and delegation of responsibilities and authority as deemed appropriate by staff.



8. **Permit Terms and Conditions.** The AASI Permit for the Project shall be subject to Arvada's continued compliance with the requirements of Chapter 6 of the County Regulations, the terms and conditions of this IGA, any conditions of approval adopted by the Board of County Commissioners in conjunction with the review and approval of this IGA, and specifically the following terms and conditions:

- a. All environmental and cultural resource avoidance measures are to be properly installed and implemented during construction and during maintenance activities thereafter.
- b. Construction and operation of the Project shall be in compliance with all applicable federal, state and local regulations.
- c. Arvada shall take the lead in identifying and coordinating actions and responses to any unanticipated discovery of sensitive environmental resources, cultural resources or contamination that occurs during construction of the Project. Arvada will inform the County of any such action.
- d. Prior to site disturbance on any portion of the Project in unincorporated Adams County, and relative to that portion of the Project, Arvada will:
  - i. Obtain all necessary property rights, easements, permits and approvals to construct the Project.
  - ii. Submit detailed construction plans to the County's Community and Economic Development Department.
  - iii. Provide the County's Community and Economic Development Department with all official federal and State consultation correspondence, completed reviews and any necessary approvals secured from all applicable agencies and special districts, including but not limited to the following:
    - (1) Colorado Department of Transportation (CDOT);
    - (2) Colorado Department of Public Health and Environment (CDPHE);
    - (3) Urban Drainage and Flood Control District (UDFCD; aka Mile High Flood District);
    - (4) Any other pertinent agencies;
    - (5) Any Federal or State agencies; and
    - (6) Any Special Districts having jurisdiction over the Project activities.
- e. Arvada agrees to follow the following conditions of approval:
  - i. Fugitive dust control mechanisms must be in place and functioning as needed to control fugitive dust.

**Commented [CF8]:** These are our standard Conditions of Approval. Subject to change as the submittal is reviewed.

- ii. Arvada shall ensure that its contractors make a reasonable attempt to keep the hours of construction between the hours of 7 a.m. to 7 p.m., Monday through Saturday. The County's Community and Economic Development Director may extend the hours and days of operation if there has been demonstration of a sufficient need.
- iii. The Project is subject to inspections by County inspectors during reasonable working hours. The County may or may not give notice of an inspection prior to the inspection.
- iv. All construction related work shall be completed within four (4) years of the execution of this IGA. A one year extension may be granted by the County' Director of Community and Economic Development.
- v. All development activities, including filling, stockpiling, and storage of fuel and hazardous materials within the 100-year floodplain shall be prohibited unless a Floodplain Use Permit is obtained from the County.
- vi. All hauling/construction trucks shall cover their loads pursuant to C.R.S. § 42-4-1407.
- vii. Maintenance of the haul route and/or construction traffic route, including dust abatement shall be the responsibility of Arvada. Arvada shall repair any rutting and potholes caused by the Project as requested by the County's Public Works Department.
- viii. All soil contaminated by hazardous fluid spills, such as fuel or hydraulic oil from maintenance of equipment, shall be removed and disposed of at a facility permitted for such disposal as required by state regulations.
- ix. During construction and maintenance of the Project within unincorporated Adams County areas, Arvada shall comply with any then-applicable County noise regulations.
- x. All construction vehicles shall have a radar activated or white noise backup alarm to minimize noise impacts to the area.
- xi. All complaints received by Arvada concerning offsite impacts, and the resolution of those complaints, shall be promptly conveyed to the County's Community and Economic Development Department. Offsite impacts shall be responded to and resolved as soon as reasonably possible by Arvada. Disputes concerning offsite impacts may be resolved by the County's Community and Economic Development Department.
- xii. If fuel will be stored on the site:
  - (1) All on-site fuel storage shall be provided with secondary containment in compliance with State of Colorado Oil Inspection Section Regulations; and
  - (2) Fueling areas shall be separated from the rest of the site's surface area and protected from storm water; and
  - (3) Arvada shall provide spill and release prevention plans for fuel storage and fueling operations.

(4) Spill and drip containment pans shall be emptied frequently.

(5) All spills shall be cleaned up and disposed of immediately at a facility permitted for such disposal.

xiii. Arvada shall comply with all applicable requirements of the Zoning, Health, Building, Engineering and Fire Codes during the construction and maintenance of the Project within areas of unincorporated Adams County.

xiv. Failure to comply with the conditions of approval set forth above may be justification for a Show Cause Hearing before the Adams County Board of County Commissioners and may result in a default of the terms of this IGA and revocation of the AASI Permit issued herein.

15. **Permit Term.** The County recognizes that the Project is large in scope, with a potential for numerous separate bid packages and a **minimum one year construction schedule**. So long as Arvada is diligently proceeding with construction activities on any portion of the Project within two years of the execution of this IGA, the Project shall be considered commenced for purposes of obtaining necessary construction or building permits in a timely manner, the language of Section 6-12 of the Regulations notwithstanding; provided, however, that Arvada shall prior to [redacted] provide notice to the County of any construction permits within unincorporated Adams County that Arvada intends to request after [redacted]. If the Project alignment changes, the type of activities are modified, or there are material modifications to the Project within unincorporated Adams County, Arvada shall notify the County's Community and Economic Development Department in writing, at which time the County may request the submission of additional information concerning any change in Project scope within unincorporated Adams County and may impose such reasonable, additional conditions as necessary to address any unforeseen impacts associated with such change in scope. The County, at its sole discretion, will determine whether a Full Amendment or a Technical Review Amendment to the IGA and/or the AASI Permit is required.

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16. **Easements and License Agreement.**

Commented [CF10]: County and Arvada will need to negotiate specific terms for any Easements or License in County ROW.

17. Any and all notices, demands, or other communications desired or required to be given under any provision of this IGA shall be given in writing and delivered personally or sent by registered or certified mail, return receipt requested, postage prepaid to the address of the County and Arvada as set forth below:

To Adams County:

Director of Community and Economic Development  
Community and Economic Development Department  
4430 South Adams County Parkway  
1st Floor, Suite W2000A Brighton, CO 80601-8216  
Phone: (720) 523-6800

and

Director of Public Works  
Adams County Public Works Department  
4430 South Adams County Parkway

1st Floor, Suite W20008  
Brighton, CO 80601-8218  
Phone: (720) 523-6875

With a copy to:

County Attorney  
Adams County Attorney's Office  
4430 South Adams County Parkway  
5th Floor, Suite CS000B  
Brighton, CO 80601-8218  
Phone: (303) 654-6116

To Arvada:

Director of Public Works  
City of Arvada  
8101 Ralston Road  
Arvada, CO 80002  
Phone: 720-898-7742

and

Director of Utilities  
City of Arvada  
8101 Ralston Road  
Arvada, CO 80002  
Phone: 720-898-7761

With a copy to:

City Attorney  
Arvada City Attorney's Office  
8101 Ralston Road  
Arvada, CO 80002  
Phone: 720-898-7180

Or to such other addresses that any party may hereafter from time to time designate by written notice to the other parties in accordance with this paragraph. Notice shall be effective upon receipt.

18. This IGA shall be binding upon the execution of this IGA by the Parties hereto.
19. The Parties hereto understand and agree that the Parties, their officers, and employees, are relying on, and do not waive or intend to waive, by any provision of this IGA, any rights, protections, or privileges provided by the Colorado Governmental Immunity Act, C.R.S. 24-10-101 et seq., as it is from time to time amended, or otherwise available to the Parties, their officers, or employees.

Deleted: [Please Add Notice Addresses]



20. This IGA is intended to describe and determine such rights and responsibilities only as between the Parties hereto. It is not intended to and shall not be deemed to confer rights or responsibilities to any person or entities not named hereto.
21. The IGA provisions contained herein shall inure to the benefit of the Parties hereto. Neither party to this IGA may assign its rights or delegate its duties under this IGA without the prior written consent of the other.
22. This IGA, the AASI Permit, the conditions of approval, and any agreement or document referred to herein, constitutes the entire understanding between the Parties with respect to the subject matter hereof and all other prior understandings or agreements shall be deemed merged in this IGA.
23. The captions of the paragraphs are set forth only for convenience and reference, and are not intended in any way to define, limit or describe the scope or intent of this IGA.
24. The Parties agree to execute any additional documents and to take any additional action necessary to carry out this IGA.
25. This IGA may be modified, amended, changed or terminated in whole or in part only by an agreement in writing duly authorized and executed by the Parties hereto with the same formality, and subject to the same statutory and regulatory requirements, as this IGA.
26. Notwithstanding anything herein to the contrary, the Parties agree not to hold each other responsible for any losses or damages incurred as a result of a party's inability to perform pursuant to this IGA due to the following causes if beyond the party's control and when occurring through no direct or indirect fault of the party: acts of God; natural disasters, actions or failure to act by governmental authorities other than the parties hereto; unavailability of power, fuel, supplies or equipment critical to a party's ability to perform; major equipment or facility breakdown; and changes in Colorado or federal law, including, without limitation, changes in any permit requirements.
27. This IGA and its application shall be construed in accordance with the laws of the State of Colorado.
28. If either party is in default of this IGA, the non-defaulting party may elect to treat this IGA as terminated, in which case the non-defaulting party may recover such damages as is proper, or the non-defaulting party may seek specific performance. No such default shall be deemed to exist until the defaulting party has been given notice of the alleged default and fails to remedy such default within 30 days of receipt of such notice and there is a determination by a court having venue that there has been a breach of this IGA.
29. In the event of any litigation, arbitration or other dispute resolution process arising out of this IGA, the Parties agree that each will pay its own costs and fees.
30. Arvada shall be solely responsible for the costs of the Project.
31. Arvada shall be solely responsible for maintaining the Project.
32. If any provision of this IGA is determined to be unenforceable or invalid for any reason, the remainder of this IGA shall remain in effect. No subsequent resolution or ordinance enacted

by the County or Arvada shall impair the rights of the County or Arvada hereunder without the written consent of all of the Parties.

IN WITNESS WHEREOF, the Parties hereto have executed this IGA with its exhibits to be effective as of date first written above.

CITY OF ARVADA, COLORADO

Lauren Simpson, Mayor Date \_\_\_\_\_

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ATTEST: CITY CLERK

Approved as to form:  
Rachel A. Morris, City Attorney

\_\_\_\_\_  
City Clerk

By: \_\_\_\_\_

Deleted: City Attorney

BOARD OF COUNTY COMMISSIONERS  
ADAMS COUNTY

\_\_\_\_\_  
Chair

\_\_\_\_\_  
Date

ATTEST:  
JOSH ZYGIELBAUM  
CLERK AND RECORDER

Approved as to form:

\_\_\_\_\_  
Deputy Clerk

\_\_\_\_\_  
Adams County Attorney's Office

# Arvada North Trunk Sewer Improvements Project

Areas and Activity of State Interest (1041) Intergovernmental Agreement (IGA) Submittal  
Report

City of Arvada

May 29<sup>th</sup>, 2024



# 1 SUMMARY

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An Intergovernmental Agreement (IGA) is being pursued between the City of Arvada (COA) and Adams County (ADCO) for the Arvada-Tennyson North Trunk Sewer Improvements Project. COA provided a submittal for conceptual review to ADCO on 1/22/2024. ADCO provided preliminary comments and indicated that the following sections of the 1041 Activities and Areas of State Interest (AASI) permit would be applicable: 1, 2, 3, 4, 8, 14, 16, 17, 18, 19, 20, 22 and supplemental items 3 and 4. This submittal includes responses to ADCO comments as well as the indicated sections of the 1041 permit.

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### 3 1041 AREAS AND ACTIVITIES OF STATE INTEREST PERMIT APPLICABLE SECTIONS

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#### 3.1 DEVELOPMENT APPLICATION FORM (#1)

The Development Application Form was completed as a part of the conceptual review submittal process. See Appendix B for completed form.

#### 3.2 APPLICATION FEES (#2)

*Table 1: Application Fees*

<b>Application Fees</b>	<b>Amount</b>	<b>Due</b>
AASI Permit	\$5,000 and cost of mailings	With Application submittal
Erosion and Sediment Control Plans	\$500	With Application submittal
Construction Plans	\$100	With Application submittal
<b>Total</b>	<b>\$5,600</b>	





### 3.3 WRITTEN EXPLANATION OF PROJECT (#3)

**A clear and concise, yet thorough description of the proposal. Please include, if applicable, timeframe, purpose of project, and improvements that will be made to the site.**

The City of Arvada (COA) recently completed a Sanitary Sewer Master Plan (SSMP) for its North Trunk Sewer (NTS) sanitary collection system. This master plan analyzed existing and future buildout flow projections for the existing NTS collection area. Multiple areas were identified as needing capacity increases to adequately convey existing and buildout flow conditions.

The portion of the program designated as North Trunk Line segment 10 (NT10) runs from W 61<sup>st</sup> Ave to the City's connection with Metro Water Recovery (just north of highway 76) along/in Tennyson Street. The objective of this portion of the program is to upsize approximately 3,650 feet of existing 21-inch and 30-inch gravity sanitary sewer. The upsizing will relieve existing condition capacity issues and provide for estimated build-out flows at the City's written level of service condition - peak sewage flow during a 25-year storm event.

All pipeline replacement work for this project will occur within the Tennyson Street right of way (ROW), shared by COA and Adams County. See Figure 1: Project Vicinity for visualization of Arvada and Adams County jurisdiction – COA is highlighted in green and ADCO is white. The new pipeline primarily maintains the existing alignment within Tennyson. At the south end of the project, the trunkline alignment is primarily along the west side of Tennyson Street ROW adjacent to the existing storm swale. This portion of the project also includes the installation of a new Metro Water Recovery metering facility which will replace the existing metering facility to adequately accept the future increased flows. North of 58th Avenue, within the railroad corridor, the new sanitary line will cross Union Pacific, BNSF, and RTD railroads as well as various other utilities including storm water and RTD duct banks. Installation of the new sanitary line in this section will be accomplished through tunneling methods as detailed in the design drawings. Final design in the railroad corridor is dependent on ongoing potholing efforts. A 42-inch line with 51-inch casing is shown in the design drawings (Appendix A ). An alternative design is also included in Appendix A which shows rehabilitating the existing 30-inch pipe and adding a new, parallel 30-inch pipe to convey build out flow. The north end of the project maintains the existing sanitary alignment near the center of the road and includes crossing Manhart Ditch and relocation of an existing water line. Further detail can be found in the attached drawings.

Currently, the project is estimated to begin in fall of 2024 and continue through early 2025. This timeframe is heavily dependent on approval from the railroads: Union Pacific, BNSF, RTD.

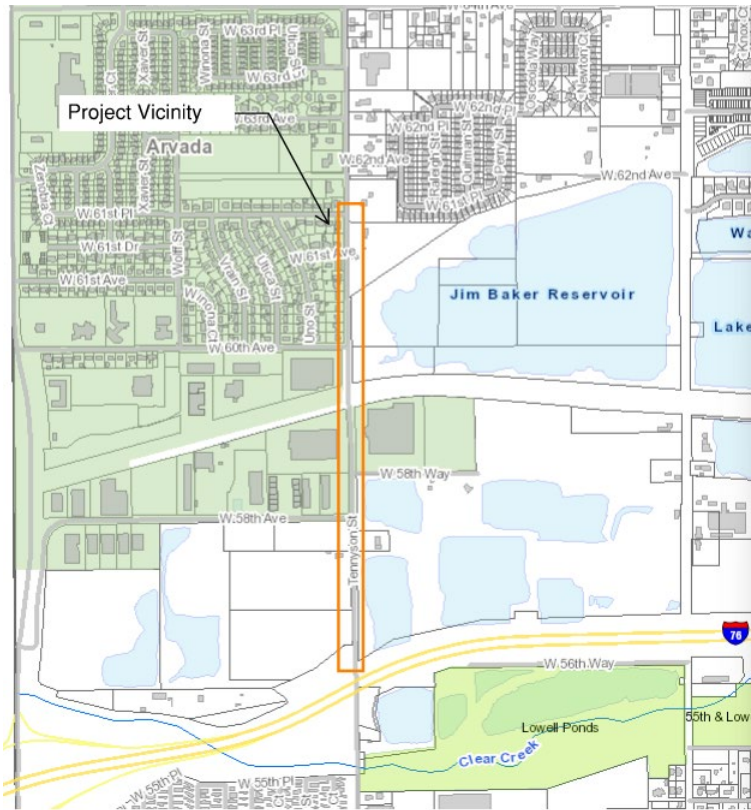


Figure 1: Project Vicinity

### 3.4 SITE PLAN SHOWING PROPOSED DEVELOPMENT (#4)

*A detailed drawing of existing and proposed improvements including:*

- *Streets, roads, and intersections*
- *Driveways, access points, and parking areas*
- *Existing and proposed structures, wells, and septic systems,*
- *Easements, utility lines, and no build or hazardous areas*
- *Scale, north arrow, and date of preparation*

Site Plan with all required information is included in the Design Drawings in Appendix A .

### 3.5 NEIGHBORHOOD MEETING SUMMARY (#8)

*A written summary shall be prepared including the materials submittal presented at the meeting, any issues identified at the meeting, and how those issues have been addressed. More detail can be found at 2-02-02 of Adams County Development Standards and Regulations.*



A neighborhood meeting was held on April 23, 2024 at the Early College of Arvada, Arvada, CO. Stakeholders located between Sheridan Blvd and Lowell Blvd and W 64th Ave and Highway 76 (within ½ mile of the Project) were invited. The mailing list was generated by COA and invitations were mailed by Arvada in accordance with Section 2-01-02 of the Regulations.

The meeting was an open house format. A large-scale map was displayed which depicted the sanitary sewer pipeline that will be replaced on a high-resolution aerial background. All stakeholders (property owners/businesses) who were within the zone for notification were also displayed on the map. Arvada representatives (Utilities engineering and communications) were available for questions. Comment sheets were available for attendees to provide feedback concerning the Project. Attendees were provided information regarding where to find Project information on the Arvada website.

The meeting was attended by 10 people. After locating their residence, business, or area of interest on the map exhibits, most of the public attendees found that the Project did not impact them directly or the impacts were limited. There was public interest regarding how traffic would be managed and associated concerns about traffic congestion. Primary concerns were related to existing congestion on 64th Ave, at the railroad crossings, and at 58th Ave. The public was advised that the Project would include traffic control plans to mitigate traffic-related impacts during construction and that all roads impacted by construction will be replaced as they were prior to construction. The project team generally did not receive negative feedback or feedback that would result in any revisions to the planned Project configuration or design. Copies of the public meeting sign-in sheet and comment cards (with personal information redacted to protect privacy) and maps displayed at the meeting are included in Appendix C .

### 3.6 INFORMATION DESCRIBING PROJECT (#14)

#### 3.6.1 Detailed plans and specifications of the project

Detailed plans and specifications are provided in Appendix A .

#### 3.6.2 Descriptions of at least three (3) or more alternatives to the Project that were considered by the Applicant.

In addition to the alternatives discussed below, the project team conducted an alignment workshop on January 30<sup>th</sup>, 2023 to discuss the options for sanitary sewer alignment within Tennyson. East, west, and central alignment options within Tennyson were discussed. When the design reached a 60% level, plans were provided to ADCO for review. ADCO provided comments which are addressed in a response letter located in Appendix B .

#### **Alternative 1: Construct project at a later date**

- This is NOT an option. COA recently completed master planning efforts for the North Trunk Sewer (NTS) system. See Appendix D for SSMP Executive Summary. Specifically, Segment 10 of the NTS, W. 61<sup>st</sup> Pl. to I-76, is over 60 years old and has current and existing capacity issues that

cause surcharging under storm conditions. This segment of sanitary trunkline does not meet the City's written level of service under the current conditions.

- Specifically, the segment under the 3 railroad tracks was not designed for surcharge/pressure conditions and has a high likelihood of experiencing pressure conditions now and into the future without pipe replacement.
- Furthermore, the SSMP (Appendix D ) indicated that in a 25-year storm event, the majority of this segment will be fully inundated with wastewater (i.e surcharging and further raising the hydraulic grade line (HGL) within the system) thus impacting customers. In order to prevent major sanitary backups to residents, businesses, and/or the environment, this project must move forward to meet the City's service commitment to existing customers.

#### **Alternative 2: Align outside of the Tennyson corridor - 4 options considered**

- Alternative 2a: Sheridan - This option would continue the sewer from 68th and Sheridan to an interceptor (Metro or Arvada) near 52nd and Sheridan. The hill is too big in this location (sewer would be 50 feet deep) and is likely the reason the sewer went down Tennyson in 1962 - a smaller hill to leave the Little Dry Creek Basin and enter the Clear Creek Basin to connect with Metro. This alternative was not evaluated further.
- Alternative 2b: Follow Little Dry Creek Basin at 76th and Sheridan and tie into Metro near the Westminster meter. This alternative requires not only miles of new pipe but renewal of all the existing pipe downstream of 76th and Sheridan. Thus, this is significantly more impactful to the public and significantly more expensive. Additionally, staff knowledge of the Little Dry Creek corridor is that there is not space available for an additional interceptor. This alternative was considered infeasible due to the extreme length of pipe and likely inability to fit the pipe in the corridor.
- Alternative 2c: Lowell - This option would take flow east at 66th over to Lowell. Again, this would require not only new pipe but renewal of all pipe downstream of 66th. The available space for an interceptor in 66th (a residential road) is likely limited and the length of pipe outside the City's jurisdiction would increase significantly. Lastly, construction between two water storage reservoirs would be technically difficult, costly, and could result in long-term infiltration. This alternative was considered infeasible due to the need to do both long lengths of new pipe and long lengths of pipe renewal.
- Alternative 2d: This alternative would route the sewer to the west at 58th to somewhere between Sheridan and Tennyson. There is no right of way or public roads in this vicinity-south of 58<sup>th</sup>. Consequently, this alternative route would bisect private property outside a roadway. Additionally, the sewer south of 58th would need renewal or a smaller new pipe installed due to the current layout of the overall existing sewer system. This alternative was not considered further because the City's preference is to not encumber private property. Furthermore, obtaining right of way impacts the project timeline, thus continuing in the unacceptable risk of the existing condition.

#### **Alternative 3: Add lift station south of the railroad corridor**



A lift station within Tennyson St. ROW or in an adjacent easement adds the benefit of pumping sewage to a higher HGL and thus allowing the new trunkline to go deeper than the current vertical alignment. However, with that approach comes several difficult and distinct challenges from a design, construction, operations, and maintenance standpoint. Additionally, the project team does not see a path to meeting CDPHE sequencing for a lift station. A lift station north of the railroad tracks is not acceptable. The railroad companies will likely not accept pumped sewage underneath the rail lines without multiple levels of containment and monitoring, all of which the vertical design does not have adequate space given the number of utilities located in this area. Per *CDPHE Wastewater Design Criteria Policy Clean Water Program Policy Number: WPC-DR-1* adding a lift station upstream of the proposed Square Lakes stormwater crossing would require the following:

1. A large enough wetwell to house redundant (N+1) submersible wastewater pumps **or** a dry pit to house (N+1) wastewater pumps and a separate wetwell to accommodate varying levels of wastewater (see Sections 4.2.1 & 4.2.2 of WPC-DR-1). The approximate footprint of a wetwell for submersible pumps would be 70'X30' to accommodate peak flow conditions. See Figure 2 for visual representation of wetwell in plan view.
2. An emergency overflow vault with active volume greater than or equal to the amount of time it takes to resolve any issues with the lift station plus a buffer period multiplied by peak hour flow (see Section 4.1.1 of WPC-DR-1). With an expected peak hour flow of 19.44 MGD at buildout and an expedited response and crisis management time of 2 hours, this would result in approximately 1.62 MG of emergency overflow storage required. Assuming a rectangular overflow tank would be utilized with an active storage water level of 15 feet, this would result in a footprint of approximately 120'X120'. Finding a location for this level of emergency storage will be difficult and will likely further cause adverse impact to the local community. See Figure 2 for visual representation of emergency overflow vault in plan view.
3. A combination of large and small wastewater pumps to handle highly variable flows.
4. Extensive electrical equipment (VFDs, PLCs, power) and a backup generator that needs to be located adjacent to the lift station. See Figure 2 for visual representation of electrical building in plan view.
5. Active odor control (ozonation, ventilation, carbon scrubbers, etc...) is required given that wastewater will be sitting in a wetwell adjacent to a recreation area, major roadway, businesses, etc... (See Section 4.4.3 of WPC-DR-1).
6. Two force mains are required for redundancy resulting in an even greater horizontal footprint within the Tennyson ROW.
7. All of the items above would be required to be in a secure area not accessible to the public. This area is zoned as FEMA floodplain and generally floodway. This zoning requires that pumps, generators, and electrical equipment be not only above grade but also elevated and/or bermed. This will have significant impact on the floodplain and community. The project would also be required to go through the CLOMR process. The CLOMR process does NOT meet the City's timeframe to mitigate an ongoing, current capacity issue.

The footprint of the project with a lift station would be much larger and take significant area out of private ownership (west side) or recreational/environmental use (Hyland Hills). Gaining an easement from Hyland Hills Parks and Recreation could be a possibility but an easement comes with the following requirements:

- Hyland Hills loses this area for future pedestrian access. ADCO’s comprehensive plan “Advancing Adams” targets this area for roadway, sidewalk, and bike path improvements. See Figure 2 for visual representation of equipment footprint in relation to the existing walkway in Hyland Hills.

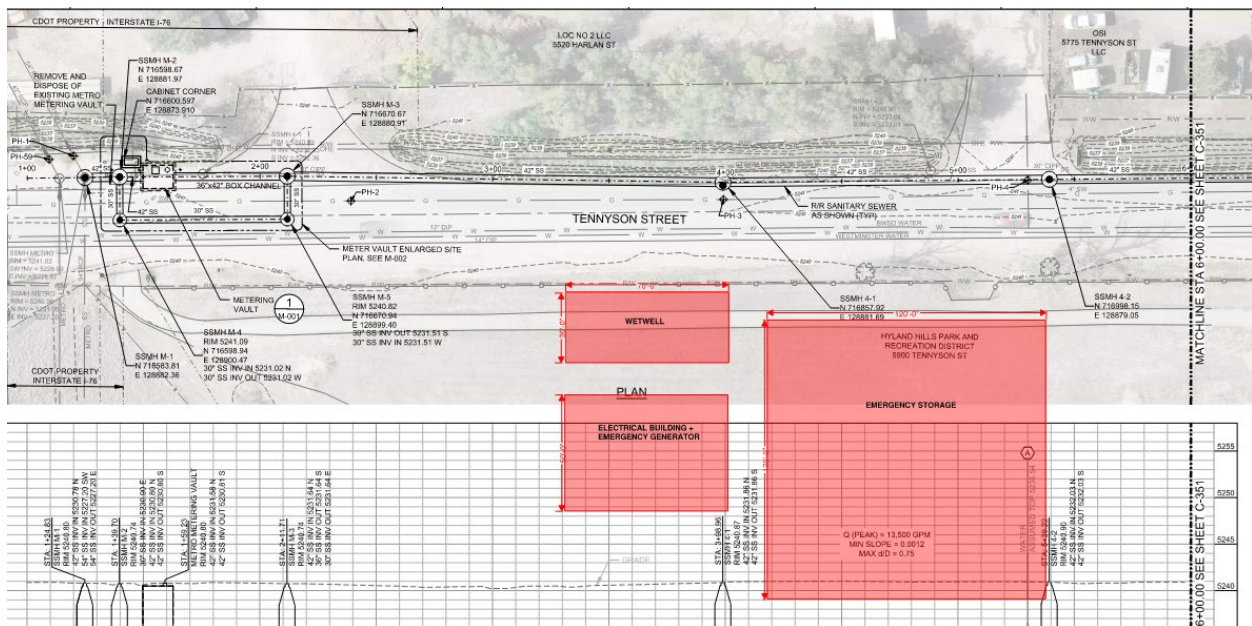


Figure 2: Plan view demonstrating footprint of pump station components

- This area is within a floodway and currently experiences flooding. Extensive regrading of the area to maintain electrical equipment and the emergency generator above the 100-year flood level (see Sections 2.2.4 & 4.1.0 of WPC-DR-1) would be necessary.
- The existing sanitary alignment is on the west side of Tennyson. To get the new trunkline to the east to a proposed wetwell would require crossing major utilities and would limit any future utility improvements in this corridor. For example, the City of Westminster maintains a large diameter raw water line which is used to pump Westminster water rights from the ponds south of I-76 up to Jim Baker reservoir. Jim Baker reservoir is used extensively by the local community.
- If the lift station alternative were to be pursued, wastewater pumped under pressure would go beneath potential stormwater infrastructure underneath Tennyson Street. This pressurized wastewater would need to be received in a head break structure prior to gravity discharge into Metro Water Recovery’s interceptor. Metro does not allow direct force main connections into gravity interceptors. In order to do this, the head breaking structure would need to be above the crown of Metro’s pipe so that wastewater can gravity flow into a connection to the interceptor. The head break structure would need to be large (larger than the proposed flume vault) so that

it could adequately dissipate energy prior to gravity flow. This further reduces limited available space within the Tennyson Street ROW.

**3.6.3 Schedules for designing, permitting, constructing and operating the Project including the estimated life of the project.**

A project schedule is provided in Appendix E. The project is using HOBAS pipe which has an estimated lifespan of greater than 75 years. This should be assumed to be the life of the project.

**3.6.4 The need for the Project, including existing/proposed facilities that perform the same or related function; and population projections or growth trends that form the basis of demand projections justifying the Project.**

The need for the project is conveyed by the City's Master Plan, completed in 2022. See Appendix D for the SSMP pages related to this project. These pages include an excerpt of the modeling results which precipitated the need for upsizing under current conditions. The entirety of the Master Plan is a public document and is available on the City website.

**3.6.5 Description of all conservation techniques to be used in the construction and operation of the Project.**

All work for this project will occur within the Tennyson St. ROW. No virgin ground will be broken during construction. There may be some temporary effects to surface water via stormwater runoff and discharge from dewatering activities to Clear Creek. However, these temporary impacts will be mitigated by the Stormwater Management Plan (SWMP) and adherence to CDPHE dewatering permit requirements, respectively. The SWMP can be found in Appendix A . Additional detail on dewatering activities and SWMP can be found in Section 3.12: Environmental Impact Review.

### **3.7 FINANCIAL FEASIBILITY OF THE PROJECT (#16)**

**3.7.1 The estimated construction costs and period of construction for each development component.** Construction costs are currently estimated at \$14 Million. See Appendix E for construction schedule detailing periods of construction for each development component.

**3.7.2 Revenues and operating expenses for the Project.**

There are no revenues specifically associated with the Arvada NTS Project. Arvada collects revenue pursuant to the rates and fees set by the Arvada City Council for providing wastewater service to Arvada's customers.

Operating expenses for the Project will be funded by the Arvada Wastewater Enterprise fund as part of the overall operation and maintenance of Arvada's wastewater conveyance system.

**3.7.3 The amount of any proposed debt and the method and estimated cost of debt service.**

As a part of the City's overall North Trunk Line (NTL) Wastewater Interceptor Program work, this project (which comprises a section of the overall NTL Program) has been planned for and funded in 2024. The City has approximately \$15,640,000 of funds allocated and appropriated for the design and construction of the project. These funds are a portion of the proceeds from a 2022 revenue bond issue.

**3.7.4 Details of any contract or agreement for revenues or services in connection with the Project.** Service is provided pursuant to Arvada's Charter and City Code. Rates and fees collected for service are used to fund Arvada's cost-of-service wastewater conveyance system.

**3.7.5 Description of the persons or entity(ies) who shall pay for or use the Project and/or services produced by the Development and those who shall benefit from any and all revenues generated by it.**

This interceptor conveys wastewater from the northeast third of Arvada, as well as south of Hidden Lake, east of Sheridan. All users of the system pay standard rates and fees.

**3.7.6 Cost of all mitigation measures proposed for the Project.**

The following cost mitigation measures will be implemented to ensure the project budget remains intact and the project follows through to completion:

- 1) Materials will be procured well in advance to avoid costly schedule delays
- 2) Partnership with trusted subcontractors will be prioritized to provide accurate scheduling, ordering, installation, etc.
- 3) Alternative or unconventional methods will be explored to determine the best solution to the projects challenges. For example, multiple tunneling methods and liner systems were reviewed to meet design flow requirements incorporating cost evaluation and size constraints.
- 4) Thorough cost reviews are underway and will continue to be performed during design/preconstruction/construction.

**3.7.7 Detailed description as to how the Project shall be financed to show that the Applicant has the ability to finance the Project.**

As a part of the City's overall North Trunk Line (NTL) Wastewater Interceptor Program work, this project (which comprises a section of the overall NTL Program) has been planned for and funded in 2024. The City has approximately \$15,640,000 of funds allocated and appropriated for the design and construction of the project. These funds are a portion of the proceeds from a 2022 revenue bond issue. The following presents reporting from Standard & Poor's:

Per the S&P rating report for Arvada Wastewater dated November 10, 2022 that assigned a rating of "AA- Stable", – "The rating reflects our view of the wastewater system's affordable rates, strong operational management, and healthy all-in coverage metrics," said S&P Global Ratings credit analyst Samantha Watkins. The 2022 bonds will be used to fund several interceptor projects as well as two





trunk line programs to increase capacity for estimated build-out flows. Additional bonding of \$30 million is planned for 2024.”<sup>1</sup>

### 3.8 LAND USE (#17)

#### 3.8.1 Description of existing land uses within and adjacent to the Impact Area.

The project area remains entirely within the Tennyson St. ROW. Table 2 lists land uses *adjacent* to the project-no encroachments upon these lands or their future uses are anticipated.

Land uses adjacent to the project vicinity include a mix of residential, public, and industrial, and commercial properties. Pages C-350 to C-357 in the design drawings in Appendix A include owners and addresses for properties adjacent to Tennyson St. ROW. Associated land uses per ADCO GIS, are listed below.

Table 2: Land Use of Parcels Adjacent to Project

Address	Name	Current Land Use	Future Land Use
5775 Tennyson St	OSI	Commercial	Mixed Use/Employment
5770 Tennyson St	Carl LLC	Commercial	Mixed Use/Employment
4420 W 58th Ave	APEX Plumbing Real Estate Holdings LLC	Commercial	Mixed Use/Employment
5849 Tennyson St	Sullivan Management LLC	Commercial	Mixed Use/Employment
5870 Tennyson St	Jamm Properties Limited	Public/Quasi Public	Parks & Open Space
5900 Tennyson St	Hyland Hills Park & Recreation District	Public/Quasi Public	Parks & Open Space
5981 Tennyson St	Mark VII Equipment Inc.	Commercial	Municipal Area
5994 Tennyson St	City of Westminster	Public/Quasi Public	Parks & Open Space
6001 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
6011 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
6021 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
6031 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
6041 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
6120 Tennyson St	Dickinson Plaza LLC	Residential	Municipal Area
6051 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
6061 Tennyson St	Holiday Minor Subdivision	Residential	Municipal Area

<sup>1</sup> Watkins, S. (2022, November 10). *Arvada, CO Wastewater Revenue Bonds Assigned 'AA-' Rating; Outlook Stable*. Retrieved from S&P Global Ratings: <https://disclosure.spglobal.com/ratings/en/regulatory/article/-/view/type/HTML/id/2915545>

6099 Tennyson St	Holiday Minor Subdivision	Residential	Municipal Area
4403 W 61st Ave	Tennyson Hills Subdivision	Residential	Municipal Area
6111 Tennyson St	Tennyson Hills Subdivision	Residential	Municipal Area
4405 W 61st Pl	Tennyson Hills Subdivision	Residential	Municipal Area
6162 Tennyson St	Sage E Pollack & Stephanie S. Flaksman	Public/Quasi Public	Parks & Open Space

**3.8.2 Description of provisions from local land use plans that are applicable to the Project and an assessment of whether the Project shall comply with those provisions.**

Relevant local land use plans from COA and ADCO were reviewed. COA’s 2014 Comprehensive Plan maintains existing land use in this corridor. Land uses include medium density residential, suburban residential, industrial/office, and commercial.

ADCO’s comprehensive plan, Advancing Adams, was also reviewed in relation to this project. The Advancing Adams Comprehensive Plan (2022) builds upon the Imagine Adams Comprehensive Plan (2012) foundation by updating policies, further refining and clarifying land use categories, and coordination land uses with the 20-minute community planning concept. The comprehensive plan addresses the community’s vision for future land uses, housing and population growth, the natural and built environments, economic development, cultural heritage, and corridors and subareas. Chapter 2 of the Advancing Adams Comprehensive Plan (2022) outlines Future Land Use Categories, establishing the framework for sustaining the existing populations and accommodating future growth.

ADCO land borders the Tennyson St. corridor to the east. Existing land use in this area include residential areas and parks and open space. These areas, on the east side of Tennyson, maintain their existing uses per the Advancing Adams Comprehensive Plan (2022).

On the south end of the project, the west side of Tennyson has been identified as a target planning area for mixed use and employment under the Square Lake Subarea Plan (2022), developed jointly by COA and ADCO. Three distinct areas are presented in Figure 3 below; The G-Line Area, Central Area, and Southern Area. The G-Line Area and Southern Area existing land uses will remain the same. The Central Area lies between the rail lines and I-76. This area has one main public road (58<sup>th</sup> Avenue) running through it. Existing land uses include heavy and light industrial and vacant land. The Central Area is largely within the Clear Creek floodway where it is mostly undevelopable, at present. This area has been identified for future mixed use and employment land use. Tennyson St. has also been targeted for roadway, sidewalk, and bike path improvements in the Square Lake Subarea Plan.



Figure 3: Visual Representation of Square Lake Subarea Plan (Square Lake Subarea Plan, 2022)

This project does not measurably impact the planned improvements in this corridor beyond existing conditions. Tennyson St. will be returned to existing conditions and in some cases the road and storm swale may be in better condition than existing. Additionally, one of the key goals of the Subarea Plan is Environmental Mitigation. The Arvada North Trunk Sewer Improvements help achieve this goal by mitigating the potential for sewer surcharging and overflow. This project is necessary to address the potential for major sanitary backups to residents, businesses, and the environment. Specifically, Segment 10 of the NTS, W. 61<sup>st</sup> Pl. to I-76, is over 60 years old and has current and existing capacity

issues that cause surcharging under storm conditions. This segment of sanitary trunkline does not meet the City's written level of service under current conditions. These issues are identified in the Master Plan Executive Summary (Appendix D ) completed by HDR in December 2022.

### 3.8.3 Description of impacts and Net Effect that the project would have on land use patterns.

Future land use projections in this corridor either maintains existing conditions or promotes growth from commercial/industrial to mixed use (Square Lakes Subarea Plan, 2022). The proposed vertical alignment maintains the same crown of pipe elevation as existing sanitary sewer through the floodway. The Square Lakes area is generally not in the COA service area and thus there is no impact.

### 3.8.4 Description of the surrounding and /or impacted community(ies).

The proposed project follows Tennyson St. from I-76 to W. 61<sup>st</sup> Place. The area adjacent to Tennyson St. has a strong existing community of residents, employees, and business owners who have a great appreciation for the existing assets and community character.

At the north end of the project, the community is composed of low to medium density residential neighborhoods. Populations in this area fall under zip code 80002 and 80003. In zip code 80003, the median household income is \$79,402, employment rate is 67.9%, and 33% have a bachelor's degree or higher. In zip code 80002, the media household income is \$87,500, employment rate is 72.4%, and 42.7% have a bachelor's degree or higher. <sup>1</sup>

In the central part of the project, surrounding the railroad corridor, there is a mix of residential and commercial enterprise to the west side of Tennyson St. and public land (Clear creek valley Park) to the east. Moving further south, mixed commercial and industrial areas lie to the west of Tennyson St. and public land (Hyland Hills Park) borders Tennyson St. to the east. While these communities will be impacted by construction temporarily, no long-term effects to the community are anticipated.

### 3.8.5 Description of the surrounding and/or impacted Cultural Resources.

No known cultural resources will be impacted. All work will occur within Tennyson St. ROW on which land has been previously disturbed.

### 3.8.6 Description of existing and unique agricultural land in the area.

There is no existing or unique agricultural land in the project vicinity.

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<sup>1</sup> ZCTA5 80002. (2020). Retrieved from United States Census Bureau:  
<https://data.census.gov/profile/80002?g=860XX00US80002>



### 3.9 LOCAL GOVERNMENT SERVICES (#18)

3.9.1 Description of existing capacity of and demand for local government services including roads, schools, water and wastewater treatment, water supply, emergency services, transportation, infrastructure, housing, law enforcement, and other services necessary to accommodate Development.

No impact to demand for government services is anticipated. The Contractor is required to submit a traffic control plan to ADCO prior to construction. All work for this project will be installed under the roadway and the existing roadway will be restored to its previous condition.

3.9.2 Description of the impacts and Net Effect of the Project on the demand for local government services and the capability of local governments to provide services.

A traffic control plan will be implemented during construction which may temporarily impede traffic. The Contractor is required to submit a traffic control plan to ADCO prior to construction. No long-range impact to demand for government services is anticipated. All work for this project will be installed under the roadway and the existing roadway will be restored to its previous condition.

3.9.3 Description of the potential effect on the existing transportation network including, but not limited to: road hierarchy, circulation system, road connections, right-of-way dedications, conformance with Adams County engineering standards, road access, alignment of roads, intersections, sidewalks and trails, pedestrian access, parks and open space.

Temporary changes to traffic flow may occur during construction. The Contractor is required to submit a traffic control plan to ADCO prior to construction. No permanent effects to the existing transportation network are expected. Tennyson St. and the adjacent areas will be returned to previous condition.

### 3.10 FINANCIAL BURDEN ON COUNTY RESIDENTS (#19)

3.10.1 Description of the existing tax burden and fee structure for government services including but not limited to assessed valuation, mill levy, rates for water and wastewater treatment, and costs of water supply.

The project will not impact the tax burden or fee structure for any government services except municipal wastewater discharge and only for customers within the service area which are already subject to rates and fees established by Arvada City Council.

3.10.2 Description of impacts and Net Effect of the Project on existing tax burden and fee structure for government services applicable to County residents and property owners.

The project will not impact the tax burden or fee structure for any government services except municipal wastewater discharge and only for customers within the service area which are already subject to rates and fees established by Arvada City Council.

### 3.11 LOCAL ECONOMY (#20)

All work for this project is occurring within Tennyson St. ROW. No changes to the existing businesses, public land, or residential areas are projected. No infrastructure impacting local economy is being built and therefore this section is not applicable.

#### 3.11.1 Description of the local economy including but not limited to revenues generated by the different economic sectors, and the value or productivity of different lands.

This section is not applicable.

#### 3.11.2 Description of impacts and Net Effect of the Project on the local economy and opportunities for economic diversification, including the number and types of jobs created.

This section is not applicable.

#### 3.11.3 Description of jobs created as a result of the Project.

This section is not applicable.

#### 3.11.4 Description of income potential from jobs created by or as a result of the Proposed Project.

This section is not applicable.

### 3.12 ENVIRONMENTAL IMPACT REVIEW (#22)

#### 3.12.1 Description of the existing natural environment and an analysis of the impacts of the project to the natural environment.

There are several public open spaces adjacent to Tennyson St. in the vicinity of the project. While these open spaces were once natural, they have since been altered for public use. Spaces adjacent to Tennyson St. include Tennyson Knolls Park, Jim Baker Reservoir, and Clear Creek Valley Park.

Tennyson Knolls Park lies between W 63<sup>rd</sup> Avenue and W 61<sup>st</sup> Place. This park lies to the northwest of work that is occurring within Tennyson St. ROW and no impacts to this space are anticipated.

Jim Baker reservoir lies to the east side of Tennyson St., between W 61<sup>st</sup> Place and W 60<sup>th</sup> Avenue, adjacent to the project. Along the west side of Jim Baker, USGS categorizes 6.49 acres of water as Freshwater Emergent wetland and is classified as PEM1C. For the rest of the 53.51 acres of the reservoir, USGS categorizes this is a lake habitat classified as a L1UBHx. One potential impact to Jim Baker Reservoir exists: construction stormwater discharge. To mitigate this potential impact, a stormwater management plan has been developed in accordance with COA and ADCO standards. Additionally, a CDPHE construction stormwater discharge permit will be acquired ahead of the project.

Between W 58<sup>th</sup> Place and State Highway 76 lies Clear Creek Valley Park, with 7 bodies of water that fall within the property. Six of the bodies of water are categorized as freshwater ponds and are classified as PABGx, cumulating of 29.02 acres. One body of water (0.91 acre) is categorized as a freshwater emergent wetland and classified as a PEM1C. Similar to the Jim Baker Reservoir, construction



stormwater discharge has the potential to impact this area. To mitigate this potential impact, a stormwater management plan has been developed in accordance with COA and ADCO standards. Additionally, a CDPHE construction stormwater discharge permit will be acquired ahead of the project.

In addition to the open spaces listed above, there is an existing stormwater swale on the west side of Tennyson St. extending from the railroad corridor to I-76. This swale will be disturbed in the construction of the project. Best management practices as outlined in the SWMP and Erosion and Sediment Control Plans (Appendix A ) will be used to convey stormwater during construction and restore the swale to previous or better condition.

At the time that the south portion of the project is under construction, the existing storm swale will be disturbed in order to remove and replace the existing trunkline. The storm swale will be reestablished whenever possible at the end of each day. A large pipe will be provided to aid in stormwater conveyance across the swale when construction activities may block the flow of water. Pumps will also be kept onsite at all times for the removal of accumulated water as needed. If any overflow does occur, a street sweeper will be kept onsite to ensure that the road is clear.

Additionally, the swale will be temporarily supported with berms on each side. An erosion control blanket or mulch control netting will line the channel to minimize erosion potential during construction. After construction is complete, the swale will be returned to existing conditions as defined in the contract documents.

**3.12.2 Descriptions in this section shall be limited to the Impact Area, and shall include an analysis of existing conditions, supported with data, and a projection of the impacts of the project in comparison to existing conditions.**

Existing conditions in parks and open spaces include moderate vegetative coverage, wetlands, and some tree coverage. No impact is anticipated in these areas beyond temporary construction stormwater discharge to be managed in accordance with ADCO, Arvada, and CDPHE standards.

The project area immediately enters the ADCO Separate Storm Sewer (MS4) Conveyance system, which includes large diameter stormwater piping and drainage swales. The ultimate receiving water for stormwater entering this system is Clear Creek. Stormwater is conveyed via ADCO stormwater system and enters a buffer zone of at least 50 feet upstream of its discharge into Clear Creek. This construction project is also within COA, which has a Phase II MS4 Permit from the State of Colorado.

There are some grasses present in the existing storm swale on the south end of the project. Vegetative coverage is approximately 65% based on aerial data. This area will necessarily be disturbed during construction. During final stabilization, the area will be seeded and mulched. Otherwise, no significant impact to vegetation is anticipated.

3.12.3 The analysis shall include a description of how the Applicant shall comply with the Applicable Approval Criteria in Section 6-17.

*3.12.3.1 Air Quality*

Current air quality in the area is “good” according to the Colorado Department of Public Health & Environment (CDPHE) website. There may be dust emissions from cutting concrete, but no prolonged exposure is expected. Construction precautions include but are not limited to wet saws or water-cooled blades, PPE and providing ample ventilation such that the cloud will not impact the surrounding environment.

*3.12.3.2 Visual Quality*

The ground cover includes concrete pavement, curb restoration, gravel, and asphalt restoration. No trees, canopies, waterfalls, streams, and vegetation will be affected by the project. Scenic vistas include Jim Baker Reservoir and Clean Creek Valley Park. All work is occurring underground within Tennyson St. No disturbance to visual quality to the area will occur.

*3.12.3.3 Surface Water Quality*

This project comes into contact with Clear Creek Segment ID COSPCL15\_C: mainstream of Clear Creek from Wadsworth Blvd to the confluence with the South Platte River. This stream segment is listed by CDPHE as impaired on the 303(d) list. The parameters of impairment include E. coli, manganese, organic sediment, temperature, and arsenic. Erosion and sediment control plans have been generated to direct the contractor to prevent any contaminants from entering the stream. Any water incurred from dewatering activities will be treated prior to discharge to Clear Creek per CDPHE requirements. Construction is not expected to increase the prevalence of any of the parameters of impairment beyond existing levels. The project team is prepared to manage both stormwater and water from dewatering activities to ensure protection of Clear Creek from any immediate water quality impacts. The amount of water anticipated is such that quantity of water will not be significantly changed. No long-term impacts to Clear Creek are anticipated.

*3.12.3.4 Groundwater Quality and Quantity*

Groundwater in the region is heavily influenced by the Rocky Mountains to the west and the local rivers, creeks, and drainages. Groundwater generally flows west to east from the foothills with more localized flow towards and along waterbodies. The Arvada area has semi-confined, unconfined, and perched aquifers within surficial sediments and confined and semi-confined aquifers in bedrock. The historically meandering and braided easterly-flowing rivers have significant influence on the local groundwater levels and hydrogeology. The unconfined aquifer groundwater levels are generally greater in the immediate vicinity of waterbodies such as rivers, creeks, and irrigation ditches and decreases with distance away from waterbodies.

Groundwater was encountered during the subsurface investigation. Borings were converted to temporary monitoring wells to characterize long term groundwater levels and collect groundwater



samples to test for contaminants. See Figure 4 for visual of water levels at the railroad crossing. Groundwater should be expected to fluctuate based on precipitation, localized irrigation, water levels in nearby water bodies and irrigation ditches, site development, and seasonal variations. In this case, groundwater is likely hydrologically connected to local water bodies (including Clear Creek). Removing groundwater during construction dewatering and discharging to Clear Creek is not expected to produce any measurable effect on quantity of water in the system and is governed by the CDPHE permit.

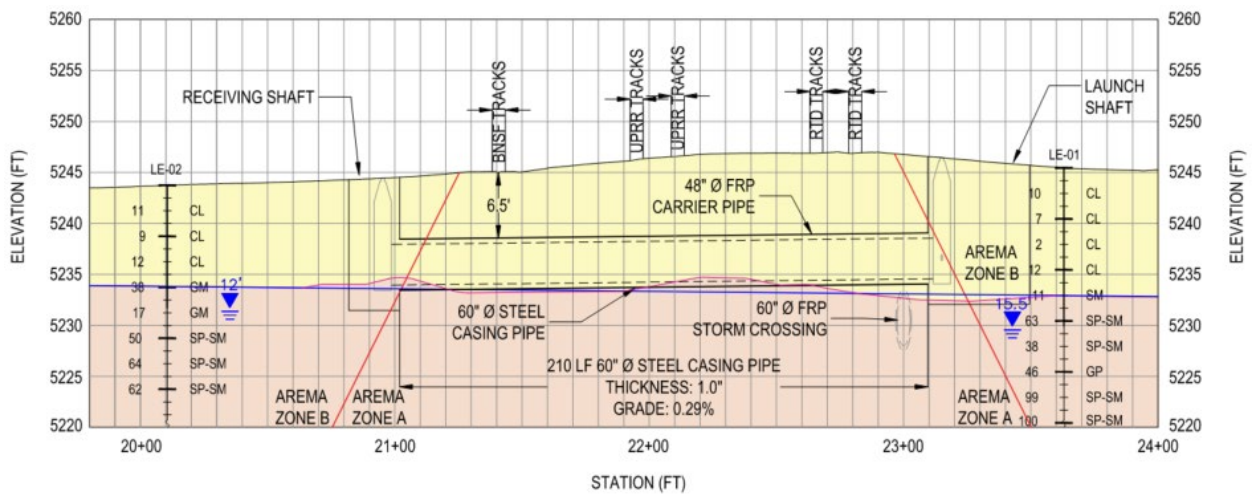


Figure 4: Geologic Profile - Railroad Crossing (Lithos Engineering, Geotechnical Baseline Report - North Trunk Sewer Improvements Tennyson and 58th)

Further detail on subsurface investigation can be found in the Geotechnical Baseline Report and Geotechnical Data Report in the Project Specifications. Further information on Dewatering activities and requirements can be found in Specification Section 02140.

### 3.12.3.5 Wetlands and Riparian Areas

Jim Baker Reservoir and Clear Creek Valley Park have categorized wetland areas as shown in the USGS National Wetlands Inventory Map (Appendix F) and described in the following section. No long-range impacts to these areas are anticipated. Temporary dewatering discharge and construction stormwater discharge will be managed through the SWMP, and CDPHE Construction Dewatering Discharge Permit as described in Sections 3.12.1 and 3.12.2.

Jim Baker Reservoir is classified as a L1UBx. L1UB has the following definition: System Lacustrine (L) subsystem Limnetic (1) which is defined by a wetland and deepwater habitat that is less than 2.5m (8.2) feet below the Lacustrine system. It's considered class Unconsolidated Bottom (UB) which includes all wetlands and deepwater habitats with at least 25% of cover of particles smaller than stones and a vegetative cover less than 30%. The water regime Permanently Flooded (H) consists of water that covers the substrate throughout the year in all years. The special modifier Excavated (X) is used to identify wetland basins or channels that were excavated by humans.

The western most side of the Jim Baker Reservoir and one of the bodies of water in Clear Creek Valley Park classify as PEN1C. They consist of 6.49 acres and .091 acres respectively, of freshwater emergent wetland classified by PEM1C. System Palustrine (P) includes nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts below .5 ppt. Class Emergent (M) is characterized by erect, rooted, herbaceous hydrophytes, excluding mosses and lichens. Subclass persistent (1) is dominated by species that normally remain standing at least until the beginning of the next growing system. This subclass is found only in the Estuarine systems. Water Regime Seasonally Flooded (C) is surface water is present for extended periods especially early in the growing season, but is absent by the end of the growing season in most years.

The rest of the Clear Creek Valley Park waters are categorized as 29.02 acres of freshwater pond habitat that is classified as PABGx. System Palustrine (P) includes all nontidal wetlands dominated by trees, shrubs, persistent emergent, emergent mosses or lichens, and all such wetlands that occur in tidal areas where salinity due to ocean-derived salts below .5ppt. Class Aquatic bed (AB) includes wetlands and deepwater habitats dominated by plants that grow principally on or below the surface of the water for most of the growing season in most years. Water Regime intermittently Exposed (G) water covers the substrate throughout the year except in years of extreme drought. Special Modifier Excavated (x) is used to identify wetland basis or channels that were excavated by humans.

#### *3.12.3.6 Terrestrial and Aquatic Animals and Habitat*

The US Fish and Wildlife Service's GIS map of Threatened and Endangered Species with Critical Habitat was investigated to determine if any critical habitat exist in the area (Appendix F ). No critical habitat or endangered species were found. No habitat will be disturbed in this project- all work will occur within the Tennyson St. right of way.

#### *3.12.3.7 Terrestrial and Aquatic Plant Life*

The National ESA (Endangered Species Act) Critical Habitat Mapper (Appendix F ) was investigated to determine if any critical habitats exist in the area. No threatened or endangered plant species or habitat have been found in the area. No habitat will be disturbed in this project- all work will occur within the Tennyson St. right of way.

#### *3.12.3.8 Soils, Geologic Conditions and Natural Hazards*

The geologic conditions in the area are characterized by surficial materials consisting of alluvial deposits within the historic floodplain of Clear Creek, mapped by Lindvall (1979) as Post Piney Creek Alluvium. These soils overlie interbedded sandstone, siltstone, and claystone bedrock of the Denver Formation (Lindvall, 1979). The project site is located within the Colorado Piedmont section of the Great Plains Physiographic Province. The piedmont, being an erosional inlier, consists of arid plains that are lower than the foothills to the west and slightly lower than the Great Plains to the east. During periods of uplift of the Rocky Mountains, younger sedimentary rock units were eroded and transported by streams and

rivers to the piedmont. As rivers have historically meandered, alluvium was deposited in a broad swath across the plain.

All work is occurring in previously disrupted ground. Over a dozen different utilities already exist under Tennyson St. No negative impact to soil and geologic conditions is expected. Additional information on soil and geologic conditions can be found in the Geotechnical Bore Report and Geotechnical Data Report in Appendix A .

#### *3.12.3.9 Nuisances*

Noise – Some general construction noise from heavy equipment can be expected during normal working hours. During the tunneling portion of the project a diesel-powered auger machine will need to run 24/7 once the auger bore enters Railroad Zone A. This is expected to last for approximately 1 week. The auger machine will be placed at the bottom of the launch pit on the North side of the Railroad tracks at a depth of approximately 13'-14'.

Glare – Glare is not anticipated.

Dust – During excavation/backfilling operations a water truck will be on-site with a hose to dampen the soil so that blowing dust is not an issue.

Fumes – Normal exhaust from heavy equipment can be expected. Due to the open nature of this work area, we do not anticipate exhaust being an issue.

Odor – The sanitary sewer bypass will contain associated odors from the sewage. Any odors from this will only be possibly noticed if standing next to the bypass or pumps which are within the construction area.

#### *3.12.3.10 Areas of Paleontological, Historic or Archaeological Importance*

No sites of paleontological, historic, or archaeological interest have been found. All work is occurring in the Tennyson St. right of way in previously disrupted ground.

#### *3.12.3.11 Hazardous Materials Description*

No hazardous materials are planned for this work apart from normal vehicle & equipment fluids. Those fluids include gasoline, diesel, motor oil, & hydraulic fluids. The trucks will be fueled off-site at service stations while the heavy equipment will be fueled daily from a mobile fueling truck. While every precaution is taken to minimize spills, spill kits are included on all trucks in the event of a spill.

#### *3.12.3.12 Balance Between Benefits and Losses*

No foreseeable benefits/losses of natural, agricultural, recreational, range, or industrial resources within County are expected.

### ***3.12.3.13 Monitoring and Mitigation Plan***

Groundwater will be collected in a 21,000 gallon frac tank. The frac tank will be placed on a containment liner with overflow protection measures that will include a separate submersible pump located inside the containment. The trailer mounted groundwater treatment system will be placed on a containment liner. A chlorination pump will inject Sodium Hypochlorite into the frac tank to oxidize dissolved and potentially dissolved metals. After the frac tank, the groundwater will be pumped through the treatment system using a skid mounted, electric powered transfer pump with VFD. Groundwater will be directed through a silica sand filter to remove insoluble metals and solids. After the silica sand filter, groundwater will enter a Manganese Oxide Greensand Plus Filter housing for the removal of Manganese. Water will enter duplex bag filter housings with 25 Micron bag filters and 10 Micron bag filters to remove macro and microparticulate Total Suspended Solids. A separate injection of Sodium Bisulfite will remove Total Residual Chlorine prior to entering the Granular Activated Carbon vessels. An anion exchange vessel will be utilized to remove Potentially Dissolved Selenium and a cation resin vessel will be utilized to remove potentially dissolved cation metals (Lead). A flowmeter will be installed at the end of the treatment system to record flow rates and total volume discharged.

### **3.13 EROSION AND SEDIMENT CONTROL PLANS (SUPPLEMENTAL ITEM #3)**

Erosion and sediment control plans can be found in Grading, Erosion, and Sediment Control Sheets EC-601 through EC-653 of the Design Drawings (Appendix A ).

### **3.14 CONSTRUCTION / ENGINEERING DESIGN PLANS (SUPPLEMENTAL ITEM #4)**

Engineering Design Drawings and Specifications can be found in Appendix A .

### **3.15 MAJOR WATER AND SEWER PROJECTS (SUPPLEMENTAL ITEM #5)**

The following requirements shall apply to Major Water and Sewer Projects:

- 3.15.1 Description of existing Domestic Water and Wastewater Treatment Systems in the vicinity of the Project, including their capacity and existing service levels, location of intake and discharge points, discharge permit requirements, service fees and rates, debt structure and service plan boundaries and reasons for and against connecting to those facilities.**

The City of Arvada provides water and sewer service within the City limits.

The North Trunk Line Segment 10 is the only large diameter wastewater pipeline in the vicinity of the project capable of conveying wastewater from northern Arvada to the Metro Water Recovery meter vault at the south end of the project. COA does not own or operate facilities with wastewater treatment processes and all wastewater collected in the North Trunk line is conveyed to Metro Water Recovery for treatment.





Various service lines discharge into the trunk line where the project is proposed. There are no additional wastewater systems within the vicinity of the project viable for consolidation. Rehabilitation and upsizing is the only feasible course of action (see 3.6.2 for alternatives analysis).

Crestview Water and Sanitation District is on the east side of Tennyson between Hidden Lake and West 60th Avenue. Their wastewater generally flows to the east - not towards Tennyson.

Berkeley Water and Sanitation District is between Sheridan and Tejon, generally between 52nd and 60th. Berkeley does not provide service within Arvada City limits. Berkeley does not have a sewer collection system in the vicinity of this project. The City of Arvada generally does not provide service outside of City limits per City Code section 102-51, with rare exceptions including a service at 6162 Tennyson St.

Denver Water provides water service to Berkeley and Crestview. Transmission and service lines affected by the project are owned by the City of Arvada. All service lines owned by Denver Water will remain as is.

Locations of intakes and discharge points are not within the vicinity of the project and this information is thus not applicable to this application. Additionally, rates and fees of districts outside the City of Arvada are not applicable to this application as the proposed replacement of the North Trunk line is not an expansion of the City's wastewater collection system. The City cannot connect to Crestview (pipes are not sized for this capacity) or Berkeley (there are no sewer pipes) and thus, providing details on these systems is not applicable.

### **3.15.2 Description of other water and wastewater management agencies in the project area and reasons for and against consolidation with those agencies.**

See section 3.15.1.

The City's wastewater collection system is conveyed to Metro Water Recovery, a regional wastewater management agency. The existing sewerline connects to a Metro Water Recovery metering vault on Tennyson north of Highway 76. The NT10 project will include the installation of a new metering vault capable of accepting the increased flows from the larger diameter wastewater pipe.

### **3.15.3 Description of how the Project may affect adjacent communities and users of wells.**

This project does not impact Berkeley nor Crestview users. This project does not impact groundwater as it is a pipe replacement project. This project will have traffic control impacts during construction but has no long term impacts different from the presence of the existing pipeline.

### **3.15.4 Description of demands that this project expects to meet and basis for projections of that demand.**

Demand modeling performed by COA for the SSMP is included in Appendix D.



**3.15.5 Description of efficient water use, recycling and reuse technology the Project intends to use.**  
This project is a replacement sewer project and thus, this section is not applicable.

**3.15.6 Description of how the Project will affect urban/rural development, urban/rural densities, and site layout and design of storm water and sanitation systems.**

The project is a replacement sewer that has no long-term impact to the County as it serves COA. This project is required to serve planned development within the City as outlined in the City's Comprehensive Plan. While this project will not affect urban/rural development in the County, if this project is not approved and constructed, there will be direct and near-term impacts on housing and commercial development plans in the City. There will be no permanent effects to Tennyson St or the surrounding neighborhoods following the completion of construction.

**3.15.7 Map and description of other municipal and industrial water projects in the vicinity and a discussion of how the project will compete with or duplicate those services in the County.**

This project does not compete with or duplicate water and sewer projects as the project only serves the COA, per City Code section 102-51. A few properties outside City limits are served by prior agreement but as there is no sewer service in the general area of the project, this is not a duplication of services.



## 4 ADCO PRELIMINARY REVIEW COMMENTS

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### 4.1 ECONOMIC DEVELOPMENT REVIEW

**Comment:** The current proposed NTS design would hinder future commercial development in the Square Lake Subarea due to the impact the sanitation line would have on the proposed regional drainage facilities near Clear Creek. The subject area is currently zoned I-2 with a future land use designation of Commercial and Mixed Use. This area is intended to be an employment center with TOD development potential because of connectivity via the Gold Strike RTD Station. The ADCO Economic Development team has already been engaged with the Arvada Economic Development Association and several of the property owners in the Square Lake Subarea. The applicant should continue to collaborate with all stakeholders to determine a solution with minimal impact to the commercial properties and business owners.

**Response:** Noted. The design maintains the same elevations for pipe crown, thus there is no impact to the 30% conceptual drainage plan.

## 4.2 PLANNER REVIEW

### PLN01:

The sewer improvements being proposed are subject to an Areas and Activities of State Interest Permit, pursuant to Section 6-06-01 of the ADCO Development Standards. In lieu of a permit application and review as provided by these regulations, the County may elect to negotiate an intergovernmental agreement for activities of state interest.

**Response:** Noted. Final plans and specs will be submitted to ADCO engineering for review/comment. ADCO review/comments will be addressed in subsequent submittal(s).

Additionally, Chapter 6 does not define a replacement sewer pipe (even a bigger pipe) that serves the same area as an expansion or a major extension. COA's position is that we are not doing a major extension or expansion of our system - rather we are right-sizing the infrastructure to handle our already defined service area for estimated build-out flows. Additionally, as the project is using the same corridor, including staying within existing right-of-way, COA is not changing any basic characteristics of the project environment (re 6-02-24).

Further, Chapter (6-02-44) defines Major Extension of Domestic Sewage Treatment System as modifications intended to serve a PROPOSED project or service area. This project will serve the existing COA service area - not new service area.

### PLN02:

If an Areas and Activities of State Interest Permit is pursued instead of a IGA, then the submittal requirements of Section 6-07 and 6-08-01 shall apply. These permits require public hearings before both the Planning Commission and Board of County Commissioners.

**Response:** In the interest of intergovernmental cooperation, COA is submitting this package as part of an IGA process.

### PLN 03:

If an Intergovernmental Agreement is pursued, the agreement will be heard before only the Board of County Commissioners. The following conditions must be met:

1. COA and the County must both be authorized to enter into the intergovernmental agreement.
2. The purpose, intent, and applicable criteria of Section 24-65.1-101, et seq., C.R.S. and of these regulations must be satisfied by the terms of the intergovernmental agreement.



3. A neighborhood/scoping meeting shall be held by COA, and a summary addressing the concerns of the neighborhood shall be submitted by the Applicant to the Community and Economic Development Department which shall include, but is not limited to, the names, addresses, telephone numbers, and concerns. The neighborhood/scoping meeting summary shall be submitted to the Community and Economic Development Department along with a presubmittal meeting application prior to the scheduling of a public hearing. The boundaries of the residents notified for the neighborhood/scoping meeting shall be determined by the Community and Economic Development Director or designee and shall not be less than 500 feet from the property lines of the location of the Proposed Project.
4. A public hearing must be conducted by the Board to publicly review and approve the proposed intergovernmental agreement. Notice of the public hearing shall be published once at least 30 and not more than 60 days prior to the hearing in a newspaper of general circulation in the County. Property owners within a minimum of 500 feet from the property lines of the location of the Proposed Project shall be notified by the Community and Economic Development Department of the date and time of the public hearing not less than 14 calendar days prior to the Board of County Commissioners hearing date.
5. Both the Board and COA must approve the intergovernmental agreement in the manner required by those entities.
6. Exercise of the provisions of this Section 6-16 by the State or political subdivision shall not prevent the entity from electing at any time to proceed under the permit provisions of these regulations.
7. Nothing in this Section 6-16 shall be construed to waive the applicability of these regulations or to create in the State or any political subdivision a right or interest to an intergovernmental agreement with the County.

**Response:** Noted. COA is pursuing an IGA.

**PLN04:** In approving an AASI permit, the criteria found in 6-17-01 and 6-17-02-01 must be met.

**Response:** COA is pursuing an IGA in lieu of an AASI permit. However, the criteria set forth in sections 6-17-01 and 6-17-02-01 are considered to be met within the 1041 Applicable Section Responses provided in this document.



### 4.3 ENVIRONMENTAL ANALYST REVIEW

**ENV1A:** The subject parcel is a CDPHE Covenant and Institutional Control Site. CDPHE must be contacted and documentation provided to ADCO for review.

API Investments LLC II  
Institutional Control ID RSNOT00075

From CDPHE:

"The proposed use restrictions limit human exposure to methane producing material which has been used for fill at the site and an upgradient diesel spill impacting the property."

"Notification for proposed construction and land use. OWNER shall notify the Department simultaneously when submitting any application to a local government for a building permit or change in land use."

Mr. Fonda Apostolopoulos, VCRA Program  
Hazardous Materials and Waste Management Division  
Colorado Department of Public Health and the Environment  
4300 Cherry Creek Drive South  
Denver, Colorado 80246-1530

**Response:** The environmental covenant site is depicted in Figure 4. Per email from Mr. Apostolopoulos (Appendix G ): "Since you will be working in an area outside of the environmental covenant, the state has no authority to review your work plans."

The contractor has been notified of the existence of the covenant site and additional precaution will be taken to ensure the safety of workers in the area during construction.

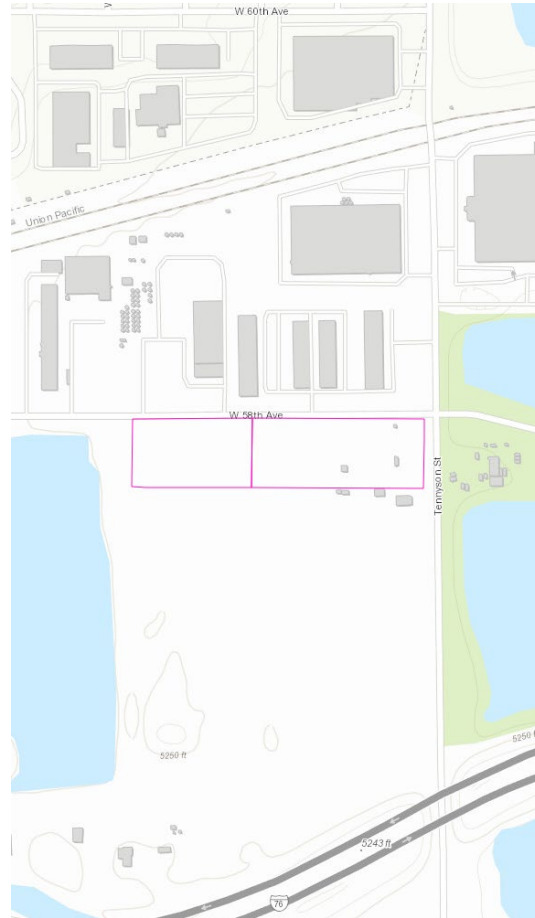


Figure 5: CDPHE Institutional Controls Environmental Covenant Site Map

**ENV1:** Projects with wastewater collection that have domestic wastewater treatment works (e.g., treatment plant, interceptor sewer, or lift station) with a design capacity to receive greater than 2,000 gallons per day (gpd) and are subject to state-wide site location, design, and permitting requirements implemented by the CDPHE Water Quality Control Division. State review and approval of the site location application and design is required by the Colorado Water Quality Control Act, Section 25-8-702, C.R.S., which states in part that: “No person shall commence the construction of any domestic wastewater treatment works or the enlargement of the capacity of an existing domestic wastewater treatment works, unless the site location and the design for the construction or expansion have been approved by the division.”

**Response:** Site Location and Design Regulations for Domestic Wastewater Treatment Works, 5 CCR 1002-22 (Regulation 22) has been approved by CDPHE as of 01/30/24 and can be found in Appendix G .

**ENV2:** The proposed project would need to meet all applicable regulatory requirements including, but not limited to, site location and design review, discharge permitting, having a certified operator, and routine monitoring and reporting. For questions regarding domestic wastewater regulation applicability or other assistance and resources, visit these websites: <https://cdphe.colorado.gov/design>

<https://cdphe.colorado.gov/clean-water-permitting-sectors>

**Response:** CDPHE approval for interceptors requires (1) Site Location Decision and (2) a self-certification letter. Site Location and Design Regulations for Domestic Wastewater Treatment Works, 5 CCR 1002-22 (Regulation 22) has been approved by CDPHE as of 01/30/24. The self-certification letter is pending final design.

CDPHE approval constitutes adherence to Wastewater Design Criteria Policy WPC-DR-1. The “Clean Water Permitting Sectors” guidance is not applicable to this project as no discharge to the environment will occur.

The metering vault will be owned by Metro Water Recovery (Metro). Metro is permitted to operate wastewater treatment facilities and the vault has been designed per their standards. Final design and construction is contingent upon Metro approval. This project upgrades existing sanitary sewer and metering vault which are currently subject to all applicable regulatory requirements. No change to existing operation, monitoring, and reporting is expected to occur.

**ENV3:** The subject parcel is located within both the Federal Emergency Management Agency (FEMA) 100-year floodplain and 100-year floodway.

**Response:** Floodplain permits are being acquired from both COA and ADCO. This project does not impact existing grading or drainage in this area. All work occurs within the Tennyson St. right of way. A small section occurs toward the edge of the right of way on the south end of the project near a storm water swale. All grading and drainage will be returned to previous condition. See Appendix A for SWMP and Erosion Control Sheets.

**ENV4:** Adams County Health Department (ACHD) has requirements for sewer systems in the floodplain. It would follow that bulk sewer piping would require the same or greater regulation based on the quantity and capacity of wastewater flow. ACHD and FEMA requirements must be determined and followed for this proposed project, and documentation provided for ADCO review.

**Response:** The requirements for sewer systems in the floodplain apply to onsite wastewater treatment systems (OWTS). This project does not include an OWTS. See response to ENV5 below and email response from Brian Mead located in Appendix G . He states: “your project does not involve an onsite wastewater treatment system, so section 11.1 of the O-22 regulation does not apply to this sewer line project.”



**ENV5:** According to ACHD Regulation O-22, Section 11.11 Floodplains: A. A new, expanded, or repair/replacement OWTS installed in a 100-year floodplain must meet or exceed the requirements of the FEMA and the local emergency agency. Repairs of an existing system must meet the requirements as feasible. The system as approved must be designed to minimize or eliminate infiltration of floodwaters into the system and discharge from the system into floodwaters. B. A new or expanded OWTS must not be installed in a floodway designated in a 100-year floodplain where a conforming OWTS outside the floodway can be installed. For any new OWTS or system repair that may affect the floodway delineation, appropriate procedures must be followed including revision of the floodway designation, if necessary. The regulation can be found here: <https://adamscountyhealthdepartment.org/septic-rules-and-regulations>

**Response:** Per Regulation O-22, an OWTS is defined as: On-Site Wastewater Treatment System - or OWTS and, where the context so indicates, the term System - means an absorption system of any size or flow or a system or facility for treating, neutralizing, stabilizing, or dispersing sewage generated in the vicinity, which system is not a part of or connected to a sewage treatment works. This project does not include an OWTS per the definition above. This trunkline is connected to a Metro Water Recovery interceptor that conveys wastewater to Metro's treatment facility.

**ENV6:** Applicant will be required to implement dust control measures to prevent off-site impacts if traffic into and within parcel(s) occurs on non-paved surfaces.

**Response:** Project specification include dust requirements include dust control measures requirements. See section 01500 Construction Facilities and Temporary Controls of the design specifications in Appendix A .

**ENV7:** Applicant should limit engine idling to the maximum extent feasible to mitigate off-site noise and air quality impacts to surrounding properties. (Refer to CRS Title 42 – Vehicles and Traffic Idling Standard, Article 14 – State Idling Standard, Section 42-14-105. Idling for Colorado law.)

**Response:** Project requirements include limiting construction noise to 50 dB overnight and 80 dB during construction hours (7:30-3:30). See specification section 01500 Construction Facilities and Temporary Controls in Appendix A . Contractor is required to submit and receive approval of a traffic control plan with ADCO prior to proceeding with the work in ADCO ROW.

#### 4.4 DEVELOPMENT ENGINEERING REVIEW

**ENG1:** Flood Insurance Rate Map – FIRM Panel # (08001C0591H,) Federal Emergency Management Agency, March 5, 2007. According to the above reference, the project site IS located within a delineated 100-year flood hazard zone; A floodplain use permit will be required.

**Response:** Floodplain permits are being acquired from both COA and ADCO.

**ENG2:** The project is located within the boundaries of the following regional drainage studies:

Major Drainageway Planning, Phase A Development of Alternative Plans for Clear Creek, Prepared for Adams County, Urban Drainage And Flood Control District (now Mile High Flood District), Jefferson County, City and County of Denver, City of Golden and City of Wheat Ridge, COA. Prepared by Icon Engineering, February 2007.

Clear Creek Phase B Update 2008, Prepared for Adams County, Urban Drainage And Flood Control District (now Mile High Flood District), Jefferson County, City and County of Denver, City of Golden and City of Wheat Ridge. Prepared by Icon Engineering, February 2008.

Utah Junction Stormwater Outfall Systems Plan Adams County, Colorado, Prepared for Urban Drainage and Flood Control District (now Mile High Flood District), Adams County. Prepared by Hydro-Triad, LTD, March 1991

For the regional drainage facilities mentioned in the studies listed above, it is recommended that the applicant either avoid them or install the line to a depth below the facility to provide sufficient cover and avoid potential utility conflicts. Show these regional facilities on the plans.

**Response:** Noted, see responses to comment ENG3 related to the proposed drainage plans associated with the Square Lakes Development. This project is a replacement of existing sanitary infrastructure. Modifications to existing pipe crowns are minimal and there is no proposed grading with this project. Modifications to existing drainage pathways are not included in this project as all work is within the existing Tennyson right of way. Final Plans and specifications will be submitted to ADCO engineering for review and approval.

A visual representation of the existing pipe is shown in Appendix H in relation to the proposed pipeline. Crowns of pipe are matching. No significant change to the existing condition of the pipe and floodplain are proposed.

**ENG3:** Per comment ENG2 above, the proposed sanitary sewer plans appear to be in direct conflict with the proposed regional drainage facilities that have been identified in the area of Tennyson Street and

Clear Creek. How will the proposed sanitary sewer improvement project accommodate these future drainage improvements along the Clear Creek?

**Response:** Final Plans and specifications will be submitted to ADCO engineering for review and approval.

1. The crown of the proposed new pipe matches the crown of the existing pipe.
2. The 30% design shown on the 2008 Clear Creek MDP is not best engineering practice and is not constructable. Therefore, a proposed new pipe that matches crown elevation of the existing sewer is not a conflict. The 2008 Clear Creek MDP also states that "It should be noted that the bridge height is controlled by the presence of a 30-inch sanitary sewer upstream of the bridge crossing location. Relocation alternatives for this sanitary line did not appear feasible, since the sewer connects directly into the parallel interceptor lines north of Interstate 76."
3. There is new hydrology for this section of Clear Creek. To COA knowledge, the section has not been analyzed with the new hydrology. Given that the new hydrology is significantly less, there is likely not a conflict with the future intent/design with the new hydrology.
4. The existing pipe is at end of life and is undersized for CURRENT flows. The COA project timeline is intended to mitigate existing environmental risk and needs to proceed on the proposed timeline.

**ENG4:** The applicant shall be responsible to ensure compliance with all Federal, State, and Local water quality construction requirements. In the event that the disturbed area of the site exceeds 1 acre and the site is within the Adams County MS4 area, then the applicant shall be responsible to prepare the SWMP plan using the Adams County ESC Template, and obtain both a County SWQ Permit and State Permit COR400000.

The site is located within the Adams County MS4 permit area, and appears to disturb over one (1) acre(s) of area. An Adams County SWQ Permit is required for development of this site. The applicant should contact Juliana Archuleta, the County's Stormwater Program Manager, to inquire about obtaining a SWQ Permit. Ms. Archuleta can be contacted at 720-523-6869 or By email at [mjarchuleta@adcogov.org](mailto:mjarchuleta@adcogov.org).

**Response:** A Stormwater Management Plan has already been formulated under COA (Appendix A ). An additional plan, adhering to ADCO standards will be generated and submitted to ADCO for approval prior to construction. A CDPHE Construction Stormwater Discharge Permit (COR400000) will also be acquired prior to construction.

**ENG5:** Prior to the issuance of any construction permits, the applicant will be required to submit for review and receive approval of all construction documents (construction plans and reports). All construction documents must meet the requirements of the Adams County Development Standards and



Regulations. The developer shall submit to the Adams County Development Review Engineering division the following: All Construction plans for work in un-incorporated Adams County, Engineering Review Application, Engineering Review Fee. The Development Review fee can be found in the Development Services Fee Schedule, located on the following web page: <http://www.adcogov.org/one-stop-customer-center>.

**Response:** Final Plans and specifications will be submitted to ADCO engineering for review and approval accompanied by the engineering review fee.

**ENG6:** The developer is responsible for the repair or replacement of any broken or damaged section of curb gutter and sidewalk or other County owned infrastructure damaged by the construction of improvements for this development.

**Response:** Noted.

**ENG7:** Although not indicated in the documents submitted, the project has the potential need for a full road closure of Tennyson Street during construction. Full road closures are highly discouraged in Adams County and rarely allowed. IF a full road closure is to be requested, the applicant is encouraged to begin coordinate with the County as soon as possible.

**Response:** Noted. The contractor has been directed to contact with Adams County regarding the Traffic Control Plan. See Section 01550 of the plans and specifications for additional Traffic Control Requirements (Appendix A ).





## 4.5 LONG RANGE PLANNER REVIEW

### Square Lakes Subarea Plan

Overall, the Square Lake Subarea provides a unique mix of uses and valuable assets to both COA and Adams County. The existing land uses provide important jobs and housing. The subarea has a strong existing community of residents, employees, and business owners who have a great appreciation for the subarea's existing assets and the community character.

The subject property has a future land use designation of Employment Mixed Use. The Employment Mixed Use designation between I-76 and 58th Avenue is intended to include a mixture of employment uses, including offices, and flex space with clean, indoor manufacturing, distribution, warehousing, and airport and technology uses.

Complete Streets & Connections: Reference Page 40 Tennyson Street (67' ROW) for complete streets conceptual alternative design. 58th Avenue & Tennyson Street: improved crossing is needed. (COA Key Stakeholder). A right-of-way project is a key time to initiate these much needed improvements to the multimodal transportation network within the subarea.

### Other Plans:

#### Making Connections

#### SW Area Framework Plan

#### Advancing Adams Comprehensive Plan

#### TOD Rail Guidelines

**Response:** Final Plans and specifications will be submitted to ADCO engineering for review and approval.

The project timing is intended to address an existing environmental risk. Further, the plans for complete streets and drainage issues are not advanced beyond conceptual to 30% at this time. Given that the COA project is using the existing ROW, and generally, the same location, COA will not be pursuing the larger project but needs to construct the sewer project as soon as practicable. Further, given that the area under discussion is outside COA jurisdiction, it's not appropriate for COA to be pursuing ROW acquisition.

A visual representation of the existing pipe is shown in Appendix H in relation to the proposed pipeline. Crowns of pipe are matching. No significant change to the existing condition of the pipe and floodplain are proposed.



#### 4.6 ROW REVIEW

**ROW1:** All required permits to work within the county right-of-way will be necessary, along with engineering review.

**ROW2:** Any easements required within county property must be negotiated and completed prior to any construction.

**Response:** All proposed improvements are located in the ROW. Temporary construction easements may be necessary and property owners have already been contacted. Final Plans and specifications will be submitted to ADCO engineering for review and approval accompanied by the engineering review fee. Construction permits will also be submitted to ADCO for approval prior to construction.

#### 4.7 NEIGHBORHOOD SERVICES REVIEW

There are no open violations at this location at this time. NO Comment.

## 5 APPENDIX

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### Appendix A

- Design Drawings
- Design Specifications
- SWMP
- Alternate Design – Railroad Corridor

### Appendix B

- Development Application Form
- Arvada North Trunk Sewer (NTS) – County Comments 60% Design

### Appendix C

- Copies of public meeting sign-in sheet
- Maps displayed at neighborhood meeting
- Berkeley Sanitation email correspondence

### Appendix D

- Sanitary Sewer Master Plan Executive Summary
- Sanitary Sewer Master Plan Selected Modeling Results

### Appendix E

- Schedule for Design
- Schedule for Construction

### Appendix F

- USGS National Wetlands Inventory
- Critical Habitat for Threatened & Endangered Species
- Terrestrial and Aquatic Plant Life

### Appendix G

- Email from Mr. Fonda Apostolopoulos
- Email from Brian Mead
- CDPHE Site Application Approval

### Appendix H

- Figure of existing and proposed pipeline