

# Addendum #2



## Capital Project Committee

### Project Information

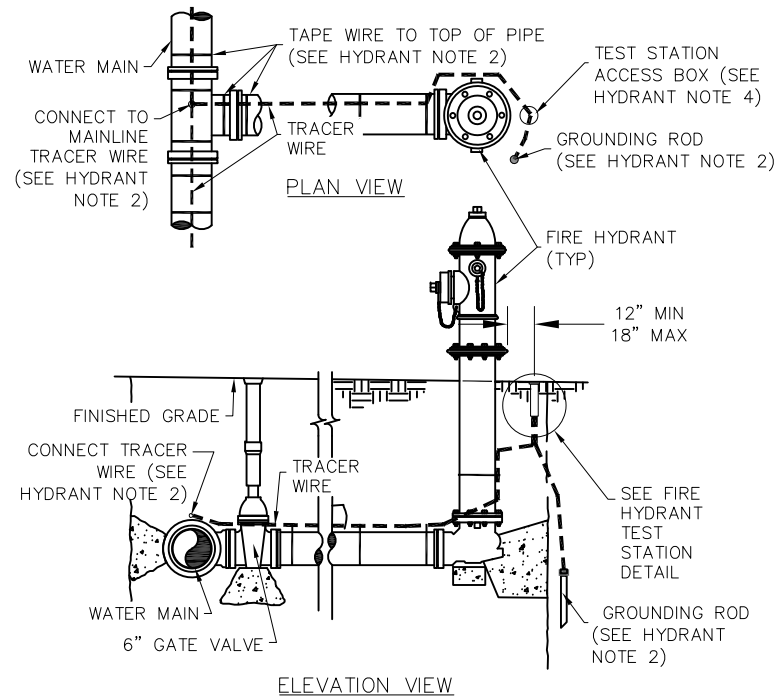
Project Name:	35th Avenue Widening and Utility Project - Phase 1
Bid Number:	FD20-11-158
Date:	December 1, 2020
Project Manager:	Dave Wells

### Addendum Items

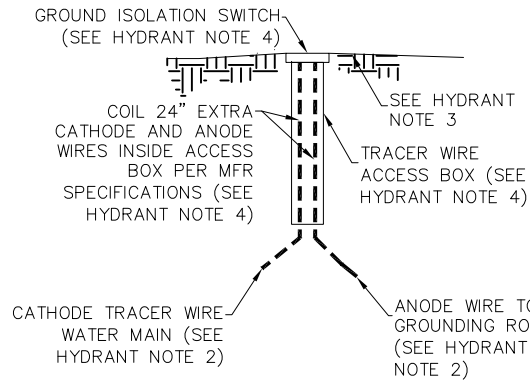
Item 1	<p>Due to the corona-virus, the City is requiring the following for submitting bids and the opening of bids:</p> <p><b>see attached instructions for submittal of bid responses</b></p> <p><b>See below for Bid Opening Instructions - December 8, 2020 at 2:00pm</b></p> <p>Join Zoom Meeting</p> <p><a href="https://greeleygov.zoom.us/j/89169045882">https://greeleygov.zoom.us/j/89169045882</a></p> <p>Meeting ID: 891 6904 5882</p> <p>Passcode: 958081</p> <p>Dial by your location</p> <ul style="list-style-type: none"><li>+1 253 215 8782 US (Tacoma)</li><li>+1 301 715 8592 US (Washington D.C)</li><li>+1 312 626 6799 US (Chicago)</li></ul>
Item 2	<p>Please see attached updated documentation - Spec. file should replace PDF page number 202-448 in the original bid package document</p>
	<p>Included is Tracer Wire standard details</p>
	<p>Included is an updated version of the 35th Ave Utility Project Phase 1 Specifications set. All the specifications are included due to a formatting issue that occurred just prior to bid document release. However, only the following specifications have been added or include changes:</p>
	<p>01785 Project Record Documents: New specification</p>

	02510 Water Utility Distribution Piping: Tracer wire and testing station verbiage change in paragraphs 2.9 and 3.5.C&D
	02511 Disinfection of Water Utility Distribution: Updated 3.1.A
	02512 Ductile Iron Pipe: New specification
	02514 Water Service Lines, Meters, and Appurtenances: Tracer wire related changes in paragraph 3.5
	02957 Sewer Manhole Rehabilitation A: New specification
	02957 Sewer Manhole Rehabilitation B – Sewer Manhole Coating: New specification
	03300 Cast In Place Concrete: Updated paragraph 2.7
	15140 Non-Potable Irrigation System: Tracer wire changes and other formatting changes that did not affect requirements throughout

**FIRE HYDRANT TRACER WIRE**

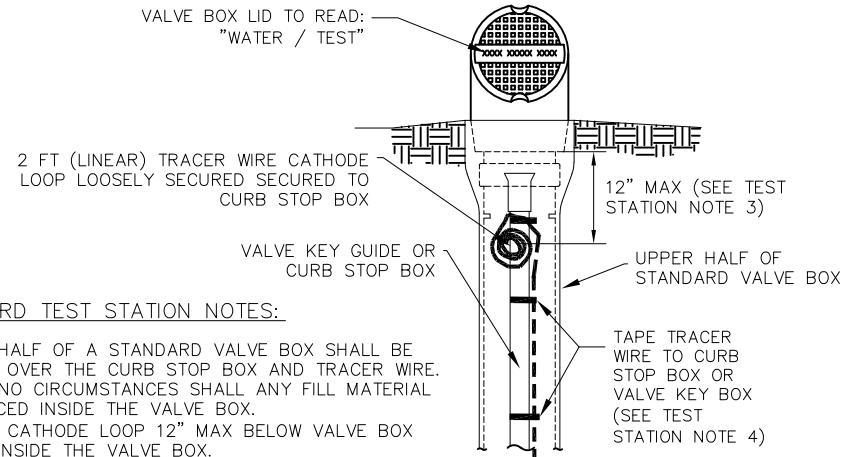


**FIRE HYDRANT TEST STATION DETAIL**



- HYDRANT TEST STATION NOTES:**
1. REFER TO RELATED DETAIL FIRE HYDRANT DETAIL, LATEST REVISION, FOR FIRE HYDRANT INSTALLATION STANDARD DRAWING.
  2. REFER TO GENERAL NOTES FOR ADDITIONAL TRACER WIRE REQUIREMENTS.
  3. GRADE SURROUNDING TRACER WIRE ACCESS BOX SHALL SLOPE AWAY FROM LID AT 2% MINIMUM GRADE.
  4. FIRE HYDRANT TEST STATION ACCESS BOX SHALL BE COPPERHEAD SNAKEPIT ACCESS POINT WITH TWO-TERMINAL SWITCHABLE LID OR APPROVED EQUAL.

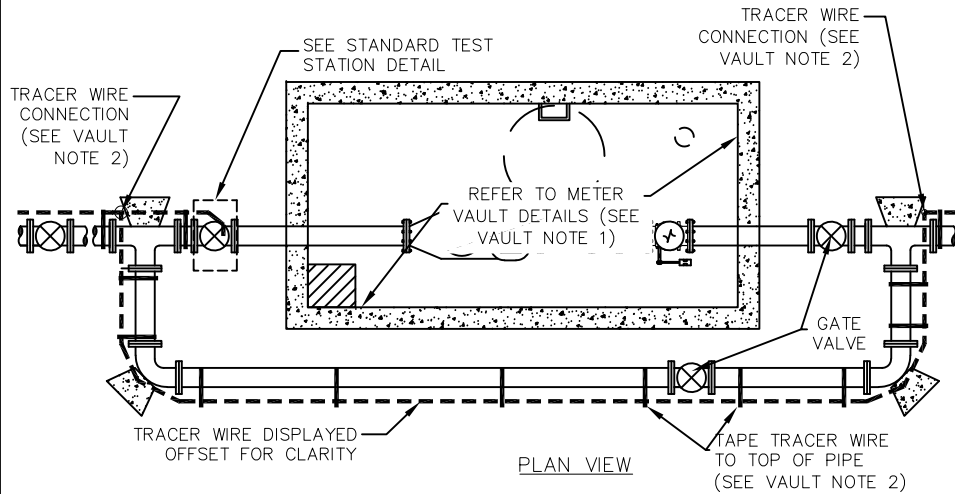
**STANDARD TEST STATION DETAIL**



**STANDARD TEST STATION NOTES:**

1. UPPER HALF OF A STANDARD VALVE BOX SHALL BE PLACED OVER THE CURB STOP BOX AND TRACER WIRE.
2. UNDER NO CIRCUMSTANCES SHALL ANY FILL MATERIAL BE PLACED INSIDE THE VALVE BOX.
3. SECURE CATHODE LOOP 12" MAX BELOW VALVE BOX COVER INSIDE THE VALVE BOX.
4. FOLLOW SAME TAPING INTERVAL FOR TRACER WIRE ALONG CURB STOP AS TRACER WIRE IS TAPED ALONG PIPE.

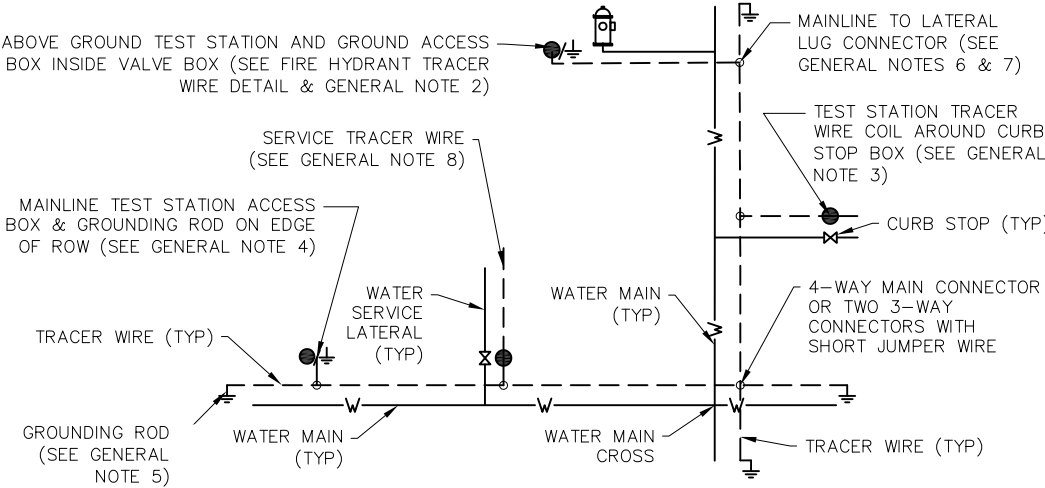
**TRACER WIRE AROUND VAULTS**



**VAULT TRACER WIRE NOTES:**

1. REFER TO RELATED DETAILS W-10, W-11, AND W-15 FOR METER VAULT DETAILS AND REQUIREMENTS.
2. REFER TO GENERAL NOTES FOR ADDITIONAL TRACER WIRE REQUIREMENTS.

**SAMPLE PLAN OF WATER MAIN TRACER WIRE**



**LEGEND**

— WATER MAIN	⊕ DRIVE-IN MAGNESIUM GROUNDING ROD (TYP)	● TRACER WIRE ACCESS BOX (LOOSE COIL AROUND CURB STOP FOR ABOVE GROUND ACCESS)
- - - TRACER WIRE	⊗ CURB STOP (TYP)	●/⊕ TRACER WIRE ACCESS BOX (ABOVE GROUND ACCESS BOX / GROUNDING ROD)
— WATER SERVICE	⊕ FIRE HYDRANT (TYP)	

**GENERAL NOTES:**

1. TRACER WIRE DEPICTED OFFSET FROM PIPE FOR CLARITY. TRACER WIRE SHALL BE INSTALLED ON TOP OF PIPE, IN ACCORDANCE WITH THE WATER & SEWER UTILITY LOCATING DETAIL UL-6, AND WATER & SEWER CONSTRUCTION SPECIFICATIONS, LATEST REVISION OF EACH.
2. TRACER WIRE ACCESS IN THE FORM OF A TEST STATION ACCESS BOX FROM A CITY APPROVED MFR MUST BE PROVIDED AND GROUNDED AT EVERY FIRE HYDRANT. REFER TO WATER & SEWER SPECIFICATIONS, LATEST REVISION, FOR PRODUCT AND MANUFACTURER RECOMMENDATIONS AND REQUIREMENTS.
3. TRACER WIRE ACCESS IN THE FORM OF A CATHODE WIRE LOOPED AROUND THE CURB STOP SHALL BE PLACED INSIDE OF A STANDARD VALVE BOX AT EVERY SERVICE LATERAL. REFER TO W&S SERVICE LATERAL UTILITY LOCATING DETAILS UL-3 AND UL-4, LATEST REVISION OF EACH, FOR ADDITIONAL INSTALLATION REQUIREMENTS.
4. FOR LONG RUNS IN EXCESS OF 1,000 FEET WITHOUT SERVICE LATERALS OR HYDRANTS - TRACER WIRE ACCESS MUST BE PROVIDED IN THE FORM OF EITHER AN APPROVED MFR GRADE LEVEL WIRE ACCESS BOX OR A STANDARD VALVE BOX WITH CATHODE WIRE LOOP. EITHER FORM OF ACCESS SHALL BE LOCATED ABOVE THE PIPE OR AT THE EDGE OF RIGHT-OF-WAY AND OUT OF THE ROAD-WAY. TRACER WIRE ACCESS BOX SHALL ALSO BE DELINEATED USING A MINIMUM 48" POLYETHYLENE MARKER POST, COLOR CODED PER APWA STANDARD FOR THE SPECIFIC UTILITY BEING MARKED.
5. TRACER WIRE MUST BE GROUNDED AT EVERY MAINLINE DEAD END/STUB, AND ALONG CONTINUOUS RUNS AT A MAXIMUM OF 1,000 FT INTERVALS WITH A 1.5 LB DRIVE-IN MAGNESIUM GROUNDING ROD PER GROUNDING ROD MFR REQUIREMENTS. PLACEMENT OF GROUNDING ROD SHALL BE INSTALLED IN SUCH A WAY THAT ALLOWS FOR PROPER WIRE LOCATING WITHOUT A LOSS OR DETERIORATION OF LOW FREQUENCY SIGNAL (512 Hz) FOR DISTANCES IN EXCESS OF 1,000 FT. EVERY FIRE HYDRANT TEST STATION SHALL BE GROUNDED PER MFR RECOMMENDATIONS.
6. TRACER WIRE SYSTEMS MUST BE INSTALLED AS A SINGLE CONTINUOUS WIRE, EXCEPT WHERE USING APPROVED CONNECTORS. NO LOOPING OR COILING OF WIRE IS ALLOWED.
7. REFER TO WATER & SEWER SERVICE LATERAL TRACER WIRE DETAIL AND GENERAL TRACER WIRE NOTES ON DETAIL UL-6, LATEST REVISION OF EACH, FOR ADDITIONAL TRACER WIRE INSTALLATION, TAPING, CONNECTION, SPLICING, AND GROUNDING REQUIREMENTS.
8. SERVICE LATERAL TRACER WIRE SHALL EXTEND PAST CURB STOP TEST STATION AND TERMINATE AT STRUCTURE PER SERVICE LATERAL UTILITY LOCATING DETAIL.



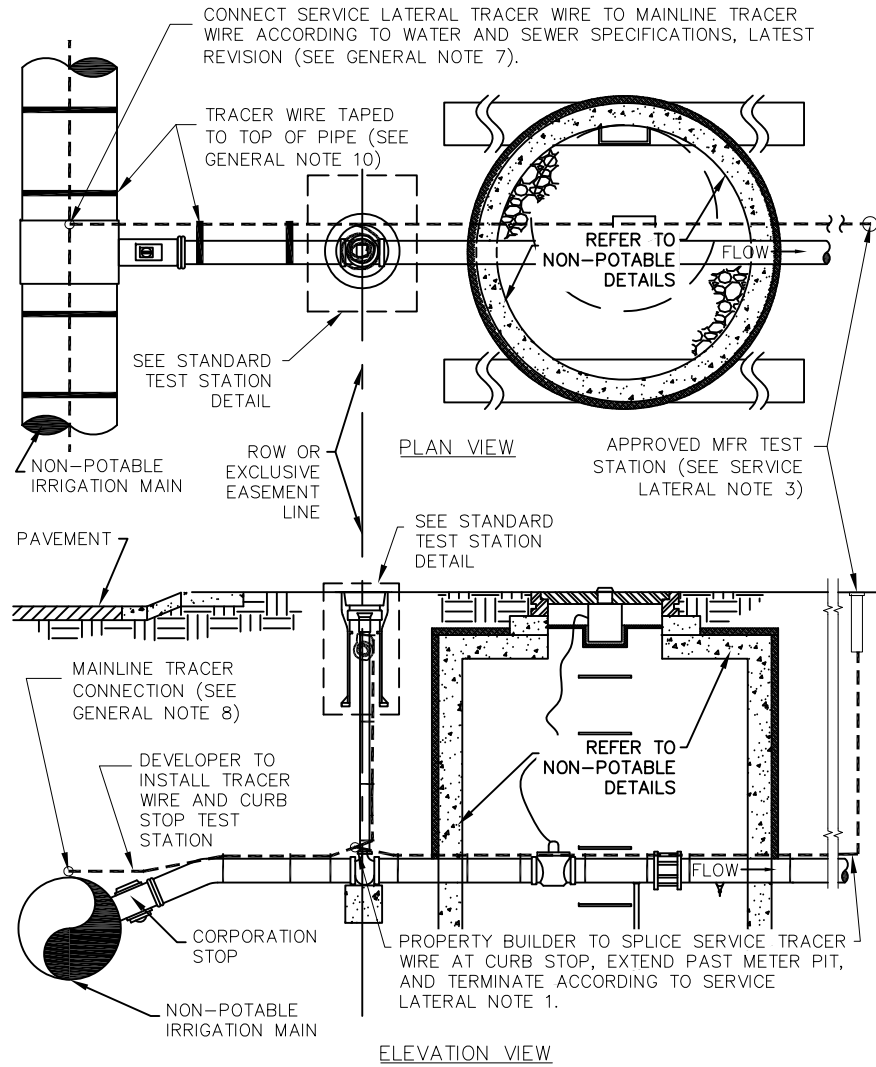
**WATER MAIN TRACER WIRE AND UTILITY LOCATING**

DETAIL NO. UL-1

DATE: NOVEMBER 2020

SCALE: N.T.S.

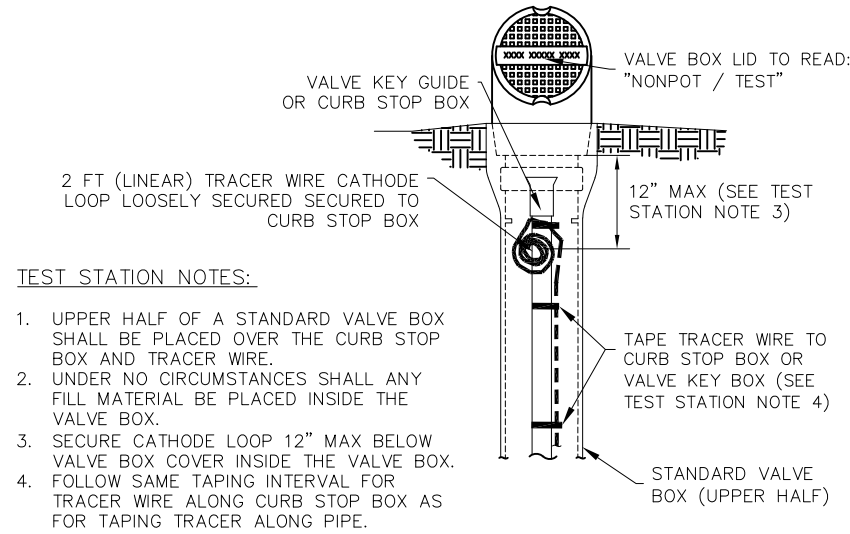
**NON-POTABLE IRRIGATION SERVICE LATERAL**



**NON-POTABLE IRRIGATION SERVICE LATERAL NOTES:**

1. TEST STATION AT SERVICE LATERAL FAR END ON OWNER SIDE OF METER:
  - 1.1. SHALL BE A MOUNTABLE OR FLUSH-GRADE ACCESS POINT AND INSTALLED PER MFR SPECIFICATIONS. SEE WATER & SEWER SPECIFICATIONS, LATEST REVISION, FOR APPROVED MFR AND MODELS.
  - 1.2. TEST STATION ACCESS SHALL BE PROVIDED AT TRACER WIRE TERMINATION NEAR THE IRRIGATION CONTROL VALVE BOX OR AS NOTED ON THE DESIGN DRAWINGS.

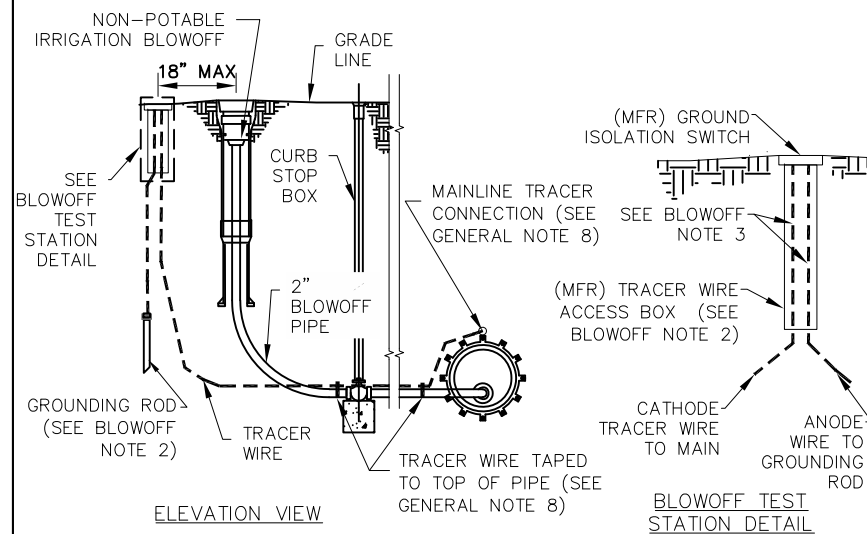
**STANDARD TEST STATION DETAIL**



**TEST STATION NOTES:**

1. UPPER HALF OF A STANDARD VALVE BOX SHALL BE PLACED OVER THE CURB STOP BOX AND TRACER WIRE.
2. UNDER NO CIRCUMSTANCES SHALL ANY FILL MATERIAL BE PLACED INSIDE THE VALVE BOX.
3. SECURE CATHODE LOOP 12" MAX BELOW VALVE BOX COVER INSIDE THE VALVE BOX.
4. FOLLOW SAME TAPING INTERVAL FOR TRACER WIRE ALONG CURB STOP BOX AS FOR TAPING TRACER ALONG PIPE.

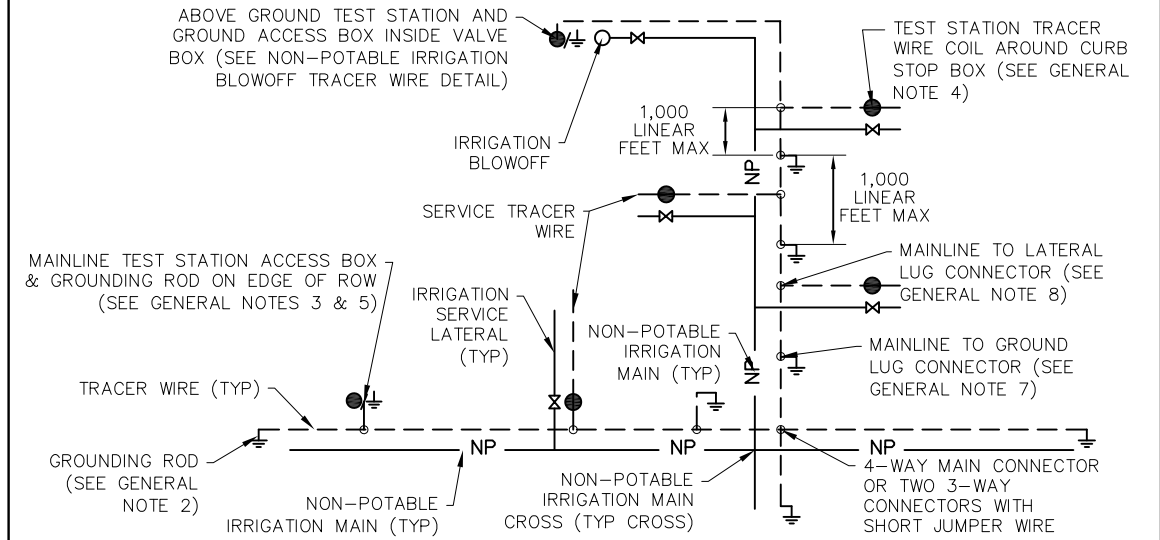
**NON-POTABLE IRRIGATION BLOWOFF AND "DEAD END/STUB" TRACER WIRE**



**BLOW-OFF TRACER WIRE NOTES:**

1. REFER TO RELATED NON-POTABLE BLOWOFF DETAIL, LATEST REVISION, FOR BLOWOFF INSTALLATION STANDARD DRAWING.
2. REFER TO GENERAL NOTES FOR ADDITIONAL TRACER WIRE REQUIREMENTS.
3. BLOWOFF TEST STATION ACCESS BOX SHALL BE COPPERHEAD SNAKEPIT ACCESS POINT WITH TWO-TERMINAL SWITCHABLE LID OR APPROVED EQUAL.
4. COIL 24" EXTRA CATHODE AND ANODE WIRES INSIDE ACCESS BOX PER MFR SPECIFICATIONS.

**SAMPLE PLAN OF NON-POTABLE IRRIGATION MAIN TRACER WIRE**



**LEGEND**

- NON-POTABLE IRRIGATION MAIN
- - - TRACER WIRE
- NON-POTABLE IRRIGATION SERVICE
- ⊗ CURB STOP (TYP)
- ⊕ "FAR END GROUND" DRIVE-IN MAGNESIUM GROUNDING ROD (TYP)
- TRACER WIRE ACCESS BOX (LOOSE COIL AROUND CURB STOP FOR ABOVE GROUND ACCESS)
- ⊕ TRACER WIRE ACCESS BOX (ABOVE GROUND ACCESS BOX / GROUNDING ROD)

**GENERAL NOTES:**

1. TRACER WIRE DEPICTED OFFSET FROM PIPE FOR CLARITY. TRACER WIRE SHALL BE INSTALLED ON TOP OF PIPE, AND INSTALLED IN ACCORDANCE WITH THE WATER & SEWER UTILITY LOCATING DETAILS, AND WATER & SEWER SPECIFICATIONS, LATEST REVISION OF EACH.
2. TRACER WIRE MUST BE GROUNDED AT EVERY MAINLINE DEAD END/STUB, AND ALONG CONTINUOUS RUNS AT A MAXIMUM OF 1,000 FT INTERVALS WITH A 1.5 LB DRIVE-IN MAGNESIUM ANODE GROUNDING ROD PER GROUNDING ROD MFR REQUIREMENTS. PLACEMENT OF GROUNDING ROD SHALL BE INSTALLED IN SUCH A WAY THAT ALLOWS FOR PROPER WIRE LOCATING WITHOUT A LOSS OR DETERIORATION OF LOW FREQUENCY SIGNAL (512 Hz) FOR DISTANCES IN EXCESS OF 1,000 FT.
3. FOR LONG RUNS IN EXCESS OF 1,000 FEET WITHOUT SERVICE LATERALS - TRACER WIRE ACCESS MUST BE PROVIDED IN THE FORM OF EITHER AN APPROVED MFR GRADE LEVEL / IN-GROUND WIRE ACCESS BOX OR A STANDARD VALVE BOX WITH CATHODE LOOP. EITHER FORM OF ACCESS BOX SHALL BE LOCATED ABOVE THE PIPE OR AT THE EDGE OF RIGHT-OF-WAY AND OUT OF THE ROAD-WAY. TRACER WIRE ACCESS BOX SHALL ALSO BE DELINEATED USING A MINIMUM 48" POLYETHYLENE MARKER POST, COLOR CODED PER APWA STANDARD FOR THE SPECIFIC UTILITY BEING MARKED.
4. SERVICE LATERAL TEST STATIONS SHALL BE IN THE FORM OF A CATHODE WIRE LOOP AT THE CURB STOP AND PLACED INSIDE OF A STANDARD VALVE BOX AT EVERY SERVICE LATERAL. REFER TO W&S SPECIFICATIONS AND GENERAL NOTES ON DETAIL UL-6, LATEST REVISION OF EACH, FOR ADDITIONAL INSTALLATION REQUIREMENTS.
5. TEST STATIONS LOCATED AT THE MAXIMUM DISTANCE FROM THE NEAREST GROUND SHALL BE INSTALLED AS AN APPROVED MFR GRADE-LEVEL/ IN GROUND WIRE ACCESS BOX WITH A GROUNDING ROD.
6. GRADE SURROUNDING TEST STATION ACCESS BOX SHALL SLOPE AWAY FROM LID AT A 2% MINIMUM GRADE.
7. "FAR END" GROUNDING RODS WIRE SHALL BE CONNECTED TO MAINLINE TRACER WIRE USING APPROVED LOCKABLE CONNECTORS WITHOUT CUTTING OR SPLICING THE MAINLINE TRACER WIRE.
8. SERVICE LATERAL TRACER WIRE SHALL BE CONNECTED TO MAINLINE TRACER WIRE USING APPROVED LOCKABLE CONNECTORS WITHOUT CUTTING OR SPLICING THE MAINLINE TRACER WIRE.
9. TRACER WIRE SYSTEMS MUST BE INSTALLED AS A SINGLE CONTINUOUS WIRE, EXCEPT WHERE USING APPROVED CONNECTORS. NO LOOPING OR COILING OF WIRE IS ALLOWED.
10. REFER TO GENERAL TRACER WIRE NOTES ON WATER & SEWER DETAIL UL-6, LATEST REVISION, FOR ADDITIONAL TRACER WIRE INSTALLATION, TAPING, CONNECTION, SPLICING, AND GROUNDING REQUIREMENTS.

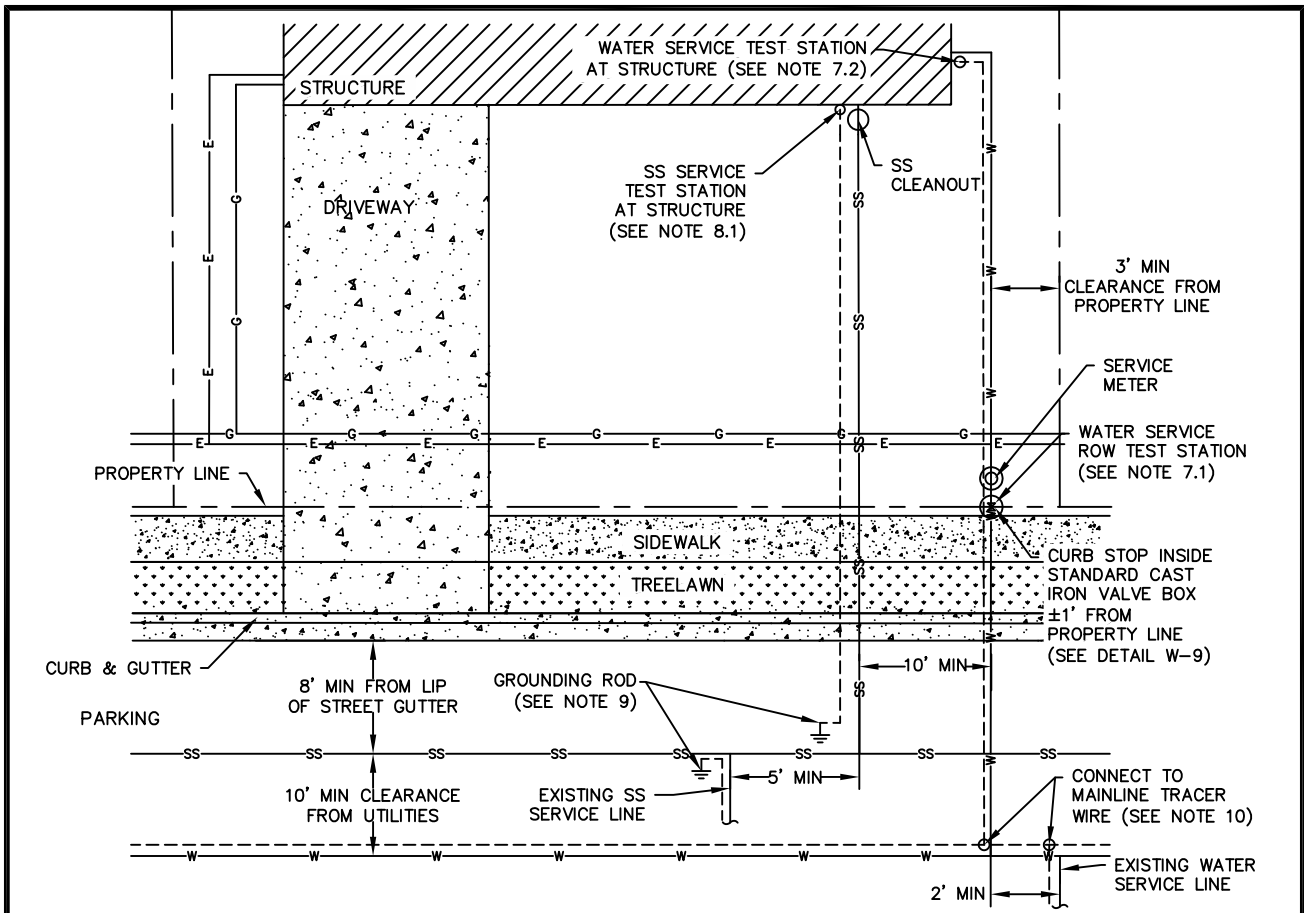


**NON-POTABLE IRRIGATION TRACER WIRE AND UTILITY LOCATING**

DETAIL NO. UL-2

DATE: NOVEMBER 2020

SCALE: N.T.S.



**NOTES:**

1. ALL BURIED PIPE, VALVES, AND APPURTENANCES SHALL BE INSTALLED ACCORDING TO THE CITY OF GREELEY WATER & SEWER DETAILS AND SPECIFICATIONS LATEST REVISION.
2. TRACER WIRE IS REQUIRED FOR ALL SERVICE PIPES, ALL WATER MAINS, AND ALL NON-POTABLE IRRIGATION MAINS.
3. TRACER WIRE IS ONLY DEPICTED AWAY FROM PIPE IN ABOVE DRAWING FOR CLARITY.
4. REFER TO GENERAL NOTES ON WATER & SEWER DETAIL UL-6, LATEST REVISION, FOR ADDITIONAL TRACER WIRE INSTALLATION, TAPING, CONNECTION, SPICING, AND GROUNDING REQUIREMENTS.
5. FOR FUTURE CONNECTION SERVICE STUBS, DEVELOPER SHALL PROVIDE A MINIMUM OF 2 FEET OF WIRE WRAPPED AND TAPED TO MARKER POST AT PROPERTY LINE (PROPERTY BUILDER SHALL SPLICE TO THIS TRACER WIRE COIL AT LATER DATE).

**LEGEND**

- W — WATER MAIN/ SERVICE
- - - - - TRACER WIRE MAIN/ SERVICE
- SS — SAN. SEWER MAIN/ SERVICE
- - - - - PROPERTY LINE
- — — — — EDGE OF CONCRETE/ PAVEMENT
- G — GAS SERVICE
- E — ELECTRIC SERVICE
- ⊥ DRIVE-IN MAGNESIUM GROUNDING ROD (TYP)

6. REFER TO WATER & SEWER CONSTRUCTION SPECIFICATIONS, LATEST REVISION, FOR APPROVED TRACER WIRE, GROUNDING ROD, TEST STATION, AND MISC. PRODUCT MFR.
7. WATER SERVICE TEST STATIONS AND TRACER ACCESS:
  - 7.1. ROW TEST STATION (AT CURB STOP): TAPE TRACER WIRE TO CURB STOP BOX AND RUN TO SURFACE. SECURE A TWO FOOT (LINEAR) COIL OF TRACER WIRE AT THE TOP OF THE CURB STOP BOX, AND PLACE THE UPPER HALF OF A STANDARD VALVE BOX AROUND THE CURB STOP AND TEST STATION.
  - 7.2. PROPERTY OWNER TEST STATION AT STRUCTURE: TERMINATE TRACER WIRE AT STRUCTURE WITH AN APPROVED TEST STATION ACCESS BOX FROM AN APPROVED MFR, MOUNTED TO STRUCTURE.
  - 7.3. SEE W&S DETAIL UL-4, LATEST REVISION, FOR ADDITIONAL DETAILS.
8. SANITARY SEWER SERVICE TEST STATIONS AND TRACER ACCESS:
  - 8.1. PROPERTY OWNER TEST STATION AT STRUCTURE: TERMINATE TRACER WIRE AT STRUCTURE WITH AN APPROVED TEST STATION ACCESS BOX FROM AN APPROVED MFR, MOUNTED TO THE STRUCTURE.
  - 8.2. SEE W&S DETAIL UL-5, LATEST REVISION, FOR ADDITIONAL DETAILS.
9. ALL SANITARY SEWER SERVICE LATERAL TRACER WIRES SHALL TERMINATE WITHIN 2FT OF THE SS MAIN WITH AN APPROVED 1.5 LB DRIVE-IN MAGNESIUM GROUNDING ROD.
10. ALL WATER SERVICE LATERAL TRACER WIRES SHALL BE CONNECTED TO MAINLINE TRACER WITHOUT CUTTING / SPICING THE MAINLINE TRACER WIRE, ACCORDING TO WATER & SEWER DETAIL UL-6, LATEST REVISION.

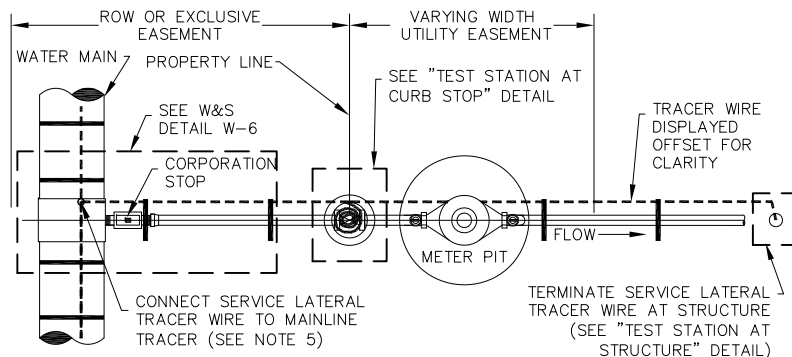


(TYP) SERVICE LATERAL UTILITY LOCATING PLAN

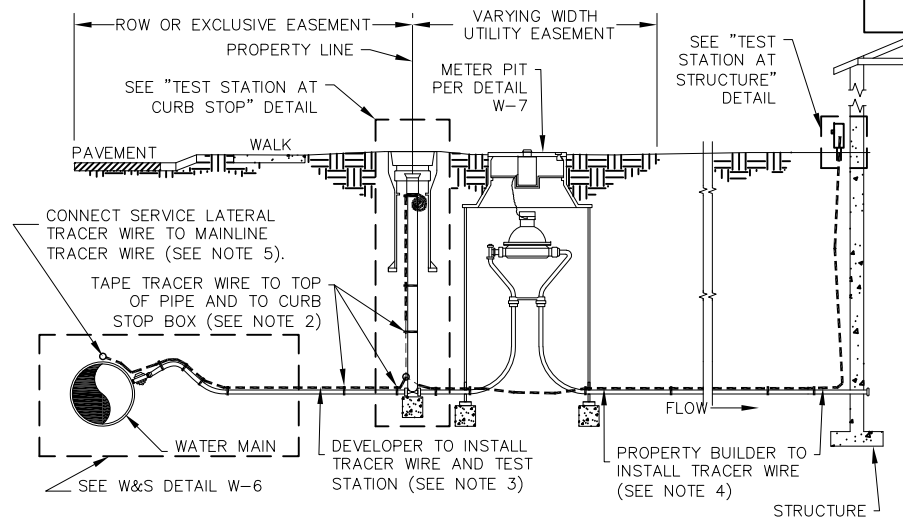
DETAIL UL-3

DATE: NOVEMBER 2020

SCALE: N.T.S.

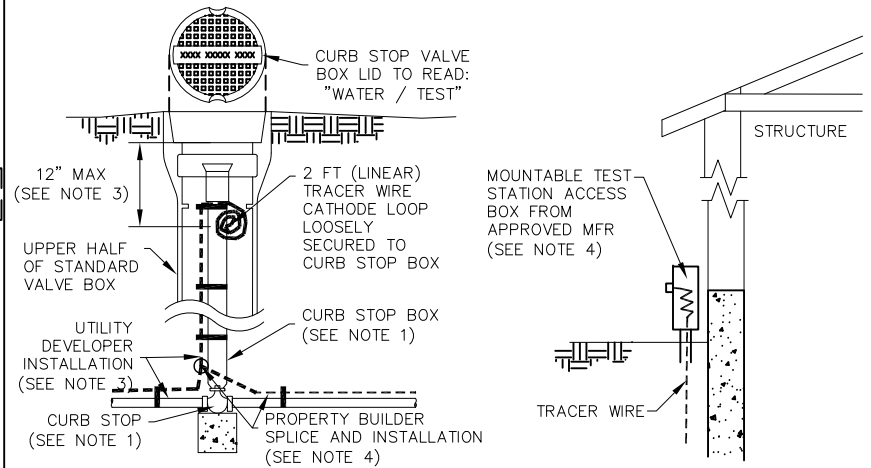


TRACER WIRE INSTALLATION PLAN VIEW



ELEVATION VIEW

WATER SERVICE TEST STATION DETAIL



TEST STATION AT CURB STOP

TEST STATION AT STRUCTURE

NOTES:

1. REFER TO RELATED WATER & SEWER DETAILS W-6 THROUGH W-11, LATEST REVISION OF EACH, FOR WATER SERVICE LATERAL AND METER INSTALLATION DETAILS.
2. REFER TO RELATED SERVICE LATERAL TRACER WIRE DETAIL UL-3, AND GENERAL TRACER WIRE NOTES ON UL-6, LATEST REVISION OF EACH, FOR ADDITIONAL TRACER WIRE TAPING, SPLICING, CONNECTING, AND GROUNDING DETAILS.
3. UTILITY DEVELOPER TO INSTALL TRACER WIRE ON MAIN AND UP TO TEST STATION AT CURB STOP ON THE EDGE OF ROW. PROVIDE 2 FT (LINEAR) OF EXCESS TRACER WIRE, SECURED AT THE TOP OF THE CURB STOP BOX, AND PLACE THE UPPER HALF OF A STANDARD VALVE BOX AROUND THE CURB STOP AND TEST STATION. FOR NEW DEVELOPMENT, UTILITY DEVELOPER SHALL PROVIDE A MINIMUM 2 FT COIL AT MARKER POST IF PRIOR TO CURB STOP INSTALLATION.
4. PROPERTY BUILDER TO SPLICE SERVICE TRACER WIRE TO TEST STATION TRACER WIRE AND INSTALL UP TO STRUCTURE, TERMINATING DIRECTLY ABOVE THE SERVICE LATERAL AT THE STRUCTURE WITH AN APPROVED ACCESS BOX FROM AN APPROVED MFR TEST STATION ACCESS BOX SHALL BE INSTALLED IN ACCORDANCE WITH MFR SPECIFICATIONS. REFER TO WATER & SEWER SPECIFICATIONS, LATEST REVISION, FOR APPROVED MFR.
5. ALL MAINLINE TRACER WIRE CONNECTIONS SHALL BE INSTALLED PER LATEST REVISION OF WATER & SEWER SPECIFICATIONS. MAINLINE TRACER SHALL NOT BE CUT OR SPLICED IN ANY WAY (SEE NOTE 3).

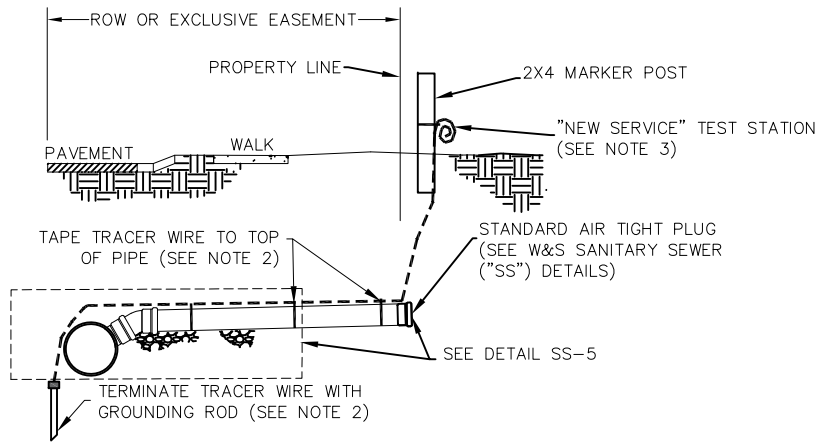


(TYP) WATER SERVICE UTILITY LOCATING DETAIL SECTION & TEST STATION

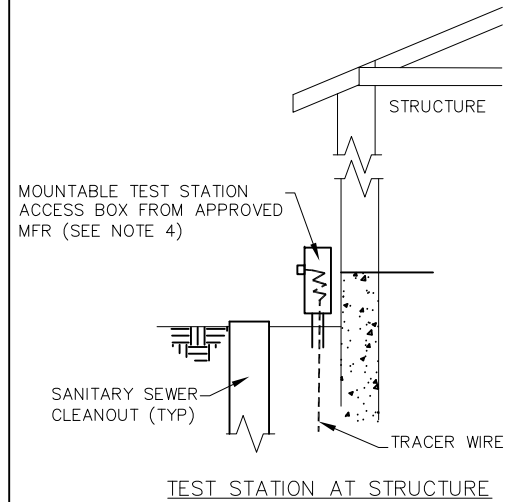
DETAIL UL-4

DATE: NOVEMBER 2020

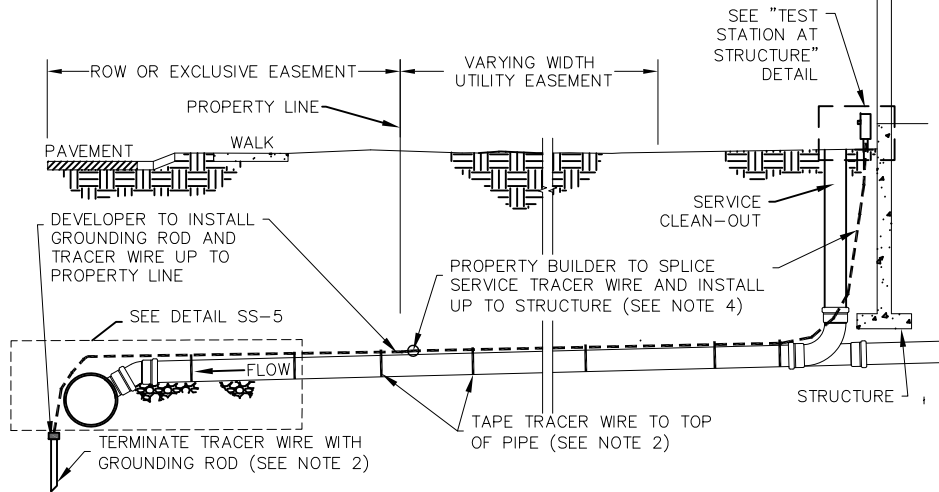
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**TRACER WIRE INSTALLATION - NEW CONSTRUCTION**



**TEST STATION AT STRUCTURE**



**TRACER WIRE INSTALLATION ELEVATION VIEW**

**NOTES**

1. REFER TO RELATED DETAIL SS-5, LATEST REVISION, FOR SANITARY SEWER SERVICE LATERAL STANDARD DRAWING.
2. REFER TO RELATED SERVICE LATERAL TRACER WIRE DETAIL UL-3, AND GENERAL TRACER WIRE NOTES ON UL-6, LATEST REVISION OF EACH, FOR ADDITIONAL TRACER WIRE TAPING, SPLICING, CONNECTING, GROUNDING, AND MISC. INSTALLATION DETAILS.
3. UTILITY DEVELOPER TO INSTALL TRACER WIRE FROM SS MAIN TO THE TEST STATION BOX ON THE EDGE OF ROW. TEST STATION FOR NEW DEVELOPMENT SHALL BE A COIL OF 2 FT (LINEAR) TRACER WIRE, SECURED TO THE SERVICE STUB MARKER POST.
4. PROPERTY BUILDER TO SPLICE SANITARY SEWER SERVICE TRACER WIRE PROPERTY LINE AND INSTALL UP TO STRUCTURE, TERMINATING AT THE SS SERVICE CLEANOUT WITH AN APPROVED MFR TEST STATION ACCESS BOX FROM AN APPROVED MFR. TEST STATION ACCESS BOX SHALL BE MOUNTED TO THE STRUCTURE WITHIN 18" OF THE SS SERVICE CLEANOUT AND INSTALLED ACCORDING TO THE TEST STATION MFR SPECIFICATIONS. REFER TO WATER & SEWER SPECIFICATIONS, LATEST REVISION, FOR APPROVED MFR.



**(TYP) SANITARY SEWER SERVICE UTILITY LOCATING  
DETAIL SECTION & TEST STATION**

**DETAIL UL-5**

DATE: NOVEMBER 2020

SCALE: N.T.S.

### TRACER WIRE NOTES

1. LOCATING MUST MEET REQUIREMENTS OF SENATE BILL 18-167 OR ANY UPDATE.
2. TRACER WIRE SHALL BE LOCATED ON TOP OF PIPE, TAPED EVERY 3 TO 4 FEET MAX AND EACH SIDE OF EVERY JOINT, FITTING, AND VALVE.
3. TRACER WIRE IS REQUIRED FOR ALL WATER SERVICE LATERALS, NON-POTABLE IRRIGATION SERVICE LATERALS, ALL SANITARY SEWER LATERALS, ALL WATER MAINS, AND ALL NON-POTABLE IRRIGATION MAINS.
4. TWO UNDERGROUND WIRE SPLICES ARE ALLOWED PER SERVICE, SHALL HAVE LOCKABLE CONNECTIONS SPECIFICALLY DESIGNED FOR DIRECT BURIAL, AND DIELECTRIC SILICONE GEL FILLED OR APPROVED EQUAL.
5. TRACER WIRE SHALL BE A SINGLE 12 AWG MULTI-STRANDED COPPER WIRE WITH WATER-TIGHT INSULATION FOR DIRECT BURIAL. SEE WATER & SEWER SPECIFICATIONS, LATEST REVISION, FOR APPROVED MFR.
6. TRACER WIRE SYSTEMS MUST BE INSTALLED AS A SINGLE CONTINUOUS WIRE, EXCEPT WHERE USING APPROVED CONNECTORS. NO LOOPING OR COILING OF WIRE AROUND THE PIPE IS ALLOWED.
7. ALL WATER SERVICE LATERAL TRACER WIRES SHALL BE CONNECTED TO MAINLINE TRACER USING AN APPROVED MAINLINE TO LATERAL LUG CONNECTOR WITHOUT CUTTING / SPLICING THE MAINLINE TRACER WIRE.
8. ALL MAINLINE TRACER WIRE BRANCHES SHALL BE MADE WITH AN APPROVED MAINLINE TO MAINLINE LUG CONNECTOR WITHOUT CUTTING / SPLICING EITHER MAINLINE TRACER WIRE.
9. REFER TO WATER & SEWER CONSTRUCTION SPECIFICATIONS, LATEST REVISION, FOR APPROVED TRACER WIRE MFR AND ADDITIONAL INSTALLATION REQUIREMENTS.

### TEST STATIONS

1. TRACER WIRE SHALL BE ACCESSIBLE AT LEAST ONCE EVERY 1,000 FT MAX.
2. TEST STATION SHALL NOT BE FURTHER THAN 1,000 FT FROM AN APPROVED "FAR-END" GROUNDING ROD. THIS GROUNDING ROD MUST MEET WATER & SEWER CONSTRUCTION SPECIFICATIONS AND DESIGN CRITERIA STATED IN THE GROUNDING NOTES.
3. TEST STATION MAY EITHER BE IN THE FORM OF A CATHODE WIRE LOOP ACCESSIBLE FROM FINAL GRADE SURFACE OR AN APPROVED TEST STATION ACCESS BOX FROM AN APPROVED MFR. EITHER TEST STATION FORM SHALL BE WITHIN THE FAR-END GROUNDING INTERVAL REQUIREMENT, AND MEET WATER & SEWER TRACER WIRE CONSTRUCTION SPECIFICATIONS AND DETAILS, LATEST REVISION OF EACH.
4. GROUND SURROUNDING TEST STATION ACCESS BOXES SHALL SLOPE AWAY FROM LID AT 2% MINIMUM GRADE.

### GROUNDING NOTES

1. ALL SANITARY SEWER SERVICE LATERAL TRACER WIRES SHALL TERMINATE WITHIN 2 FT OF THE SS MAIN WITH AN APPROVED DRIVE-IN MAGNESIUM GROUNDING ROD. SINGLE GROUNDING ROD MAY BE UTILIZED FOR UP TO 3 SEWER SERVICES MAX.
2. MAINLINE TRACER WIRE MUST BE GROUNDING AT EVERY DEAD END/STUB, AND ALONG CONTINUOUS RUNS AT A MAXIMUM OF 2,000 FT INTERVALS WITH A 1.5 LB DRIVE-IN MAGNESIUM GROUNDING ROD PER MFR REQUIREMENTS. PLACEMENT OF GROUNDING ROD SHALL BE INSTALLED IN SUCH A WAY THAT ALLOWS FOR PROPER WIRE LOCATING WITHOUT A LOSS OR DETERIORATION OF LOW FREQUENCY SIGNAL (512 HZ) FOR DISTANCES IN EXCESS OF 1,000 FT.
3. IF GROUNDING ROD IS TOO CLOSE TO A TEST STATION THAT IT INTERFERES WITH PROPER LOCATING, THE GROUNDING ROD MUST BE SWITCH-ABLE IN ORDER TO TEMPORARILY DEACTIVATE THE INTERFERING GROUND SIGNAL IN THE VICINITY. SUCH A TEST STATION SHALL BE IN THE FORM OF A TEST STATION ACCESS BOX FROM A CITY APPROVED MFR.
4. REFER TO WATER & SEWER CONSTRUCTION SPECIFICATIONS, LATEST REVISION, FOR APPROVED GROUNDING ROD MFR AND ADDITIONAL REQUIREMENTS.



## TRACER WIRE GENERAL NOTES

DETAIL UL-6

DATE: NOVEMBER 2020

SCALE: N.T.S.



**35<sup>TH</sup> AVENUE UTILITY PROJECT PHASE 1  
PROJECT SPECIAL SPECIFICATIONS**

<u>SECTION</u>	<u>TITLE</u>
02240	Dewatering
02275	Riprap and Riprap Bedding
02960	Temporary Sanitary Sewer Bypass Pumping
11285	Slide Gates

**CITY OF GREELEY CONSTRUCTION SPECIFICATIONS - VOLUME III (POTABLE WATER  
DISTRIBUTION, SANITARY SEWER COLLECTION, AND NON-POTABLE IRRIGATION SYSTEMS)**

<u>SECTION</u>	<u>TITLE</u>
01713	Water Distribution System Testing
01715	Sewer and Manhole Testing
01785	Project Record Documents
02315	Excavation and Fill
02445	Casing Pipe – Borings and Encasements
02510	Water Utility Distribution Piping
02511	Disinfection of Water Utility Distribution
02512	Ductile-Iron Pipe
02513	Polyvinyl Chloride (PVC) Pressure Pipe
02514	Water Service Lines, Meters, and Appurtenances
02515	Water Utility Distribution Valves
02516	Water Utility Distribution Fire Hydrants
02530	Sanitary Utility Sewerage Piping
02533	Polyvinyl Chloride (PVC) Non-Pressure Pipe
02535	Sanitary Utility Sewerage Manholes, Frames, and Covers
02957	Sewer Manhole Rehabilitation A

- 02957 Sewer Manhole Rehabilitation B – Sewer Manhole Coating
- 03300 Cast-In-Place Concrete
- 03400 Precast Concrete
- 15140 Non-Potable Irrigation System

**35<sup>TH</sup> AVENUE UTILITY PROJECT PHASE 1  
PROJECT SPECIAL SPECIFICATIONS**

The following Specification Sections have been prepared by me or under my direct supervision:

<u>SECTION</u>	<u>TITLE</u>
02240	Dewatering
02275	Riprap and Riprap Bedding
02960	Temporary Sanitary Sewer Bypass Pumping
11285	Slide Gates



## **SECTION 02240**

### **DEWATERING**

#### **PART 1 - GENERAL**

##### **1.1 DESCRIPTION OF WORK**

- A. Provide all material, equipment, and labor to install and maintain all pumps, piping, drains, well points, and other facilities required to effectively control, collect, and dispose of groundwater or surface water to permit safe and proper completion of the Work. Use appropriate equipment and methods for dewatering based on existing site conditions.
- B. Maintain the foundations and other portions of the Work free from water as required for constructing each part of the Work.
- C. Comply with all applicable environmental protection laws and requirements in operation of the dewatering system.
- D. Remove all components of the dewatering system after it is no longer required.

##### **1.2 SUBMITTALS**

- A. Submit in accordance with Section 01330: Submittals.
- B. Dewatering Plan: Submit a Dewatering Plan prepared by a qualified dewatering specialist, with experience in design, installation, and operation of dewatering installations. The Dewatering Plan shall be prepared by a Licensed Professional Engineer in the State of Colorado and include the following:
  - 1. Details regarding the anticipated types and locations of various dewatering facilities, and design calculations required substantiating the Dewatering Plan.
  - 2. Superintendence plan and schedule, indicating who will be responsible for observing the dewatering system and the proposed schedule describing when personnel will be on site to observe and maintain the system.
  - 3. Coordination with other work including schedule, dewatering and diversion methods and operations, erosion and sediment control measures, equipment, and location and elevation of pumps, pipes, and any other features planned for use in the dewatering plan
  - 4. Final recommendations for dewatering.
  - 5. If the Contractor purchases, rents, installs, or mobilizes to the site any elements of the dewatering system before approval of the dewatering submittal, the Contractor does so at its own risk, and will not be due any additional compensation from the Owner if such elements are not subsequently used for the work.
  - 6. Approval of the dewatering system proposed by the Contractor will only be with respect to the basic principles of the methods the Contractor intends to employ. Approval does not relieve the Contractor of full responsibility for adequacy of the dewatering system.

##### **1.3 DEFINITIONS**

- A. Definitions

1. Dewatering: Removing water by single or multiple stage wellpoints, deep wells, ejector wells or sumps, as approved based on the Contractor's submittals.
2. Hydrostatic Groundwater Level: The groundwater level at any location during construction and before dewatering.
3. Sump: A depression excavated or constructed, from which water is pumped as part of dewatering.

#### **1.4 AVAILABLE DATA**

- A. Logs of test borings and groundwater observations at the time of drilling are included on the Drawings and Baseline Report.
- B. The Contractor may refer to the boring and test pit logs on the Drawings, but shall draw their own conclusions as to the applicability of the information contained therein. The Contractor may choose to perform additional investigations to develop their dewatering plan. It is the Contractor's responsibility to evaluate site subsurface conditions with respect to required dewatering facilities.
- C. The subsurface conditions and groundwater observations from the test pits and borings apply only to the locations of the test pits and borings and at the time of the explorations and measurements. The subsurface conditions at the site may be different at the time of construction as compared to when observations were made and recorded, and the groundwater level can be expected to fluctuate. These factors should be appropriately considered in developing the Contractor's Dewatering Plan.

#### **1.5 QUALITY ASSURANCE AND QUALITY CONTROL**

- A. Dewatering operations shall be adequate to assure the integrity of the finished project and shall be the responsibility of the Contractor.

### **PART 2 - PRODUCTS**

#### **2.1 DEWATERING SYSTEM**

- A. The dewatering system shall be single- or multiple-stage wellpoints, deep wells, ejector wells, or sumps used for dewatering and which fulfill the dewatering requirements specified in this Section. The materials and construction of the dewatering wells will be selected by the Contractor and the Contractors' dewatering specialist.

### **PART 3 - EXECUTION**

#### **3.1 GENERAL**

- A. Design, furnish, install, maintain, and operate a dewatering system that prevents loss of fines, boiling, quick conditions, or softening of foundation strata and maintain stability of bottom of excavations so that every phase of the work can be performed in a dry, safe, and stable environment. Operate dewatering systems such that excavation bottoms are firm, suitably dry, and free from standing water at all times.
- B. Locate elements of the dewatering system such that interference with excavation and construction activity is minimized. Locations are subject to approval by the Engineer.
- C. At all times during construction, provide ample means and devices to remove promptly, and dispose of properly, all water entering excavations and keep the bottoms of excavations firm and free of standing water until structures to be built thereon are completed and/or backfill to be placed therein is placed. Conduct pumping and dewatering operations such that no disturbance to foundation subgrade

materials or to fill materials supporting any other work will result. Discharged water shall be piped to an approved area.

- D. Install silt barriers or other discharge control measures at dewatering discharge locations, to control and prevent siltation. Provide suitable discharge controls in accordance with applicable federal, state, and local permit regulations, and Section 01570: Sediment and Erosion Control. Do not allow dewatering discharge to cause siltation or other negative environmental impact on natural waterways or other property.

### **3.2 INSTALLATION AND OPERATION**

- A. Operate the dewatering system to lower water levels as required and then operate continuously 24 hours per day, 7 days per week until all facilities and structures affected by the dewatering have been satisfactorily constructed, including placement of fill materials.
- B. Maintain groundwater levels low enough to fulfill the requirements of this Section and do not allow the water level to rise until constructed facilities are complete, so that the water can be allowed to rise without damaging facilities, their foundations, or surrounding areas and structures.
- C. Provide superintendence in accordance with the approved plan during all periods of dewatering. Superintendence means providing qualified Contractor personnel knowledgeable in operation and maintenance of dewatering system(s). The Contractor is responsible for any damage resulting from failure to maintain the dewatering system.
- D. Provide complete standby equipment and power sources available for immediate operation as may be required, to adequately maintain the dewatering on a continuous basis in the event that all or any part of the dewatering system becomes inadequate or fails. Provide an automatic switchover system to the standby power source to ensure uninterrupted power supply to pumps in an emergency. Spare pumps shall be automatically engaged if primary pumps fail for any reason.
- E. When the dewatering system does not meet the specified requirements, and as a consequence, loosening or disturbance of the foundations strata, instability of the slopes, or damage to the foundations or structures occurs, the Contractor is responsible for supplying all materials and labor and performing all work for restoring foundation soils, slopes, foundations, and structures, to the satisfaction of the Engineer, and at no additional cost to the Owner.
- F. When failure to provide adequate dewatering and drainage causes disturbance of the soils below design foundation or excavation grade, provide adequate dewatering and excavate and re-fill the disturbed areas with approved, properly compacted fill material. Such work shall be at the Contractor's expense and at no additional cost to the Owner.

### **3.3 REMOVAL**

- A. Obtain written approval from the Engineer before discontinuing operation of any portion of the dewatering system(s).
- B. Remove all elements of the dewatering system(s) from the site at the completion of dewatering work.

## SECTION 02275

### RIPRAP AND RIPRAP BEDDING

#### PART 1 - GENERAL

##### 1.1 SECTION INCLUDES

- A. Furnish all labor, equipment, and materials necessary for placing boulders, riprap, riprap bedding, and grouting in conformance with the Construction Drawings and Specifications.

##### 1.2 RELATED SECTIONS

- A. Section 02240—Dewatering.

##### 1.3 REFERENCES

- A. Where reference is made to any standard, the version in affect at the time of bid opening shall apply.
- B. Colorado Department of Transportation
  - 1. Standard Specifications for Road and Bridge Construction.

##### 1.4 SUBMITTALS

- A. Submit under provisions of Section 01300.
- B. Certification: Submit certification stating both source of stone and that materials for all types of riprap will meet requirements of this Section.
- C. Product Data: Descriptions of all materials to be provided under this Section. In addition, provide sample of angular stone.
- D. Riprap Bedding
  - 1. Gradation test results for each type of riprap bedding shall be submitted.

#### PART 2 - PRODUCTS

##### 2.1 MATERIALS

- A. Riprap Bedding
  - 1. Imported bed course material for slope protection, or riprap filter blanket, shall be a porous free draining material consisting of sand, gravel, crushed stone or other approved free draining material. This material shall meet the following gradation requirements:

**GRADATION FOR GRANULAR BEDDING**

<b>Sieve Size</b>	<b>% by Weight Passing</b>
	<b>Type I</b>
3/8"	100
#4	95-100
#16	45-80
#50	10-30
#100	2-10
#200	0-2

**B. Riprap**

- Imported riprap stone shall be rough, fractured to sub angular, and have a specific gravity of at least 2.65. Riprap shall consist of individual angular rock fragments which shall be unweathered, dense, hard, sound, and resistant to abrasion; shall be free from cracks, seams, and other defects that would tend to unduly increase their destruction by water and frost action. Boulder and riprap stones shall be nearly cubical as possible, with neither breadth nor thickness of a single stone less than one-third of its length. Thus, slab type stones, flaking rock, rounded stones, asphalt, broken concrete, concrete slabs, or other materials not classified as rock will not be allowed for use as boulders or riprap material. Riprap shall be clean, free of fines, and shall meet the following requirements:

**CLASSIFICATION AND GRADATION OF RIPRAP**

<b>Riprap Designation</b>	<b>% Smaller Than Given Size by Weight</b>	<b>Intermediate Rock Dimension (inches)</b>	<b>D50* (inches)</b>
Type VL	70 – 100	12	6
	50 – 70	9	
	35 – 50	6	
	2 – 10	2	
Type L	70 – 100	15	9
	50 – 70	12	
	35 – 50	9	
	2 – 10	3	
Type M	70 – 100	21	12
	50 – 70	18	
	35 – 50	12	
	2 – 10	4	
Type VH	100	42	24
	50 – 70	33	
	35 – 50	24	
	2 – 10	9	

\* D50 = Median Particle size.

**C. Void-Filled Riprap**

- Where “Void-Filled Riprap” is designated on the Drawings, riprap shall be mixed with the materials and associated portions listed in the table below:



**MIX REQUIREMENTS FOR TYPE VL AND L VOID-FILLED RIPRAP**

Approx. Proportions (Loader Buckets)	Material Type	Material Description
6	Riprap	Type VL or L
1	Void-fill material	2- to 4-inch diameter cobble (round washed river rock that is well-graded, 100% passing 6-inch sieve, 35-50% passing 3-inch sieve, 5-20% passing 2-inch sieve).
1	Void-fill material	4-inch minus pit run surge (round river rock and sand, well graded, 90-100% passing 4-inch sieve, 70-80% passing 1.5-inch sieve, 40-60% passing 3/8-inch sieve, 10-30% passing #16 sieve).
1	Void-fill material	Riprap bedding material.
½ to 1	Void-fill material	Native topsoil.
Top Layer	Top dressing	Additional 4- to 12-inch diameter cobbles (round washed river rock that is well graded, 80-100% passing 12-inch sieve, 35-50% passing 6-inch sieve, 5-20% passing 4-inch sieve) shall be mixed in on the surface of exposed sections of void-filled riprap (covering approximately 15% of the surface) prior to compaction of the void-filled riprap. Cobbles shall be fully embedded into the mass of the void-filled riprap.

**PART 3 - EXECUTION**

**3.1 GENERAL**

- A. No riprap bedding or riprap shall be placed until the subgrade has been prepared, dewatered and properly compacted, or otherwise prepared in accordance with the provisions of the Specifications and as specified on the Drawings. No material shall be placed until the subgrade has been checked and approved by the Engineer in writing.

**3.2 PLACEMENT OF RIPRAP BEDDING**

- A. All riprap bedding shall be placed uniformly under all placed riprap material, including replenished riprap materials, to a minimum thickness of 6 inches, and shall not account for the minimum thickness of riprap as shown on the Drawings. Uniform spreading of all riprap bedding shall be done using approved devices and machinery. Excessive rutting of the finished bedding surface shall be avoided. Riprap bedding shall be kept clean and free of other soils. If the riprap bedding is contaminated with other soils or deleterious material, it shall be removed and replaced by the Contractor immediately. Where compaction is required, the bedding shall be compacted to 65% relative density (ASTM D4253).

### **3.3 RIPRAP PLACEMENT**

- A. Riprap shall be placed with a maximum drop height of 3 feet to reduce segregation of particle sizes. Placing in layers or by dumping into chutes or similar methods which may cause segregation are specifically prohibited. The riprap shall be placed, in one preparation, to the line, grade, and thickness as shown on the drawings, without undue displacement of the granular filter bedding underneath.
- B. Riprap shall be placed to grade in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the spaces between the larger rock fragments in such a manner as will result in a well-keyed, densely placed, uniform layer of riprap of the specified thickness. Consolidation of the riprap by backhoe or other means will be necessary to ensure interlocking of rock fragments. Placed riprap shall be uniform and free from bulges, humps, or cavities. Hand placing will be required only to the extent necessary to secure the results specified above.
- C. The entire mass of riprap shall be placed on either channel slope or bottom so as to be in conformance with the required gradation mixture and to line, grade, and thickness shown on the Drawings.
- D. Riprap shall be placed to full course thickness at one operation and in such a manner as to avoid displacing the underlying bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.
- E. All material used for riprap protection for channel slope or bottom shall be placed and distributed such that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.
- F. The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials.
- G. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the rock layer thickness shall not be allowed.
- H. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism.
- I. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material.
- J. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.
- K. Contractor shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the Drawings at no additional cost to Owner. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

### **3.4 VOID-FILLED RIPRAP PLACEMENT**

- A. The Engineer shall observe mixing and placing of the void-filled riprap material.
- B. Approved individual component materials of void-filled riprap mix shall be delivered to site in separate marked stockpiles. Mixing shall be accomplished using a front-end loader or other approved means to add the specified number of "loader buckets" of each material to a mixing stockpile. Ensure that each loader bucket comprises an approximately equal volume. If the loader operator is only able to fill the bucket partially full with large riprap (due to the force required to push the bucket into the pile), but uses full buckets of finer material, the mix proportions will not be correct. Avoid picking up

excessive amounts of native soil from the subgrade under the stockpiled materials during the loader bucket mixing operations. The Engineer may reduce or eliminate the volume of topsoil added to the mixture based on the amount of native soil was incorporated during the bucket mixing operation.

- C. Once all the materials have been added to the mixing stockpile in the specified proportions, thoroughly mix the pile using a loader, large track hoe excavator, or other approved means to fill the voids of the riprap without displacing the riprap or creating pockets of finer material absent of riprap.
- D. Segregation of materials shall be minimized when hauling from the stockpile to the installation location. Remixing shall occur as necessary to correct for any segregation as the material is placed.
- E. The loose material shall be placed in a single lift of sufficient height such that final grade will be achieved upon compaction. Additional mixing with a track excavator shall be required after initial placement to ensure that the void-filled riprap is thoroughly mixed and no segregation or excessive amount of smaller void-fill material is present on the surface. The mixing and placement process shall result in larger riprap (D50 size or larger) flush to the top surface with faces and shapes arranged to minimize voids, and smaller material between and below larger materials.
- F. If the top of the compacted material is below final grade, placement of only the smaller void-fill materials to achieve final grade will not be permitted. Additional void-filled riprap shall be added and the entire section mixed with a track excavator to eliminate the presence of smaller void-fill material on the surface.
- G. Avoid segregation of materials and remix any section where the combined material consists primarily of the void-fill materials. The density and interlocking nature of riprap in the mixed material shall essentially be the same as if the riprap was placed without filling the voids. This requires care and persistence on the part of the Contractor to install the work correctly.
- H. At the direction of the Engineer, a 50:50 mixture of pit run and riprap bedding material shall be sprinkled on the surface of the void-filled riprap and washed-in with water using a high pressure hose to fill-in small voids. This shall be done just prior to compaction of the void-filled riprap.
- I. If specified as part of the cobble mix, the top dressing of cobbles shall also be mixed in on the surface of exposed sections of void-filled riprap material prior to compaction of the riprap material.
- J. Compaction of the void-filled riprap shall be performed by running over the void-filled riprap with a large, heavy duty track excavator or dozer. The moisture content of the mixture shall be at optimum conditions prior to compaction and water shall be added, as necessary, at the direction of the Engineer. Compaction of void-filled riprap shall be reviewed and approved by the Engineer.
- K. Where indicated on the Drawings, a surface layer of 4 to 6 inches moist topsoil shall be placed over the void-filled riprap. The topsoil surface layer shall be compacted to approximately 85% of maximum density and within two percentage points of optimum moisture in accordance with ASTM D698. Topsoil shall be added to any areas that settle.
- L. Contractor shall install a test section of at least 100 square feet of void-filled riprap for the review and approval of the Engineer prior to installation of the remaining void filled-riprap.
- M. Elevation tolerance for the void-filled riprap shall be 0.10 feet. Thickness of void-filled riprap shall be no less than thickness shown and no more than 2-inches greater than the thickness shown.

### **3.5 TOLERANCES**

- A. Thickness: Minus 10 percent to plus 20 percent as shown on Drawings.

## SECTION 02960

### TEMPORARY SANITARY SEWER BYPASS PUMPING

#### PART 1 - GENERAL

##### 1.1 SECTION INCLUDES

- A. Temporary sanitary sewer bypass pumping to maintain sanitary sewer service during construction.

##### 1.2 RELATED SECTIONS:

- A. All Sections.

##### 1.3 SUBMITTALS

- A. Submittals shall conform to requirements of Section 01300 – Submittal Procedures.
- B. Submit Temporary Sanitary Sewer Bypass Plan for review by the Engineer and Owner prior to start of any fieldwork. A Professional Engineer licensed by the State of Colorado shall sign the Plan. The Plan shall include the following:
  - 1. Names and qualifications of equipment suppliers and installation subcontractors. The Contractor shall document at least 5 years of experience and verifiable history of projects requiring bypass pumping.
  - 2. A description of the proposed temporary bypass systems indicating arrangement, location, capacities of system components, installation details and criteria, and operation and maintenance procedures. This description shall also include the following information:
    - a. Bypass pumping phasing plan with exhibits and descriptions for each phase, including a schedule for installation and maintenance of bypass pumping system, and staging areas for pumps.
    - b. Bypass pump sizes, capacity, number of each size to be onsite, and power requirements.
    - c. Size, length, material, location, and method of installation for suction and discharge piping.
    - d. Standby power generator size and location.
    - e. Method of noise control for each pump and/or generator.
    - f. Design calculations demonstrating adequacy of the proposed systems for intended applications. Calculations shall include flow and head calculations including friction loss for the length and type of pipe and static head.
    - g. Bypass pump curve(s) showing pump operating range.

- h. Daily operations of the pump(s) and the maintenance of the pump(s) during the non-working hours.
    - i. Calculation of available time between pump failure and flooding, backups, etc.
  - 3. Diagrams indicating the location of all system components, including, but not limited to, pumps, pipes, catch points, and discharge points. Include road crossing details.
  - 4. Name and telephone number for the Sewer Flow Control Supervisor who is to be on call 24 hours per day while pumps are in operation.

#### **1.4 ENVIRONMENTAL REQUIREMENTS**

- A. Comply with Colorado Department of Public Health and Environment (CDPHE) guidelines.

### **PART 2 - PRODUCTS**

#### **2.1 EQUIPMENT AND MATERIALS**

- A. Contractor shall provide all labor, materials, and equipment necessary to provide adequate sanitary sewer bypass during construction of the Project without causing damage to public or private property or allowing unauthorized discharges of sanitary sewer flows.
- B. The Contractor is responsible for determining the capacity of the sanitary sewer bypass system. The Contractor shall consider the “full pipe” capacity of the sewer system being bypassed when determining the capacity of the bypass system. Based on City of Greeley modeling data, the peak hourly flow rate is expected to be approximately 1,550 GPM through the 18-inch diameter pipe, and the peak hourly flow rate is expected to be approximately 176 GPM through the 12-inch diameter pipe. Equipment and materials to provide this range of flow capacity are at the option and risk of Contractor.
- C. Temporary Bypass Pumping System: All bypass pumping system materials shall be suitable for contact with domestic sanitary sewage. The bypass pumping system shall include the following components:
  - 1. Bypass pump(s) with sufficient capacity to bypass sanitary sewer flows without causing damage to public or private property.
  - 2. Backup pump(s) on site to provide 100% redundancy; backup pumps shall be isolated from the primary system by a valve.
  - 3. Bypass pumping control system.
  - 4. Bypass pumping system failure alarm(s).
  - 5. Discharge piping with leak-free joints.
- D. Temporary Pumps: Pumps utilized in the bypass pumping system shall be self-priming and non-clog type capable of passing a non-compressible four-inch (4”) sphere, designed for pumping domestic sewage containing solids and stringy materials. Pumps shall not require the use of foot

valves or vacuum pumps in the priming system. All pumps used must be constructed to allow dry running for long periods of time to account for the cyclical nature of effluent flows. The pumps may be electric, or diesel powered. Engine exhaust shall be invisible, without objectionable fumes, smoke, oil mist, or carbon particles. Provide equipment of sufficient capacity to handle peak flow rates.

- E. Discharge and suction piping sizing shall be determined according to flow calculations and system operating calculations.
- F. High Density Polyethylene (HDPE): Piping shall be homogenous throughout, free of visible cracks, discoloration, pitting, varying wall thickness, holes, foreign material, or other deleterious faults. Pipe shall be assembled and joined on site using coupling, flanges, or butt-fusion method to provide leak proof joints. Thread or solvent joints are not acceptable. Pipe fusion shall be carried out by personnel certified as fusion technicians by manufacturer of HDPE pipe and/or fusing equipment. Butt-fusion joints shall be true alignment and uniform roll-back beads resulting from use of proper temperature and pressure.
- G. Flexible Hoses and Associated Couplings and Connectors: Flexible hose and couplings shall be abrasive resistant and suitable for the intended services (i.e., fire hoses are not permitted). They shall be rated for external and internal loads anticipated including test pressure. External load design shall incorporate anticipated traffic loadings, including traffic impact loading where applicable. When subjected to traffic loading, the system shall be composed of traffic ramps and covers maintaining an H-20 loading requirement while in use or as directed by the Engineer.
- H. All rigid or hard piping shall be constructed with positive restrained joints.
- I. Under no circumstance will aluminum irrigation type piping or glued PVC pipe be allowed.
- J. Unmanned Bypass Pumping: All unmanned bypass pumping operations shall be fitted with an auto-dialer feature to monitor the operation of the pump and notify the Contractor in the event of a pump failure or overflow situation.
- K. Noise Control: Bypass pumping system components shall not have excessive noise levels and shall be restricted to a maximum of seventy decibels (70 dB) at a distance of 100 feet. If pumping is required on a 24-hour basis, engines shall be equipped in a manner to keep noise to a minimum.

## **PART 3 - EXECUTION**

### **3.1 TEMPORARY BYPASS PUMPING**

- A. Sanitary sewer bypass shall be completed in such a manner that there is no damage to public or private property. Repair and reparations for damage caused by or associated with sanitary sewer flows are the sole responsibility of the Contractor to fix, repair, clean and make whole.
- B. Sewage Spills: Violations of any state or federal laws caused by sewage spills shall be the sole responsibility of the Contractor. Should any liquid or solid matter from the sewer collection system be spilled, discharged, leaked, or otherwise deposited to the open environment as a result of the bypass operations, Contractor shall be responsible for all cleanup and disinfection of the affected area and all associated costs. The Contractor shall also be responsible for notifying the Owner, sewer system operating personnel, and appropriate regulatory agencies and performing all required cleanup operations at no additional cost to the Owner.

## **SECTION 02960 TEMPORARY BYPASS PUMPING**

- C. Install, operate, and maintain temporary bypass systems in accordance with the Temporary Bypass Plan. Notify Engineer in writing of any changes made to accommodate field conditions and changes to the Work. Provide revised drawings and calculations with such notification.
- D. In the event of accidental spill or overflow, immediately stop the overflow and take action to clean up and disinfect spillage. Promptly notify Engineer so that required reporting can be made to the Colorado Department of Public Health and the Environment (CDPHE).
- E. Flow shall not be transferred to any new or modified facilities until the Owner has inspected and accepted the work.

### **3.2 FIELD QUALITY CONTROL AND MAINTENANCE**

- A. Testing: Contractor shall perform leakage and pressure tests of the bypass pumping discharge piping using clean water prior to actual operation. The Owner will be given 24 hours' notice prior to testing.
- B. Inspection: Contractor shall inspect bypass pumping system every two hours to ensure that the system is working properly.
- C. Maintenance Service: Contractor shall ensure that the temporary pumping system is properly maintained.
- D. A Sewer Flow Control Supervisor is required to be on call 24 hours per day and be physically located within 30 minutes of the project site at all times while the pumps are in operation. The Sewer Flow Control Supervisor shall be knowledgeable in the operation of the sanitary sewer bypass system and shall have the authority to purchase replacement parts as needed to repair the sanitary sewer bypass system.
- E. Extra Materials:
  - 1. Spare parts for pumps and piping shall be kept on site as required.
  - 2. Adequate hoisting equipment for each pump and accessories shall be maintained on the site.

### **3.3 PREPARATION**

- A. Precautions:
  - 1. Contractor is responsible for locating any existing utilities in the area the Contractor selects to locate the bypass pipelines. The Contractor shall locate their bypass pipelines to minimize any disturbance to existing utilities and shall obtain approval of the pipeline locations from the Owner. All costs associated with relocating utilities and obtaining approvals shall be the responsibility of the Contractor.
  - 2. During all bypass pumping operation, the Contractor shall protect the pumping station and main and all local sewer lines from damage inflicted by any equipment. The Contractor shall be responsible for any physical damage to the pump station and mains and all local sewer lines caused by human or mechanical failure.

B. Notifications:

1. Contractor shall notify property owners, residents, and business managers in writing prior to plugging, bypassing, or otherwise affecting a sewer service. This notification shall be provided a minimum of 72 hours in advance, but no more than 144 hours in advance prior to plugging or bypassing a sewer service. Contractor shall not plug a sewer service for more than 4 hours without providing additional accommodations.

**3.4 INSTALLATION AND REMOVAL**

- A. Contractor shall remove manhole sections or make connections to the existing sewer and construct temporary bypass pumping structures only at the access location indicated on the Drawings and as may be required to provide suction conduit.
- B. Plugging or blocking of sewage flows shall incorporate primary and secondary plugging devices. When plugging or blocking is no longer needed for performance and acceptance of Work, it is to be removed in a manner that permits the sewage flow to slowly return to normal without surge, to prevent surcharging, or causing other major disturbances downstream.
- C. When working inside a manhole or force main, the Contractor shall exercise caution and comply with OSHA requirements for working in the presence of sewer gases, combustible oxygen-deficient atmospheres, and confined spaces.
- D. The installation of bypass pipelines is prohibited in all saltmarsh/wetland areas. The pipeline must be located off streets, sidewalks, and on shoulders or the roads. When the bypass pipeline crosses local streets and private driveways, where roadway ramps cannot be used, the Contractor must place the bypass line in trenches and cover with temporary pavement or plates.
- E. Upon completion of the bypass pumping operations, and after the receipt of written permission from the Owner, the Contractor shall remove all piping, restore all property to pre-construction condition, and restore all pavement and roadways. The Contractor is responsible for obtaining any approvals for placement of temporary pipelines from local agencies.



## SECTION 11285

### SLIDE GATES

#### PART 1 - GENERAL

##### 1.1 SECTION INCLUDES

- A. Furnish all materials and services necessary for the slide gate system as shown on the Contract Drawings and as specified in accordance with provisions of the Contract Documents, and completely coordinated with work of all other trades. Although such work is not specifically shown or specified, furnish all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure and complete installation.
- B. Furnish all materials and services necessary for the installation of the handwheel on the dissipation structure.

##### 1.2 RELATED SECTIONS

- A. Section 03300—Cast-In-Place Concrete

##### 1.3 REFERENCES

- A. Where reference is made to any standard, the version in affect at the time of bid opening shall apply.
- B. American Society for Testing and Materials International (ASTM):
  - 1. A36: Standard Specification for Carbon Structural Steel
  - 2. A126: Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
  - 3. A307: Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod
- C. American National Standards Institute / American Water Works Association (ANSI/ AWWA):
  - 1. C560: Cast-Iron Slide Gates
- D. The Society for Protective Coatings/National Association of Corrosion Engineers (SSPC/NACE):
  - 1. SSPC SP 10/NACE No. 2 – Near-White Blast Cleaning

##### 1.4 SUBMITTALS

- A. General:
  - 1. Submit under provisions of Section 01330—Submittals.
  - 2. Prior to manufacturing any of the components for the installation of the slide gate and appurtenances, detailed shop drawings shall be submitted to the Engineer for approval.
  - 3. Manufacturer drawings shall be certified as meeting ANSI/AWWA C560 Standards for dimensions, construction, and materials used for all parts of the slide gate and manual slide-gate actuator mechanism.

## **1.5 SYSTEM WARRANTY**

- A. Defects in material or workmanship of new system components shall be repaired or replaced at no cost to the Owner for a period of two (2) years from date of final completion as determined by the Engineer and Owner.

## **PART 2 - MATERIALS**

### **2.1 GENERAL**

- A. The slide gate shall be installed on the outlet end of the non-potable water pipe at the dissipation structure.
- B. The slide gate shall be designed for totally submerged silty conditions.
- C. The slide gate handwheel shall be installed on the dissipation structure at the top of the ditch in accordance with the Drawings.
- D. The slide gate shall be rated for 20 feet of seating head and 10 feet of unseating head.
- E. The slide gate operator shall be lockable.

### **2.2 SLIDE GATE MATERIALS**

- A. Seat – Cast Iron – ASTM A126, Class B
- B. Slide – Cast Iron – ASTM A126, Class B
- C. Cross Bar – Cast Iron – ASTM A126, Class B
- D. Cross Bar Bolt & Nut – Steel, Plated – ASTM A307, A164
- E. Wedge – Cast Iron – ASTM A126, Class B
- F. Wedge Fasteners – Steel, Plated – ASTM A307, A164
- G. Side Angle – Steel, Galvanized – ASTM A36
- H. Stem Support – Steel, Galvanized – ASTM A36
- I. Head Bar – Steel, Galvanized – ASTM A36
- J. Head Bar Fasteners – Steel, Plated – ASTM A307, A164
- K. Stem – Steel – ASTM A108, Grade 1045
- L. Keeper – Cast Iron – ASTM A126, Class B
- M. Keeper Bolts & Nuts – Steel, Plated – ASTM A307, A164
- N. Lift Nut – Brass – ASTM B584, Alloy 844
- O. Stop Nut – Brass – ASTM B16
- P. Handwheel – Cast Iron – ASTM A126, Class B

- Q. Handwheel Set Screw – Steel, Plated – ASTM A307, A164
- R. Stem Supt., Bolts/Nuts – Steel, Plated – ASTM A307, A164

### **2.3 Manufacturers**

- A. Series 6400 as manufactured by Fresno Gates.
- B. Series C-20 as manufactured by Waterman USA.
- C. Approved equal.

## **PART 3 - EXECUTION**

### **3.1 TESTING**

- A. Field Leakage Test:
  - 1. A field leakage test shall be performed by the Contractor after installation of the slide gate.
  - 2. The manufacturer shall be notified of the test in sufficient time to enable manufacturer to have a representative present for that test.
  - 3. After all adjustments have been made and the mechanisms properly lubricated, each gate slide shall be run through three complete cycles as a final check on proper operation before starting the leakage test.
  - 4. Seating and unseating heads shall be measured from the top surface of the water to the center of the gate.
  - 5. At the design seating head, the leakage shall not exceed 0.1 gpm per foot of seating perimeter.
- B. Manufacturer's Representative:
  - 1. The system manufacturer shall provide a field representative for a minimum of one (1) day of field time as required to inspect, test, or approve all aspects of the installation.

**35<sup>TH</sup> AVENUE UTILITY PROJECT PHASE 1**  
**CITY OF GREELEY CONSTRUCTION SPECIFICATIONS - VOLUME III (POTABLE WATER**  
**DISTRIBUTION, SANITARY SEWER COLLECTION, AND NON-POTABLE IRRIGATION SYSTEMS)**

<u>SECTION</u>	<u>TITLE</u>
01713	Water Distribution System Testing
01715	Sewer and Manhole Testing
01785	Project Record Documents
02315	Excavation and Fill
02445	Casing Pipe – Borings and Encasements
02510	Water Utility Distribution Piping
02511	Disinfection of Water Utility Distribution
02512	Ductile-Iron Pipe
02513	Polyvinyl Chloride (PVC) Pressure Pipe
02514	Water Service Lines, Meters, and Appurtenances
02515	Water Utility Distribution Valves
02516	Water Utility Distribution Fire Hydrants
02530	Sanitary Utility Sewerage Piping
02533	Polyvinyl Chloride (PVC) Non-Pressure Pipe
02535	Sanitary Utility Sewerage Manholes, Frames, and Covers
02957	Sewer Manhole Rehabilitation A
02957	Sewer Manhole Rehabilitation B – Sewer Manhole Coating
03300	Cast-In-Place Concrete
03400	Precast Concrete
15140	Non-Potable Irrigation System

## **SECTION 01713**

### **WATER DISTRIBUTION SYSTEM TESTING**

#### **PART 1 – GENERAL**

##### **1.1 SCOPE**

- A. This section addresses the hydrostatic testing of potable water distribution and non-potable irrigation lines.
- B. The Contractor is responsible for the hydrostatic testing of water lines.

##### **1.2 SUBMITTALS**

- A. Testing Plan: Submit prior to testing and include the following:
  - 1. Testing dates.
  - 2. Piping systems and section(s) to be tested.
  - 3. Test type.
  - 4. Method of isolation.
  - 5. Calculation of maximum allowable leakage for piping section(s) to be tested.
- B. Certifications of Calibration for testing equipment, including pressure gauges, that are no more than 6 months old from date of use.
- C. Certified Test Report.

#### **PART 2 – PRODUCTS**

##### **2.1 PRESSURE GAUGES**

- A. Contractor shall supply all pressure gauges used for leakage testing meeting the following requirements:
  - 1. Dial Size: Nominal 2-inch dial size.
  - 2. Accuracy: 2 percent of span.
  - 3. Scale Range: Such that normal operating pressure lays between 50 percent and 80 percent of the scale range.
  - 4. The maximum allowable pressure gauge increment shall be five (5) psi.

#### **PART 3 – EXECUTION**

##### **3.1 GENERAL**

- A. Testing shall be conducted when:

1. Backfill and compaction has been completed, but before street improvements are installed.
2. Main has been flushed.
  - a. Disinfection shall occur after leak testing is completed and accepted. Disinfection to follow construction specification *Section 02511, Disinfection of Water Utility Distribution*.
- B. Contractor shall ensure that thrust blocking or other types of restraining systems will provide adequate restraint prior to pressurizing the system.
  1. At least seven (7) days shall have elapsed since the last concrete thrust restraint was cast.
  2. A minimum of seventy-two (72) hours shall elapse if high-early-strength cement is used.
- C. The Contractor shall provide all equipment and personnel to perform the hydrostatic test.
  1. Test equipment shall be able to maintain a continuous internal pipe pressure required for the test psi and accurately measure leakage from the pipe over a two (2) hour, minimum, test period.
  2. A water meter shall be used to measure the amount of water used in pressurizing the system.
- D. When existing water mains are used to supply the test water, they shall be protected from backflow pressures by temporarily installing a double check-valve assembly between the test and the supply main.
- E. Do not test against the City's existing valves.
  1. Provide temporary watertight plugs and temporary thrust restraint until tests pass.
  2. After system passes testing, remove plugs and thrust restraint and connect to existing valve with cut-in sleeve or solid sleeve.
- F. New Piping Connected to Existing Piping:
  1. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to the City.
  2. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by the City.
- G. The City shall be notified 48 hours in advance of testing. The City shall witness tests and record times, leakage readings, and pressure over the test period.
- H. A hydrostatic pressure test shall be performed against all new valves at the point of connection to the existing system. This test shall be performed prior to connecting the new system to the existing one.
- I. Only City personnel shall operate existing City owned valves.
- J. Filling the Line

1. Potable water shall be used. An alternative water source will require prior approval from the City.
  2. When filling the pipeline, it shall be filled at a rate which will not cause surges nor will it exceed the rate at which the air can be released.
  3. Where permanent air release vents are not available, the Contractor shall install corporation stops at high points in the water line in order to evacuate trapped air.
  4. All corporation stops, which were installed to facilitate evacuation of air from the water main, shall be removed and plugged with a “cc” threaded brass plug after the water main is filled, and prior to pressure testing.
- K. Pipe shall remain filled with water for a minimum of twenty-four (24) hours prior to the hydrostatic pressure test.
- L. Prior to the tests, inspect valves within the test section to make sure they are fully operational.
- M. Operate all valves in the system in the presence of City personnel.
- N. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.

### 3.2 PRESSURE TEST

- A. “Leakage” is the quantity of water that must be added to the pipeline to maintain a pressure within five (5) psi of the specified test pressure after the air has been expelled and the pipe has been filled with water.
- B. Test pressure
1. Test pressure shall be 150 psi or 150% of the operating pressure, whichever is greater, at the highest elevation of the test section.
  2. A residual pressure, within five (5) psi of the test pressure, shall be maintained for a minimum two (2) hours.
- C. The maximum allowable leakage for each test section is determined by the following formula and table:

$$L = \frac{SD\sqrt{P}}{133,200}$$

Where: L = maximum allowable leakage, in gallons per hour  
 S = length of pipe tested, in feet  
 D = nominal pipe diameter, in inches  
 P = average test pressure during the leakage test, in psi (gauge)

There will be no additional leakage allowance for valves.

- D. If the pipeline under test contains sections of various diameters, the allowable leakage will be the sum of the computed leakage for each size.

### **3.3 PASSING**

- A. If the tests disclose leakage greater than that specified, the defective materials and joints shall be located and repaired. The tests shall be repeated until the leakage is less than the maximum allowed.
- B. With the exception of obvious leaks, passing of the pressure test shall be on the basis of maximum allowable leakage per section tested. No leakage is allowed through the bonnet of any valve or appurtenance. Any valve or appurtenance that is tested and leaks will be removed and replaced.
- C. All visible leaks shall be repaired regardless of maximum allowable leakage.



## SECTION 01715

### SEWER AND MANHOLE TESTING

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the testing of sanitary sewer collection mains, manholes, and appurtenances.
- B. All sanitary sewer pipelines shall be air tested per these specifications.
- C. All sanitary sewer manholes shall be vacuum tested per these specifications.
- D. All sanitary sewer collection systems shall be video inspected per these specifications.

##### 1.2 REFERENCES

- A. ASTM International (ASTM)
  - 1. C1244, Standard Test Method for Concrete Sewer Manholes by Negative Air Pressure (Vacuum) Test Prior to Backfill, latest revision.
  - 2. F1417, Standard Test Method for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air, latest revision.

##### 1.3 SUBMITTALS

- A. Video Inspections
  - 1. DVDs
    - a. Submit three copies of completed, narrated, color DVDs identified by Project name, street name, right-of-way property name, and manhole numbers.
    - b. DVDs become property of the City of Greeley Water and Sewer Department
  - 2. Inspection Logs
    - a. Submit cleaning and television inspection logs for each section of sewer line to be rehabilitated.
    - b. Include the following minimum information
      - i. Stationing and location of lateral services, wyes, or tees
      - ii. Date and clock time references
      - iii. Pipe joints
      - iv. Infiltration/Inflow defects
      - v. Cracks

- vi. Leaks
    - vii. Offset joints
  - 3. Submit specific detailed description of proposed bypass pumping system, including written description of plan addressing schedule, quantity, capacity, and location of pumping equipment.
  - 4. Submit spill plan to address any spills that might occur.
  - 5. Field Quality-Control Submittals: Indicate results of Contractor-Furnished tests and inspections.
  - 6. Qualifications Statement
    - a. Submit qualifications of applicator.
- B. Exfiltration and Infiltration Testing
  - 1. Submit the following items prior to the start of testing
    - a. Testing procedures
    - b. List of test equipment
    - c. Testing sequence schedule
    - d. Provisions for disposal of flushing and test water
    - e. Certification of test gage calibration
  - 2. Test and Evaluation Reports: Indicate results of manhole and piping tests
  - 3. Qualifications Statement
    - a. Submit qualifications for applicator
- C. Vacuum Testing
  - 1. Submit the following items prior to start of testing
    - a. Testing procedures
    - b. List of test equipment
    - c. Testing sequence schedule
    - d. Provisions for disposal of flushing and test water
    - e. Certification of test gage calibration
  - 2. Test and Evaluation Reports: Indicate results of manhole tests
  - 3. Qualifications Statement

- a. Submit qualifications for applicator
- D. Air Testing
  - 1. Submit the following items prior to the start of testing
    - a. Testing procedures
    - b. List of test equipment
    - c. Testing sequence schedule
    - d. Provisions for disposal of flushing and test water
    - e. Certification of test gage calibration
  - 2. Test and Evaluation Reports: Indicate results of piping tests
  - 3. Qualifications Statement
    - a. Submit qualifications for applicator
- E. Mandrel Testing
  - 1. Submit the following items prior to start of testing
    - a. Testing procedures
    - b. List of test equipment
    - c. Testing sequence schedule
    - d. Provisions for disposal of flushing and test water
    - e. Certification of test gage calibration
    - f. Deflection mandrel drawings and calculations
  - 2. Test and Evaluation Reports: Indicate results of piping tests.

## **PART 2 – PRODUCTS**

### **2.1 Video Inspections**

- A. DVDs
  - 1. Description: Digital video formatted discs
  - 2. Audio track containing simultaneously recorded narrative commentary and evaluations of videographer, describing in detail condition of pipeline interior.

### **2.2 Exfiltration and Infiltration Testing**

- A. Equipment

1. Plugs
2. Pump
3. Measuring device

### **2.3 Vacuum Testing**

- A. Equipment
1. Vacuum pump
  2. Vacuum line
  3. Vacuum tester base
    - a. Compression band seal
    - b. Outlet port
  4. Shutoff valve
  5. Stopwatch
  6. Plugs
  7. Vacuum Gage: Calibrated to 0.1 in. Hg

### **2.4 Air Testing**

- A. Equipment
1. Air compressor
  2. Air supply line
  3. Shutoff valves
  4. Pressure regulator
  5. Pressure relief valve
  6. Stopwatch
  7. Plugs
  8. Pressure Gage: Calibrated to 0.1 psi

### **2.5 Mandrel Testing**

- A. Equipment
1. Properly sized rigid ball or “go, no go” mandrel
  2. Pull/retrieval ropes

## **PART 3 – EXECUTION**

### **3.1 GENERAL**

- A. Testing shall be conducted when:
  - 1. Backfill and compaction has been completed, but before paving and curb gutter improvements are installed.
  - 2. Line and manholes have been thoroughly cleaned of all foreign material.
- B. The Contractor shall furnish all equipment, labor, and incidentals necessary to perform tests. The pressure gauge shall be capable of indicating pressure to the nearest 0.1 pounds per square inch (psi) increment.
- C. The City shall witness tests and record times, leakage readings, and pressure over the test period. Contractor shall provide the City a minimum forty-eight (48) hours advance notice of any tests.

### **3.2 ALIGNMENT TEST**

- A. Lamp testing shall be on an as needed basis at the City's discretion.
- B. Lamp each section of sanitary sewer between manholes to determine whether any displacement of pipe has occurred.
- C. Lamping shall be done after pipe trench is compacted and brought to grade or pavement subgrade.
- D. "Full moon" shall be visible for vertical grade alignment. No less than "half moon" shall be visible for horizontal alignment.
- E. Repair poor alignment, displaced pipe, or other defects discovered at the city's discretion.

### **3.3 PIPE DEFLECTION TEST**

- A. Mandrel testing shall be completed on an as needed basis at the City's discretion.
- B. Each section of sanitary sewer shall be tested for deflection by an independent testing firm as hired by the Contactor prior to City acceptance and as deemed necessary within the warranty period by the City.
  - 1. The maximum allowable deflection for City acceptance is 5% of the base internal diameter.
  - 2. The maximum allowable deflection at the end of the warranty period shall be 7.5% of the base internal diameter.
  - 3. Mandrel outside diameters in inches are as follows:

**TABLE 3.3-A: Allowable Pipe Deflection – Mandrel Test**

Pipe Size (in)	Base I.D.	5% Deflection Mandrel	7.5% Deflection Mandrel
8"	7.665	7.282	7.090
10"	9.563	9.085	8.846
12"	11.361	10.793	10.509
15"	13.898	13.203	12.856

- C. Sections of the pipe which fail the deflection test shall have the defects repaired and the test repeated.

**3.4 AIR TESTING SANITARY SEWER MAINS**

- A. Conduct tests in conformance with ASTM F1417 and these specifications.
- B. All pressures in this section assume no groundwater back pressure, if groundwater is present, increase test air pressures to compensate for the back pressure. Each foot of groundwater produces approximately 0.433 psi back pressure. For groundwater in excess of five feet (5') above the pipe crown, an infiltration test shall be used in lieu of air testing.
- C. Preparation for tests:
1. Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results.
  2. Provide a relief valve on the pressuring equipment to avoid over-pressurizing and damaging an otherwise acceptable line. Set relief valve at 5.0 psi.
  3. Plug and brace all openings in the main sanitary sewer line and the upper connections. Check all pipe plugs with a soap solution to detect any air leakage. If leaks are found, release the air pressure, eliminate the leaks and start the test procedures over again.
- D. Test Procedure:
1. Add air until internal pressure of the sewer line is raised to approximately 4.0 psi gage. Maintain the air pressure between 3.5 psig and 4.5 psig until the air temperature in the pipe is stabilized with the pipe/ground temperature.
  2. Disconnect the air supply and reduce the air pressure to 3.5 psig before starting the test.
  3. If the groundwater is higher than the top of the pipe, the test pressure shall be adjusted to account for the higher groundwater. The test pressure shall be increased by 0.433 psi per foot of ground water up to five (5) feet of groundwater. For groundwater over five (5) feet in depth, an infiltration test shall be conducted in place of the air test.
  4. Determine the time required for the air pressure to drop from 3.5 psig to 2.5 psig.
    - a. The time elapsed shall not be less than:

$$T = 0.085 \frac{DK}{Q}$$

Where: T = shortest time(s) allowed for the air pressure to drop 1.0 psig.  
 K = 0.000419DL but not less than 1.0  
 Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF  
 D = measured average inside diameter of pipe (in)  
 L = length of test section (ft)

- b. Example calculation for an eight-inch (8") diameter sanitary sewer pipe with a test section 400 feet long:

$$T = 0.085 \left[ \frac{8in(0.000419)(8in)(400ft)}{0.0015CFM / SF} \right]$$

T= 608 seconds or 10 minutes 08 seconds (10:08)

- c. The following table contains the test durations for pipe diameters between eight-inches (8") and fifteen inches (15"), for pipe lengths up to 500 feet.

**TABLE 3.4-D: Specified Test Duration for Length of Pipe Indicated (Duration indicated in min:sec)**

Pipe Diameter (in)	Pipe Length (feet)						
	0-150	200	250	300	350	400	500
8	7:34	7:34	7:34	7:36	8:52	10:08	12:38
10	9:26	9:26	9:53	11:52	13:51	15:49	19:45
12	11:20	11:24	14:15	17:05	19:56	22:47	28:26
15	14:10	17:48	22:15	26:42	31:09	35:36	44:26

5. If lateral or service lines are included in the test, their length may be ignored for computing required test time if the test time requirements are met. If the test section fails, time shall be recomputed to include all the lateral lengths using the following formula:

$$T = 0.085 \left[ \frac{D_1^2 L_1 + D_2^2 L_2 + \dots + D_n^2 L_n}{D_1 L_1 + D_2 L_2 + \dots + D_n L_n} \right] \frac{K}{Q}$$

Where:

T = shortest time(s) allowed for the air pressure to drop 1.0 psig.  
 K = 0.000419(D<sub>1</sub>L<sub>1</sub> + D<sub>2</sub>L<sub>2</sub> + ... + D<sub>n</sub>L<sub>n</sub>) but not less than 1.0  
 Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF  
 D<sub>1</sub>, D<sub>2</sub>, etc. = measured average inside diameter of pipe (in)  
 L<sub>1</sub>, L<sub>2</sub>, etc. = length of test section (ft)

If the recomputed test time is short enough to allow the section tested to pass, then the test section meets the requirements of this specification.

- E. Sections of the pipe which fail the air test shall have the defects repaired and the test repeated.

### **3.5 EXFILTRATION TEST**

- A. Exfiltration testing may only be completed upon approval from the City.
- B. Contractor shall provide a pre-approved device capable of measuring flow in the pipe in fifteen (15) minute intervals and providing a total flow at the end of the testing period.
- C. Flow measurement shall be twenty-four (24) hours minimum and shall be conducted before backfill and trench/area dewatering operations are complete.
- D. The maximum allowable exfiltration for sanitary sewers shall not exceed 50 gallons per day/inch nominal diameter pipe/mile (0.95 gpd/inch/100ft).

### **3.6 INFILTRATION TEST**

- A. If groundwater exists in excess of five feet (5') above the pipe crown an infiltration test for leakage shall be used.
- B. Contractor shall provide a pre-approved device capable of measuring flow in the pipe in fifteen (15) minute intervals and providing a total flow at the end of the testing period.
- C. Flow measurement shall be twenty-four (24) hours minimum and shall be conducted only after backfill and trench/area dewatering operations are complete and groundwater has returned to normal elevations.
- D. The maximum allowable infiltration for sanitary sewers shall not exceed 50 gallons per day/inch nominal diameter pipe/mile (0.95 gpd/inch/100ft).

### **3.7 VACUUM TESTING MANHOLES**

- A. Manholes shall be tested before the ring and cover and grade adjustment rings are installed, and after backfill and compaction is complete.
- B. Conduct tests in conformance with ASTM C1244 and these specifications.
- C. Preparation for tests:
  - 1. All lift holes, joints, and other imperfections shall be filled with an approved non-shrink grout, to provide a smooth finish appearance.
  - 2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manholes.
- D. Test Procedure:
  - 1. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendation.
  - 2. A vacuum of ten-inches (10") mercury shall be drawn in the manhole, the valve on the vacuum line of the test head closed, and the vacuum pump shut off.
  - 3. The time shall be measured for the vacuum to drop to nine-inches (9") mercury.
  - 4. The manhole shall pass if the time for the vacuum reading to drop from ten-inches (10") mercury to nine-inches (9") mercury meets or exceeds the values indicated in the



following table:

**TABLE 3.6-D: Manhole Vacuum Testing Durations**

Depth* (ft)	Diameter (in)		
	48	60	72
	Time (seconds)		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121
* Round actual depth of manhole to next depth up (ex. 11 foot deep manhole, use depth of 12 feet)			

- E. If the manhole fails any test, necessary repairs shall be made by an approved method and the manhole shall be retested until a satisfactory test is obtained.

**3.8 TELEVISIONING SANITARY SEWER MAIN**

- A. All sanitary sewer lines shall be televised prior to final acceptance and three (3) months prior to the end of the warranty period or as deemed necessary within the warranty/construction period by the City. The televising shall be made by the Contractor or a Sub-consultant to the contractor and the recording shall be submitted to the City for review and acceptance. The individual completing the video recording shall be NASSCO trained and certified.
  - 1. The recording shall be made using a color camera, self-propelled or other, having sufficient light to show detail of problem areas and joints.
  - 2. Camera shall have a swivel head capable of looking up each service connection.
  - 3. Camera speed shall not exceed three (3) ft/s.
  - 4. If problem area or concerns are seen by the operator, then the camera shall be backed up and an extended look at the area will be recorded.
  - 5. All recordings will have location (i.e. manhole # to manhole #), time, date, and footage displayed.
  - 6. All recordings will include an evaluation of the manholes.
- B. The warranty period for the sanitary sewer collection system WILL continue to be in effect for the time specified in these specifications or until the Water and Sewer Department has received and approved the video recordings, which ever is longer.

## SECTION 01785

### PROJECT RECORD DOCUMENTS

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the requirements for Project Record Documents.
- B. Reference *Section 2* of these Criteria for supplementary information to this specification.

##### 1.2 RECORD DOCUMENTS

- A. Quality Assurance:
  - 1. Furnish qualified and experienced person, whose duty and responsibility shall be to maintain record documents.
  - 2. Accuracy of Records:
    - a. Coordinate changes within record documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change.
    - b. Field verify all as-built dimensions and materials.
    - c. Purpose of Project record documents is to document factual information regarding aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive Site measurement, investigation, and examination.
  - 3. Make entries within 48 hours after receipt of information that a change in the Work has occurred.
  - 4. Prior to submitting each request for progress payment, the City may request review and approval of current status of record documents. Failure to properly maintain, update, and submit record documents may result in a deferral of the whole or any part of Contractor's Application for Payment, either partial or final.

#### PART 2 – PRODUCTS

#### SECTION NOT USED

#### PART 3 - EXECUTION

##### 3.1 MAINTENANCE OF DOCUMENTS AND SAMPLES

- A. Do not use Record Documents for construction purposes.
- B. Store documents in Contractor's field office apart from documents used for construction. Protect Record Documents from deterioration and store in a secure location.
- C. File documents and samples in accordance with the specification's section numbers.

- D. Maintain documents and samples in a clean, dry, legible condition and in good order.
- E. Documents shall be made available for inspection by the City upon request.

### **3.2 RECORDING DURING CONSTRUCTION**

- A. Label each drawing “RECORD DURING CONSTRUCTION DRAWING” in neat large-printed letters.
- B. Mark whichever drawing is most capable of showing “field” condition fully and accurately, however, where shop drawings are used for mark-up, record a cross reference at corresponding locations on the Record During Construction Drawings.
- C. Mark drawings legibly with a pen or pencil. Ink shall not be water based or subject to easy smearing. Use other colors to distinguish between variations in separate categories of work as follows:
  - 1. Red – Incorporated items (added)
  - 2. Green – Deleted items
  - 3. Blue – Comments for information only, not to be added to drawings (black shall not be used since it does not show well on black and white drawings)
  - 4. Yellow – Items marked as “correct”
  - 5. Orange – Items addressed by drafting (pickups) to check your own work
- D. Date entries.
- E. Call attention to entry by “cloud” drawn around area or areas affected.
- F. Record information concurrently with construction progress.
- G. Record new information which is recognized to be of importance to the City that was not shown on the Construction Drawings or shop drawings. Give particular attention to concealed work which would be difficult to measure and record later.
- H. Record all field dimensions, elevations, details, deviations in sizes, locations, materials, or other features of the Work. It shall be possible, using these Record During Construction Drawings to correctly and easily locate, identify, and establish dimensions of work features which will be concealed in finished work or underground.
- I. Establish locations of concealed and underground work, utilities and appurtenances, with accurate horizontal and vertical dimensions. Horizontal locations shall be referenced to a minimum of two (2) permanent surface improvements. Vertical element locations shall be in relation to the project vertical datum.
- J. Do not backfill, cover, place or proceed with any work until necessary Record During Construction Drawings information is obtained.

### **3.3 RECORD DURING CONSTRUCTION DRAWINGS AND SUBMISSION**

- A. Contractor shall submit Record During Construction Drawing information to the Engineer of Record and City for review and approval.

1. The Engineer of Record and City shall review the submitted Record During Construction Drawing information and any corrections, additions, or omissions identified shall be incorporated into the Record During Construction Drawings by the Contractor prior to approval.
- B. Accompany the submittal to the Engineer of Record and City with a transmittal letter containing:
1. Date
  2. Project title and number
  3. Contractor's name, address, and telephone number
  4. Index containing title and number of each Record Document
  5. Signature of Contractor or his authorized representative
- C. Record During Construction Drawings shall be submitted and approved by the Engineer of Record and City prior to issuance of Substantial Completion.

### **3.4 FINAL AS-CONSTRUCTED RECORD DRAWINGS AND SUBMISSION**

- A. Engineer of Record shall incorporate changes from approved Record During Construction Drawings to produce final As-Constructed Record Drawings. As-Constructed Record Drawings shall be submitted to the City for review and approval within 3 months of the Engineer of Record receiving the approved Record During Construction Drawings.
1. The City shall review the submitted As-Constructed Drawing information and any corrections, additions, or omissions identified from the comparison to the approved Record During Construction Drawings shall be incorporated into the As-Constructed Record Drawings by the Engineer of Record prior to approval.
- B. Engineer of Record shall submit approved As-Constructed Record Drawings to the City as noted below within 1 month of City approval of As-Constructed Record Drawings:
1. 22" x 34" blueline or blackline form.
  2. Electronic PDF format
  3. AutoCAD per the most current version of "Electronic Data Submittal Standards (EDSS)"
  4. GIS shape files per the most current version of "Electronic Data Submittal Standards (EDSS)"

## SECTION 02315

### EXCAVATION AND FILL

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section covers excavation and trenching, including but not limited to dewatering, preparation of subgrades, pipe bedding, backfilling, compacting, groundwater barriers, materials testing, and finish grading for underground pipelines and appurtenances.

##### 1.2 REFERENCES

- A. American Association of State Highway and Transportation Officials (AASHTO)
  - 1. T26, Standard method of Test for Quality of Water to be Used in Concrete, latest revision.
  - 2. T99, Moisture–Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop (Method A), latest revision.
- B. American Concrete Institute (ACI)
  - 1. 305, *Hot Weather Concreting*, latest revision.
- C. ASTM International (ASTM)
  - 1. C33, *Standard Specification for Concrete Aggregates*, latest revision.
  - 2. C94, *Standard Specification for Ready-Mixed Concrete*, latest revision.
  - 3. C150, *Standard Specification for Portland Cement*, latest revision.
  - 4. D422, *Standard Test Method for Particle-Size Analysis of Soils*, latest revision.
  - 5. D448 (AASHTO M43), *Standard Classification for Sizes of Aggregate for Road and Bridge Construction*, latest revision.
  - 6. C618, *Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*, latest revision.
  - 7. D698, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>))*, latest revision.
  - 8. C1012/C1012M, *Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution*, latest revision.
  - 9. D1557, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft<sup>3</sup> (2,700 kn-m/m<sup>3</sup>))*, latest revision.
  - 10. D4318, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*, latest revision.

11. D4832, *Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders*, latest revision.
  12. D6023, *Standard Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)*, latest revision.
  13. D6024, *Standard Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application*, latest revision.
  14. D6938, *Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*, latest revision.
- D. (National Electrical Manufacturers Association (NEMA))
1. Z535.1, *Safety Color Code*, latest revision.
- E. Occupational Safety and Health Administration (OSHA)
1. 29 CFR Part 1926, *Safety and Health Regulations for Construction*, latest revision.

### 1.3 SUBMITTALS

- A. Dewatering
1. Water Control Plan: Submit for review by the City prior to start of any field work. At a minimum, the Water Control Plan shall include the following:
    - a. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, discharge locations to be utilized, and dewatering pollution control BMPs.
    - b. Drawings showing locations, dimensions, and relationships of elements of each system.
    - c. Design calculations demonstrating adequacy of proposed dewatering systems and components.
    - d. Surface water control and drainage installations and related pollution control BMPs.
    - e. Locations and types of monitoring systems.
    - f. Proposed methods and locations for disposing of the removed water.
    - g. Any treatment system in place to meet discharge quality criteria if applicable.
    - h. If the system is modified during installation or the operation, revise or amend and resubmit the Water Control Plan.
  2. Statement of Qualifications for Dewatering Specialist: Provide a summary of project experience and references for designer of dewatering systems.
  3. Well Permits: Submit to City before start of field work.

4. Discharge Permits: Submit to City before start of field work and keep onsite for the duration of the work.
- B. Fill and Backfill
1. Results of particle size testing of proposed offsite source material in accordance with ASTM D422.
  2. Results of Atterberg limit testing of proposed offsite source material in accordance with ASTM D4318 (fine-grained material only).
  3. Results of Modified proctor testing of proposed offsite source material in accordance with ASTM D1557.
  4. Certified test results from independent testing agency.
- C. Trench Backfill
1. Shop Drawings: Manufacturer's descriptive literature for marking tapes.
  2. Samples: Submit samples of materials proposed to be used in the Work to demonstrate material conformance with these Specifications.
    - a. Samples to be provided include:
      - i. Trench stabilization material.
      - ii. Bedding and pipe zone material.
      - iii. Granular drain.
      - iv. Granular backfill.
      - v. Earth backfill.
      - vi. CLSM.
      - vii. Geotextile.
  3. CLSM: Certified mix designs, certified laboratory performance of mix designs, and strength test results provided by a certified laboratory.
    - a. Include material types, weight per cubic yard, and 2- and 28-day unconfirmed compressive strengths for each component of CLSM mix.
      - i. Form a minimum of six test cylinders with proposed materials to confirm design strength and mix design in accordance with ASTM D4832. Break four of the cylinders at 7 days in conformance with applicable concrete cylinder specifications and provide test results to City for review. Break the remaining two cylinders at the discretion of City. Complete mix design and cylinder breaks at least 21 days prior to use of the material in the Work. Final mix approval and use of the material will not occur prior to confirmation for strength by the cylinder breaks.

- ii. Determine the materials and proportions used to meet the requirements of these Specifications. Continuously monitor soil composition. Perform sieve analysis and adjust CLSM mix if general composition changes or as directed by City. Modify CLSM mix as necessary to meet the strength, flowability, pumpability, and set time requirements for each individual pour.
  - iii. Do not place CLSM until City has approved the mix design. City's approval of the mix design indicates conditional acceptance. Final acceptance will be based on tests conducted on field samples and conformance with these Specifications.
- 4. Catalog and manufacturer's data sheets for compaction equipment.
- 5. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
- 6. Credentials of certified labs.
- 7. Description and location of proposed sources of imported material. Include documentation that imported materials are free of hazardous substances.
- 8. Test for conformance and submit certification and test records of materials showing that they meet the applicable requirements prior to commencing permanent placement of the materials for the Work. Tests, certification, and test records of materials will be performed within 6 months of submittal.
- 9. Submit a description of material testing work plan and program including as minimum onsite and offsite soils/materials laboratory testing facility location, facility details, testing certifications, experience of testing personnel, frequency of testing regarding material quality and material placement.

#### **1.4 CONSTRUCTION STAKING**

- A. Construction staking shall be performed under the direct supervision of a Professional Land Surveyor licensed in the State of Colorado.
- B. Adequate staking shall be provided to establish acceptable horizontal and vertical control.
- C. Offsets shall be staked so that the City Inspector may check vertical and horizontal alignment.
- D. All survey notes and construction staking notes shall be entered into bound, hard cover field books, kept at the construction site for the duration of the project, and shall be made available to the City upon request.
- E. All survey data, which is developed by the Contractor or the Engineer in performing surveys required by the work, shall be available to the City for examination and reproduction throughout the construction and warranty periods.
- F. The City Inspector shall be informed of all field changes to the City accepted Construction Drawings. Approval for the changes shall be required from the City prior to the changes being made in the field.



## 1.5 FIELD CONDITIONS

### A. Drainage and groundwater.

1. Keep excavations and trenches free of water during construction. Divert surface runoff and utilize sumps, gravel blankets, well points, drain lines or other means of dewatering, as necessary.
  - a. Dewater the excavation or trench until the structure, pipe, or other, to be installed therein, is completed to the extent that no damage from hydrostatic pressure, floatation, or other cause will result.
  - b. Water shall be removed from the trench to the extent necessary in order to provide a firm subgrade and dry conditions for pipeline installation.
2. The pipeline being constructed shall not be used for dewatering.
3. The piping used to dewater the trench shall not be left in the trench when backfilled.
4. Groundwater barriers shall be installed if groundwater is encountered or expected. Groundwater barriers shall be installed as shown on the drawings and, as necessary, every 400'. Refer to the City of Greeley Standard Drawing for additional installation requirements.
5. Prior to beginning dewatering operations, the Contractor shall obtain all necessary permits and appropriate authorization to start dewatering. If groundwater will be discharged or drained into an irrigation ditch, pond, stream or waterway, a CDPHE Dewatering Permit will be required.
  - a. The Contractor is required to complete and process the Discharge Monitoring Report (DMR) that is typically a part of the Dewatering Permit.
  - b. Upon completion of the work, the Contractor shall be responsible for completing a CDPHE Discharge Termination Notice.

### B. Blasting is not permitted within the jurisdiction of the City unless otherwise authorized by the City. If authorized, permitting and requirements associated with blasting are the responsibility of the Contractor.

### C. Sequencing

1. Backfill shall be completed, at the end of each day, to the extent that no damage from hydrostatic pressure, flotation, or other causes will result.
2. Where excavation is a hazard to automotive or pedestrian traffic, the amount of open trench and the time duration of that opening shall be minimized. The City shall direct the amount of open trench that is acceptable for the condition encountered.
3. During construction, maintain access to private residence and businesses.

### D. Underground Obstructions

1. It is the Contractor/City's responsibility to call for utility locates. Call UNCC at 1-800-922-1987 or dial 811 for locates.

2. The Contractor shall expose and verify the size, location, and elevation of underground utilities and other obstructions, sufficiently in advance of construction to permit changes to be made to the Construction Drawings in the event there is a conflict with the proposed and existing utilities. In the event there is a conflict, the Contractor shall notify the City, and affected utility company immediately.
  3. Protect and support utilities, appurtenances, structures, etc., by shoring, bracing or other means necessary.
- E. Weather
1. Do not install pipe or place pipe bedding on frozen soil in the trench bottom.
  2. Do not place frozen materials, snow or ice in backfill, fill, or embankments.
  3. Do not deposit, tamp, roll or otherwise mechanically compact backfill in water.

## **1.6 Quality Assurance**

- A. Preparation of Subgrade
1. Notify City when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.
- B. Excavation
1. Provide adequate survey control to avoid unauthorized overexcavation.
- C. Fill and Backfill
1. Notify City when:
    - a. Structure or pipeline is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
    - b. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
    - c. Fill material appears to be deviating from Specifications.

## **PART 2 – PRODUCTS**

### **2.1 GENERAL**

- A. All material shall be free from frozen matter, stumps, roots, brush, other organic matter, cinders, corrosive material, debris, broken asphalt and concrete, and any other objectionable material that is not suitable in the opinion of the City.
- B. If job excavated material is not sufficient or suitable, suitable material shall be imported. Reference *SDC* construction specifications for import fill requirements.

### **2.2 DEWATERING**

- A. Experience Requirements

1. Dewatering System Designer: Registered professional engineer with a minimum of 5 years of experience in the design of dewatering systems for excavations with shoring support.
  2. Dewatering System Installer (Subcontractor): Experience record including minimum of three projects with dewatering systems for shored excavations in similar conditions. Experienced in the installation and operation of similar dewatering systems as employed by the dewatering plan.
- B. Equipment and Materials
1. Equipment and materials are at the discretion of Contractor as necessary to achieve desired results for dewatering.
  2. Eductors, well points, or deep wells, where used, must be furnished, installed and operated by an experienced contractor regularly engaged in groundwater control system design, installation, and operation.
  3. All equipment must be in good repair and operating order and standby equipment and materials shall be kept available and in operating condition to ensure continuous operation.

### **2.3 MARKING TAPE**

- A. Nondetectable:
1. Inert polyethylene, impervious to known alkalis, acids, chemical reagents, and solvents likely to be encountered in soil.
  2. Thickness: Minimum 5 mils.
  3. Width: 3 inches.
  4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
  5. Manufacturers and Products:
    - a. Reef Industries; Terra Tape.
    - b. Mutual Industries; Non-detectable Tape.
    - c. Presco; Non-detectable Tape.
- B. Detectable:
1. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
  2. Foil Thickness: Minimum 0.35 mils.
  3. Laminate Thickness: Minimum 5 mils.
  4. Width: 3 inches.

5. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
  6. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
  7. Manufacturers and Products:
    - a. Reef Industries; Terra Tape, Sentry Line Detectable.
    - b. Mutual Industries; Detectable Tape.
    - c. Presco; Detectable Tape.
- C. Color: In accordance with APWA Uniform Color Code for Temporary Marking of Underground Facilities.

Color*	Facility
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communication alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewer and drain lines
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines

\* As specified in NEMA Z535.1, Safety Color Code.

## 2.4 STABILIZATION MATERIAL

- A. If the existing soil in the trench bottom is judged to be unsuitable by the City, at a minimum, the top six-inches (6") of the trench subgrade shall be removed and replaced with stabilization material. If deemed necessary by the City, more than six-inches (6") of material from the trench bottom may require removal and replacement with a stabilization material.
- B. Stabilization material is crusher-run rock, conforming to CDOT #357 (ASTM D448, AASHTO M43).

**TABLE 2.4-C: Stabilization Material – CDOT #357**

Size (inch)	Percent (%) Passing
2 ½"	100
2"	95-100
1"	35-70

1/2"	10-30
#4	0-5

Or approved equivalent.

## 2.5 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

- A. The CLSM facility shall be certified by the National Ready Mixed Concrete Association. Mixing times shall conform to the requirements of ASTM C94, Specification for Ready-Mixed Concrete. Hand mixing is not allowed. The production facility shall supply a load ticket with the actual batch weights of the component materials.
- B. Thoroughly mix all water added at the project site in accordance with the recommendations stated in ACI 305, Hot Weather Concreting. Measure all water added to the mix. The water cement ratio as stated in the flowable fill mix design approved by the City is not to be exceeded. Do not add water after discharge of the flowable fill from the mixer begins.
- C. Place flowable fill within the 90 minutes after the addition of cement or fly ash to the mix. The City reserves the right to reduce the allowable time for placement to account for adverse weather conditions or other factors that may accelerate the stiffening of the mix.
- D. Select and proportion the ingredients to obtain an unconfined compressive strength at 2 days to be a minimum of 50 psi, an unconfined compressive strength at 28 days a maximum of 125 psi, and an air content between 7 and 13 percent. Proportion the materials to produce a mixture with a consistency that flows under a very low head. Determine compressive strength in accordance with ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders. Determine air content in accordance with ASTM D6023, Standard Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM).
- E. Materials:
  - 1. Portland Cement: Cement Type I or Cement Type II as defined by ASTM C150, Specification for Portland Cement including Table 1, 2, and 4.
  - 2. Aggregate: Conform to all requirements for fine aggregate as defined by ASTM C33, Specification for Concrete. Keep the aggregate materials moist for 24 hours before use in the mixture.
  - 3. Fly Ash (if used): Conform to requirements of Class F fly ash as defined by ASTM C618, Specification for Coal Fly Ash and Raw or Calcined Natural Pollolan for Use as a Mineral Admixture in Concrete, except as modified herein:
    - a. Test in accordance with ASTM C1012/C1012M to verify that the sulfate resistance is acceptable.
  - 4. Water: All water used in the CLSM mixture shall meet the requirements of AASHTO T26, Quality of Water to be used in Concrete. Obtain such water from a source approved by the City.

## 2.6 GEOTEXTILE (FILTER) FABRIC

- A. Geotextile fabric shall be used in conjunction with stabilization material unless approved otherwise by the City. See City of Greeley Standard Drawings for more details.

- B. Geotextile fabric shall conform to Colorado Department of Transportation, Division of Highways, State of Colorado “*Standard Specifications for Road and Bridge Construction*”, *Section 712.08, Class A Table 712-2*, latest edition.
- C. Acceptable geotextile fabric manufacturers are:
  - 1. TenCate – Mirafi 500X
  - 2. Webtec, Inc. Geosynthetics – TerraTex GS
  - 3. Or approved equivalent.

**2.7 BEDDING ZONE MATERIALS**

- A. The bedding zone shall extend six-inches (6”) below the invert of the pipe to six-inches (6”) above top of pipe.
- B. Bedding material for sanitary sewer pipe shall be 57/67 rock.

**TABLE 2.7-B: Bedding Material – 57/67 rock**

Size (inch)	Percent (%) Passing
1 ½"	100
1"	95-100
¾"	90-100
½"	25-60
3/8"	20-55
#4	0-10
#8	0-5
#200	1 max

Or City approved equal.

- C. Bedding material for water pipe shall be ASTM C33 sand.

**TABLE 2.7-C: Bedding Material – ASTM C33 Sand**

Size (inch)	Percent (%) Passing
3/8"	100
#4	95-100
#8	80-100
#16	50-85
#30	25-60
#50	5-30
#100	0-10
#200	0-3

Or City approved equal.

- D. Groundwater Barrier shall meet the following soil classification:

1. Unified Soil Classifications
  - a. GC – clayey gravels, clayey sandy gravels
  - b. SC – clayey sands, clayey gravelly sands
  - c. CL – inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, clean clays.
  - d. Material shall not be lumpy or hard but shall be finely divided, suitable, and free from stones.
2. Or Flow Fill in conformance with *SDC* construction specifications.

## **2.8 INSULATION BOARD**

- A. Insulation board shall be installed above the bedding zone when the depth of cover over the water line is less than five (5) feet.
- B. Insulation board shall be a minimum one-inch (1”) thick. Acceptable insulation board manufacturers are:
  1. Dow Chemical Company - Styrofoam™
  2. Owens-Corning
  3. Or approved equivalent.

## **2.9 TRENCH BACKFILL MATERIAL**

- A. Trench backfill material shall be placed from a point six-inches (6”) above the top of pipe exterior to six-inches (6”) below the ground surface, or bottom of topsoil layer, or bottom of the pavement subgrade, whichever is applicable. Trench backfill shall conform to *SDC* construction specifications.
- B. Reference *SDC* construction specifications for flow fill requirements.

## **PART 3 – EXECUTION**

### **3.1 PREPARATION**

- A. Topsoil shall be stripped from areas which are to be disturbed by construction and stockpiled.
- B. Topsoil shall be segregated from non-organic trench material and debris.

### **3.2 SUBGRADE PREPARATION**

- A. General
  1. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.
  2. Bring subgrade to proper grade and cross-section and uniformly compact surface.

3. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.
  4. Maintain prepared ground surface in finished condition until next course is placed.
- B. Compaction
1. Under Earthfill and Exposed Cut Surfaces: Compact upper 8 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D1557 or 93 percent relative compaction as determined in accordance with ASTM D698.
  2. Under Structures Including Slabs, Tanks and Other Miscellaneous Structures: Areas shall be overexcavated to such an extent so as to provide a minimum of 6 inches of granular fill on prepared subgrade. Scarify and compact the upper 8 inches of subgrade to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.
- C. Moisture Conditioning
1. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.
  2. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.
- D. Testing
1. Proof-roll subgrade with a fully loaded tandem-axle dump truck or similar vehicle to detect soft or loose subgrade or unsuitable material. Proof-roll shall be conducted prior to scarifying/recompaction to identify soft or loose subgrade or unsuitable material. City shall be notified 2 days in advance of proof-rolling activities and will be present to examine and approve subgrade before backfilling begins.
  2. Contractor shall provide an independent testing laboratory to conduct in-place density tests in accordance with ASTM D6938 at a minimum rate of one test per every 5,000 square feet of prepared subgrade.
- E. Correction
1. Soft or Loose Subgrade:
    - a. Adjust moisture content and recompact, or
    - b. Over excavate as specified in Section 3.3 of this specification, and replace with suitable material from the excavation. If unsuitable soil is encountered at a depth of 3 feet below planned subgrade, excavation shall be halted and the City notified immediately.
    - c. In the event the unacceptable material is encountered at the 3-foot overexcavation, a geogrid shall be provided and placed, and overlain with a geotextile. The overexcavation shall be filled to plan grade with subgrade stabilization aggregate. Subgrade Stabilization Aggregate shall be placed in lifts not more than 10 inches thick and shall be compacted to the satisfaction of the City.



2. Unsuitable Material: Over excavate as specified in Section 3.3 of this specification, and replace with suitable material from the excavation.

### 3.3 EXCAVATION

#### A. General

1. Excavate to lines, grades, and dimensions shown in the drawings and as necessary to accomplish work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.
2. Do not overexcavate without written authorization of City.
3. Remove or protect obstructions as shown in the drawings.

#### B. Unclassified Excavation

1. Excavation is unclassified. Complete all excavation regardless of the type, nature, or condition of the materials encountered.

#### C. Trench Width

1. Minimum Width of Trenches: As specified in Section 3.6 of this specification.
2. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

#### D. Pipe Bedding Grooves for Nonperforated Drain Lines

1. Semicircular, trapezoidal, or 90-degree-V.
2. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

#### E. Embankment and Cut Slopes

1. Shape, trim, and finish cut slopes to conform with lines, grades, and cross- sections shown in the drawings, with proper allowance for topsoil or slope protection, where shown.
2. Remove stones and rock that exceed 3-inch diameter and that are loose and may roll down slope. Remove exposed roots from cut slopes.
3. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed work.
4. Temporary earthen slopes shall be at an inclination of maximum 3 horizontal to 1 vertical (3H:1V) or designed by a Professional Engineer in the State of Colorado.

#### F. Stockpiling Excavated Material

1. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.
  2. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.
  3. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.
  4. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.
  5. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could induce excessive settlement.
- G. Disposal of Spoil
1. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.
  2. Dispose of debris resulting from removal of underground materials, organic matter, trash, refuse, junk, and other materials in accordance with local and federal governmental regulations.

### **3.4 DEWATERING**

- A. General
1. Design and operate surface water and groundwater dewatering controls to protect work in progress at all times.
- B. Surface Water Control
1. Remove surface runoff controls when no longer needed.
- C. Dewatering Systems
1. Design, install, and operate dewatering systems to bring groundwater to a depth of 3 feet or greater below the lowest point of excavation, prior to beginning excavation and at all times during excavation, and as necessary to accomplish the following:
    - a. To prevent loss of ground as water is removed.
    - b. To avoid inducing settlement or damage to existing facilities, completed work, or adjacent property.
    - c. To establish adequate factor of safety against uplift or instability of excavation bottom.
  2. Install instrumentation prior to beginning excavation, as necessary to demonstrate the above requirements are met. Provide detailed summary of findings from instrumentation, and comparison to the expectations of the Water Control Plan, prior to beginning excavation.

3. Continuously control water during construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water until Backfill has been placed, and the structures are capable of resisting hydrostatic force and have been properly leak tested.
4. Perform dewatering operations in a manner that will protect existing roads, structures, utilities, and receiving waters. The Contractor shall be solely responsible for preventing damage to roads, buildings or structures, sewers and other utility installations, pavements, sidewalks, and other property that may result from Contractor's dewatering operations.
5. Immediately repair any structure damaged as a result of the dewatering operations at no additional costs to the City.
6. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.
7. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.
8. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.
9. The City shall be advised of any changes made to accommodate field conditions. Upon completion of the dewatering system installation, revise and resubmit information drawings as necessary to show the installed configuration including grade elevation at the time wells were installed, well depth, screen lengths, slot size, filter pack grain size analysis, and depth of pump intake.
10. Remove system in accordance with CDPHE upon completion of construction or when dewatering and control of surface or ground water is no longer required.

D. Disposal of Water

1. Obtain discharge permit for water disposal from CDPHE.
2. Treat water collected by dewatering operations, to meet effluent limitations and other requirements as required by CDPHE prior to discharge.
3. Discharge water as required by discharge permit and in a manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed work, or adjacent property. Dewatering flows shall be discharged directly through piping and dewatering /treatment facilities to a receiving stream or storm sewer at a location acceptable to the City and approved in the discharge permit.
4. Remove solids from dewatering flow treatment facilities and perform other maintenance of dewatering flow treatment facilities (best management practices) as necessary to maintain their efficiency.

E. Protection of Property

1. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed work, and adjacent property.

2. Securely support existing facilities, completed work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.
3. Limit lowering of groundwater table outside of excavation to no lower than 5 feet below the lowest recorded stabilized ground water table, unless lower levels have been agreed to by City prior to dewatering.

F. Remediation of Groundwater Depletion

1. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to well owner prior to beginning the work or as satisfactory to each well owner.

### 3.5 FILL AND BACKFILL

A. General

1. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.
2. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to the specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.
3. During filling and backfilling, keep level of fill and backfill around each structure and pipeline even.
4. Do not place fill or backfill if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.
5. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:
  - a. Fill or backfill to an elevation 2 feet above top of item to be laid.
  - b. Excavate trench for installation of item.
  - c. Install bedding, if applicable, as specified in Section 3.6 of this specification.
  - d. Install item.
  - e. Backfill envelope zone and remaining trench, as specified in Section 3.6 of this specification, before resuming filling or backfilling specified in this section.
6. Tolerances:
  - a. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
  - b. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

7. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.
- B. Backfill Under and Around Structures
1. Under Structures:
    - a. Overexcavate and prepare subgrade as specified in Section 3.2 of this specification, or fill on prepared subgrade with earthfill to within 6 inches of bottom of structure.
    - b. Earthfill shall be placed in 8-inch maximum lifts and compacted at moisture content of optimum plus or minus 2 percent. Each lift of moisture conditioned earthfill shall be compacted to a minimum 95 percent relative compaction as determined in accordance with ASTM D1557.
    - c. Place a minimum 6 inches of granular fill below structures and slabs. Granular fill shall be compacted to a minimum 95 percent of maximum dry density at plus or minus 2 percent of optimum moisture content as determined in accordance with ASTM D1557.
  2. Select Cohesive Fill: Backfill with Select Cohesive Fill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557 or 93 percent relative compaction as determined in accordance with ASTM D698.
  3. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 8-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557 or 93 percent relative compaction as determined in accordance with ASTM D698.
- C. Fill
1. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities: Unless otherwise shown, place earthfill as follows:
    - a. Allow for 6-inch thickness of topsoil where required.
    - b. Maximum 8-inch thick lifts.
    - c. Place and compact fill across full width of embankment.
    - d. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557 or 93 percent relative compaction as determined in accordance with ASTM D698.
    - e. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.
- D. Site Testing
1. Gradation:

- a. One sample from each 1,500 tons of finished product or more often as determined by City, if variation in gradation is occurring, or if material appears to depart from Specifications.
  - b. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
  - c. Remove material placed in Work that does not meet Specification requirements.
2. Contractor shall provide an independent testing laboratory to conduct in-place Density Tests: In accordance with ASTM D1556 or D6938. During placement of materials, test every 500 cubic yards, but no less than two tests per day for each day material is being placed, and no less than two tests per lift.

E. Replacing Overexcavated Material

1. Replace excavation carried below grade lines shown or established by City as follows:
  - a. Beneath Structures: Granular fill.
  - b. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
  - c. Trenches:
    - i. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 3.6 of this specification.
    - ii. Authorized Overexcavation: Trench stabilization material, as specified in Section 3.6 of this specification.
  - d. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
    - i. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
    - ii. Steep Slopes (Steeper than 3:1):
      - ii-a. Correct overexcavation by transitioning between overcut areas and the designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed work.
      - ii-b. Backfilling overexcavated areas is prohibited, unless in City's opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

F. Placing Fill Over Geosynthetics

1. General:
  - a. Place fill over geosynthetics with sufficient care so as not to damage.

- b. Place fill only by back dumping and spreading only.
  - c. Dump fill only on previously placed fill.
  - d. While operating equipment, avoid sharp turns, sudden starts or stops that could damage geosynthetics.
2. Hauling: Operate hauling equipment on minimum of 3 feet of covering.
3. Spreading:
- a. Spreading equipment shall be track mounted D 6 or lighter.
  - b. Operate spreading equipment on minimum of 12 inches of fill over geosynthetics.
  - c. Spread fill in same direction as unseamed overlaps to avoid separation of seams and joints.
  - d. Never push fill downslope. Spread fill over sideslopes by pushing up from slope bottom.
  - e. Correct wrinkles in geomembranes as required by manufacturer.
  - f. Maintain proper overlap of unseamed geosynthetics as required by manufacturer.
  - g. Avoid overstressing geosynthetics and seams.
4. Compaction: Compact fill only after uniformly spread to full thickness shown.
5. Geosynthetic Damage:
- a. Mark punctures, tears, or other damage to geosynthetics, so repairs may be made.
  - b. Clear overlying fill as necessary to repair damage.
  - c. Repairs to geosynthetics shall be made by respective installers as specified in respective specification section for each geosynthetic.

### **3.6 TRENCHING**

- A. Do not drop backfill directly upon any structure or pipe. Do not place backfill around or upon any structure until the concrete or CLSM has attained sufficient strength to withstand the loads imposed.
- B. Place backfill after water is removed from the excavation as specified in Section 3.4 of this specification, and the excavation bottom or surface upon which backfill is to be placed is firm and has been dried to a moisture content suitable for scarifying and recompaction. Remove water in a manner that minimizes soil erosion from trench sides and bottom. Provide continuous water control until trench backfill is complete.

- C. Excavate trenches by open cut methods, except where a boring is indicated on the Construction Drawings, required by jurisdictional agencies, or desired by the Contractor and approved by the City.
- D. Do not use mechanical equipment in locations where its operation would cause damage to trees, buildings, culverts, utilities, structures or other property above or below ground. In all such locations, hand-excavating methods shall be used.
- E. Use mechanical equipment designed and operated so the rough excavated trench bottom elevation can be controlled with uniform trench width and vertical sidewalls from an elevation one (1) foot above the top of installed pipe to the bottom of the trench. The trench alignment shall be sufficiently accurate to permit pipe to be aligned properly between the pipe and sidewalls of the trench. Do not undercut the trench sidewall to obtain clearance.
- F. Contractor shall follow the most current regulations concerning excavations set forth by OSHA: 29 CFR Part 1926.
- G. Excavation in Rock
  - 1. When rock is present, over-excavate a minimum of six-inches (6") below the bottom of the required trench bottom.
  - 2. Backfill to required trench bottom with compacted bedding material.
- H. Preparation of Trench Bottom
  - 1. Grade trench bottom uniformly to provide clearance for each section of pipe and bedding material.
  - 2. Remove loose materials, water and foreign objects.
  - 3. Provide firm subgrade suitable for placement of bedding material.
  - 4. Wherever unstable material is encountered in the bottom of the trench, over-excavate such material to a depth suitable for constructing a stable subgrade or as determined by the City. Backfill over-excavation with stabilization material and compact. A geotextile fabric layer shall be placed between the stabilization material and the bedding material.
- I. Stockpiling Excavated Materials
  - 1. Pile suitable material for backfilling in an orderly manner a sufficient distance from trench banks to avoid overloading and to prevent slide or cave-ins.
  - 2. Do not stockpile excavated material against existing structures or appurtenances.
  - 3. The Contractor shall follow the most current OSHA regulations concerning excavations.
- J. Trench Widths
  - 1. Trench width shall be maintained to within three-inches (3") of that specified on the City of Greeley Standard Drawings unless otherwise specified by the City.

### **3.7 PIPE BEDDING**

- A. Placement and Compaction



1. Distribute, grade, and compact bedding material to provide uniform and continuous support beneath the pipe at all points between bells and pipe joints.
2. Bell holes shall be dug deep enough to provide a minimum two-inches (2") of clearance between the bell and bedding material. The pipe shall not be supported by the pipe bell.
3. Deposit bedding material and compact uniformly and simultaneously on each side of the pipe to prevent lateral displacement.
4. Compact granular bedding material by vibrating, slicing with a shovel, or bent tee-bar.
5. All utility trenches within the street right-of-way (including service lines) must be mechanically compacted to not less than 95% of maximum density within  $\pm$  two percent (2%) of optimum moisture content as determined by AASHTO T99. Alternatively, utility trenches can also be backfilled with flowable fill to within one foot of finished grade.
6. Trench backfill in utility easements within 20 feet of right-of-way shall be mechanically compacted to 95% maximum density or backfilled with flowable fill to within one foot of finish grade.
7. Trench backfill in utility easements beyond 20 feet from right-of-way shall be compacted to 90% maximum density.
8. Place pipe bedding in accordance with the City of Greeley Standard Drawings.

### **3.8 MARKING TAPE INSTALLATION**

- A. Continuously install marking tape along centerline of all buried piping, at depth of 2 feet. Coordinate with piping installation drawings.
  1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.
  2. Nondetectable Marking Tape: Install with metallic piping.

### **3.9 GROUND WATER BARRIERS**

- A. Ground water barriers shall be constructed in such a manner to impede the passage of water through the bedding material and shall be installed when high groundwater conditions exist or as directed by the City.
- B. Ground water barriers shall be keyed at least one (1) foot into the trench wall and bottom, and spaced ten (10) feet upstream of each manhole for gravity sanitary sewers or every 400 feet on water lines and sanitary sewer force mains.
- C. At a minimum, ground water barriers shall extend one (1) foot above the bedding material.
- D. Refer to City of Greeley Standard Drawings for additional installation requirements.

### **3.10 INSULATION BOARD**

- A. Insulation board, if preapproved by the City, shall be installed above the bedding zone wherever the depth of cover over the water main is less than five (5) feet.
  1. Insulation board installation shall consist of two (2) overlapping boards, one-inch (1") minimum thickness per board, with off-set joints.

2. Insulation board shall be placed across the full trench width.
- B. Refer to City of Greeley Standard Drawings for additional installation requirements.

### **3.11 BACKFILLING AND COMPACTION**

- A. Backfill trench promptly after completion of pipe bedding, but only after the City has inspected the work.
- B. Backfilling and compaction operations and requirements shall be in accordance with the *SDC*.
- C. Use backfilling and compaction methods and equipment appropriate for the backfill material. Do not use equipment or methods that will transmit damaging shocks to the pipe.
- D. Do not perform compaction by jetting or water settling.
- E. Rock and bedrock encountered in the excavation shall not be used in backfill.
- F. For areas not receiving surface improvements after construction, return the final grading to the depth of stripping over all areas disturbed by construction operations and replace topsoil.
- G. All surface cuts shall be, as a minimum, restored to a condition equal to, or better than, that prior to construction. All gravel or paved streets shall be restored in accordance with the regulation and requirements of the agency having control or jurisdiction over the street, roadway or right-of-way.
- H. Controlled Low Strength Material:
1. Discharge side of trench from truck mounted drum type mixer into trench.
  2. Discharge CLSM into trench at temperature below 75 degrees F.
  3. Utilize pumps or chutes to place the CLSM in the trench. When CLSM material is indicated for the entire pipe zone, continue placing CLSM on one side of the pipe until CLSM has traveled under the pipe and up the other side to a depth of 1 foot above the pipe bottom. Adjust water in mixture to maintain fluid consistency but maintain strength requirements. Rod or vibrate CLSM as necessary to keep soil particles in suspension so that the material flows freely.
  4. Maintain stability of pipe and conduit throughout CLSM placement and curing. Anchor pipe as needed to prevent movement of the pipe caused by flotation or lateral displacement. If any movement occurs, remove the CLSM material and place the pipe back on line and grade. Remove sloughed material or other debris from top of previously placed CLSM.
  5. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
  6. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
  7. In other areas fill the trench section as shown.
  8. Allow CLSM to set before placing backfill. Prior to placing backfill over CLSM, achieve an indentation diameter less than or equal to 3 inches as determined by ASTM D6024.

### 3.12 MATERIALS AND QUALITY CONTROL TESTING

- A. The Contractor is responsible for quality control testing and the testing shall be performed by an independent testing agency employed by the Contractor.
- B. For backfill compaction and moisture requirements and the required materials testing, frequency of tests, and standard testing methods, reference the *SDC*.
- C. The following requirements shall also apply:
  - 1. Groundwater Barriers
    - a. Compaction – 95%
    - b. Moisture –  $\pm 2\%$
  - 2. Bedding Material
    - a. Compaction – 80% of relative density
  - 3. CLSM:
    - a. Provide adequate facilities for safe storage and proper curing of CLSM test cylinders onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
    - b. Provide CLSM testing of air content and for making cylinders from the point of discharge into forms. When CLSM is pumped, Samples used shall be taken from discharge end of pump hose.
    - c. Specimens shall be made, cured, and tested in accordance with ASTM D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
    - d. One set of test cylinders shall be tested per each 100 cubic yard of CLSM placed, but no less than one set per day. Frequency of testing may be changed at discretion of City.
    - e. Reject CLSM represented by cylinders failing to meet strength and air content specified.
- D. Services
  - 1. Water services shall have a minimum of one (1) moisture/density test per service.
  - 2. Sanitary sewer services shall have a minimum of two (2) moisture/density tests per service or at the City Inspector's discretion.
  - 3. Moisture/density tests in the vicinity of vaults, valve boxes and manholes shall be performed at a minimum of one (1) foot away from the edge of vault/manhole sections or valve boxes.
    - a. Tests shall be performed in random directions from the vault, manhole, or valve box, on separate lifts.

- b. A minimum of one (1) test shall be performed, on opposite sides of the vault, manhole or valve box, for every two (2) feet of backfill material.
4. The Contractor shall keep copies of all quality control test results in a notebook at the job site for the duration of the project. Test results shall be made available to the City at all times.

### **3.13 COMPACTION TEST FAILURE**

- A. If the required compaction and moisture is not obtained, it shall be the responsibility of the Contractor to recompact or rework the material to the required state of compaction and moisture.
- B. In cases where there is a failure to achieve the required compaction or moisture, the City may require that the backfill be removed and recompact or replaced entirely with suitable materials.
- C. Water line and sanitary sewer line/manhole testing may be required after recompaction if the testing had been performed prior to recompaction.
  1. Water line testing shall be performed between valves on both sides of the recompact area.
  2. Sanitary sewer line testing shall be performed between manholes on both sides of the recompact area.
  3. Sanitary sewer manhole testing shall be performed if recompact occurs in the vicinity of the manhole.

## SECTION 02445

### CASING PIPE – BORINGS AND ENCASEMENTS

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the installation of a casing pipe by boring (or jacking) or as an open trench encasement and includes the acceptable products, materials, and construction practices.
- B. The specifications provided in this section are the minimum City requirements for casing pipe borings and encasements.
- C. The Design Engineer may be required by the City to provide additional design and installation considerations depending on the situation.
- D. The requirements included in this Section shall be superseded by other regulators if the other regulators requirements are more stringent. Other regulations could include CDOT, railroad, county, etc.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C206, *Field Welding of Steel Water Pipe*, latest revision.
  - 2. C150/A21.50, *Thickness Design of Ductile-Iron Pipe*, latest revision.
  - 3. C151/A21.51, *Ductile-Iron Pipe, Centrifugally Cast, For Water*, latest revision.
  - 4. C900, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In., For Water Distribution*, latest revision. (Both slip joint and fusible)
- B. ASTM International (ASTM)
  - 1. A139, Standard Specification for Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over), latest revision.
  - 2. D3350, Polyethylene Plastic Pipe and Fittings Materials, latest revision.
  - 3. F714, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, latest revision.
- C. American Water Works Association (AWWA)
  - 1. C901, *Polyethylene (PE) Pressure Pipe and Tubing ½ inch through 3 inch*, latest revision.
  - 2. C906, *Polyethylene (PE) Pressure Pipe and Fittings, 4 inch through 63 inch*, latest revision.
  - 3. M23, *PVC Pipe – Design and Installation*, latest revision.

4. M41, Ductile-Iron Pipe and Fittings, latest revision.

### **1.3 DESIGN CONSIDERATIONS**

- A. The Design Engineer shall specifically design each casing pipe boring (or jacking) installation.
  1. Casing pipe thicknesses specified in this section are based upon superimposed loads and not upon the loads which may be placed on the casing pipe as a result of jacking operations.
  2. Provide increased casing pipe strength as necessary to withstand jacking loads.
- B. The Design Engineer shall size the casing pipe such that the inside clearance is at least one and one-inch (1") greater than the maximum outside diameter of the casing spacer runners.

### **1.4 REQUIREMENTS OF REGULATORY AGENCIES**

- A. The type of casing pipe material and its properties will normally be specified by the agency granting permission to cross. Such crossings shall be subject to approval by the City to avoid conflicts in requirements or standards between the City and the agency granting permission to cross.
- B. The Contractor shall provide a letter, permit, or an approved crossing application to the City from the agency granting the crossing approval. Copies of all documents required to be sent to the regulating agency shall be provided to the City.
- C. The Contractor shall obtain the necessary bonds, insurance or indemnity required by the crossing permit for protection against damage, interference with traffic, or service that may be caused by the construction activities.

## **PART 2 – PRODUCTS**

### **2.1 CARRIER PIPE**

- A. The carrier pipe shall be the same nominal diameter as the system main on either side of the casing pipe.
- B. In situations where one (1) pipe joint falls within the casing pipe, the carrier pipe material shall be consistent with the pipe material being used for the rest of the project.
- C. For situations where more than one (1) pipe joint falls within the casing pipe, the carrier pipe shall be restrained through the casing and the carrier pipe material shall be:
  1. Potable Water Distribution System and Non-Potable Irrigation System – Restrained ductile iron pipe (DIP) in accordance with construction specification *Section 02512, Ductile-Iron Pipe*.
  2. Sanitary Sewer System – Restrained gravity sewer C-900 PVC (green in color) in accordance with construction specification *Section 02533, Polyvinyl Chloride (PVC) Non-Pressure Pipe*. Restrained gravity sewer PVC shall extend from manhole to manhole on either side of the casing pipe.
  3. Or other approved equivalent.

## 2.2 CASING PIPE

### A. Material

1. AWWA C900 Polyvinyl Chloride (PVC) Pipe
2. Steel Pipe
  - a. The casing pipe shall be new, smooth steel conforming to ASTM A139, Grade B (no hydro.)
  - b. Minimum Yield Strength – 35,000 psi
  - c. Exterior Coating – Not required.
3. AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing
4. AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings

B. The following table indicates what casing pipe diameter and material to use in relation to the carrier pipe diameter. It also provides steel casing pipe minimum wall thicknesses and specifies when to use casing spacers and end seals.

**TABLE 2.1-B: Casing Pipe Specifications**

Carrier Pipe Diameter (in)	Casing Pipe Diameter (in)	Borings and Encasements	Encasements Only
		Steel Casing Pipe – Minimum Wall Thickness (in)	Casing Pipe Materials
2" or less Water Services	4"	0.250	C900 PVC
3"	6"	0.258	C900 PVC, Steel, HDPE
4"	8"	0.322	C900 PVC, Steel, HDPE
6"	12"	0.375	C900 PVC, Steel, HDPE
8"	16"	0.375	C900 PVC, Steel, HDPE
10"	20"	0.375	Steel
12"	24"	0.375	Steel
15"	30"	0.500	Steel
16"	30"	0.500	Steel

- End seals are required on all casing pipe installations.  
 - Casing spacers are required on all carrier pipes except for 2" diameter or less water services.

Or approved equivalent.

## 2.3 ACCESSORIES

### A. Casing Spacers

1. Casing spacers shall be in a "centered-restrained" configuration in the casing pipe.

2. Casing spacers shall be sized such that the height of the risers and runners have no less than one-inch (1") clearance from the inside wall of the casing pipe.
3. Band
  - a. Casing spacers shall be constructed of circular stainless steel bands that bolt together to form a shell around the carrier pipe.
  - b. Material – T-304 stainless steel
  - c. Minimum Thickness – 14 gauge
  - d. Use an eight-inch (8") band width for carrier pipes twelve-inches (12") in diameter and smaller, unless otherwise recommended by the manufacturer.
  - e. Use a twelve-inch (12") band width for carrier pipes larger than twelve-inches (12") in diameter, unless otherwise recommended by the manufacturer.
4. Liner
  - a. Material – Polyvinyl Chloride (PVC)
  - b. Minimum Thickness – 0.090-inches
  - c. Hardness-Durometer – 85-90
  - d. Electrical Properties – 1,380 V/min
5. Risers (Support Structures)
  - a. Material – T-304 stainless steel
  - b. Maximum Thickness – 10 gauge
  - c. Reinforced over six-inches (6") in height
  - d. MIG welded to band
6. Assembly Hardware
  - a. Bolts – 5/16" - 18 x 2 1/2" T-304 stainless steel or plated
  - b. Nuts – Hex, 5/16"
  - c. Washers – 5/16" SAE 2330
7. Runners
  - a. Material - Glass Filled Polymer or Ultra High Molecular Weight (UHMW) Polyethylene
  - b. Minimum Width – Two-inches (2")
  - c. Runners shall be mechanically bolted to the risers.



8. Manufacturers
  - a. Cascade Waterworks Mfg.
  - b. PSI Pipeline Seal & Insulator, Inc.
  - c. CCI Pipeline Systems
  - d. Or approved equivalent.
- B. Casing Pipe End Seals
  1. Material - Seamless neoprene rubber
  2. Minimum Thickness – 1/8”
  3. Type – Pull on
  4. Bands and clamps – T-304 stainless steel
  5. Size shall be specific to the casing-carrier pipe combination.
  6. Manufacturers
    - a. Cascade Waterworks Mfg. – Model CCES
    - b. PSI Pipeline Seal & Insulator, Inc. – Model C
    - c. CCI Pipeline Systems – Model ESC
    - d. Or approved equivalent.
- C. Grout
  1. Grout shall consist of one (1) part Portland Cement and three (3) parts sand.
- D. Anode Bags
  1. 17-pound high potential magnesium anode bags.
- E. Connections
  1. Connections shall be made with Perma-lock.

### **PART 3 - EXECUTION**

#### **3.1 CARRIER PIPE INSTALLATION**

- A. Carrier pipe shall be installed at the elevations and grades shown on the Construction Drawings.
- B. Install the carrier pipe in accordance with the pipe material’s specification.
- C. Restrain the carrier pipe within the casing pipe, as required in accordance with this specification.

- D. Install casing spacers one (1) to two (2) feet on either side of the bell joint and one (1) every six (6) to eight (8) feet apart thereafter, for a total of three (3) casing spacers per pipe length unless otherwise specified by the manufacturer or City. Casing spacers are required on all carrier pipes except for two-inch (2") diameter or less water services.
- E. Seal the ends of the casing pipe with casing pipe end seals. End seals are required on all casing pipe installations.

### 3.2 CASING PIPE INSTALLATION

#### A. General

- 1. All excavations shall meet the requirements set forth in the construction specification *Section 02315, Excavation and Fill*.
- 2. Vertical and horizontal offset staking shall be provided at both ends of the casing pipe.
- 3. Casing pipe shall be installed to the grade and alignment shown on the approved Construction Drawings. Grade and alignment shall not deviate more than 0.3 feet horizontally and 0.1 foot vertically from that shown on the Construction Drawings.
- 4. Open trench excavation shall not be permitted where boring or jacking is specified.

#### B. Polyvinyl Chloride (PVC) Casing Pipe

- 1. AWWA C900 Polyvinyl Chloride (PVC) casing pipe shall be installed in accordance with construction specification *Section 02513, Polyvinyl Chloride (PVC) Pressure Pipe*.

#### C. Smooth Steel Pipe

- 1. Provide adequate equipment to ensure a smooth, continuous, and uniform casing with no exterior voids.
- 2. Joints shall be butt welded in accordance with AWWA C206. Weld each section of pipe around the entire circumference of the joint to form a continuous conduit capable of resisting all applied stresses, including jacking stresses.
- 3. A seventeen (17) pound high potential magnesium anode shall be installed at each end of steel casing pipes with a cathodic testing station as shown in the Standard Drawings.

#### D. High Density Polyethylene (HDPE)

- 1. Installed per manufacturers standards.
- 2. Minimum SDR-17

#### E. Grouting (As required)

- 1. Fill all spaces between the casing pipe and the earth with grout.
- 2. Plug each hole after pumping through the casing has stopped to prevent backflow of grout.

## SECTION 02510

### WATER UTILITY DISTRIBUTION PIPING

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the installation of potable water distribution mains from six-inch (6") to twenty-four inch (24") diameter and includes the acceptable products, materials, and construction practices that may be used in installation. Installation of six-inch (6") pipe shall require approval from the City of Greeley Water and Sewer Department.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C104/A21.4, *Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water*, latest revision.
  - 2. C111/A21.11, *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*, latest revision.
  - 3. C151/A21.51, *Ductile-Iron Pipe, Centrifugally Cast, for Water*, latest revision.
  - 4. C153/A21.53, *Ductile-Iron Compact Fittings for Water Service*, latest revision.
- B. ASTM International (ASTM)
  - 1. A536, *Standard Specification for Ductile Iron Castings*, latest revision.
  - 2. F3125/F3125M, *Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength*, latest revision.

##### 1.3 SUBMITTALS

- A. Shop Fabricated Piping:
  - 1. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, color, and other pertinent information.
  - 2. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
- B. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
- C. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
- D. Pipe Corrosion Protection: Product data.

## 1.4 JOB CONDITIONS

- A. Pipe delivered for construction shall be strung so as to minimize entrance of foreign material.
- B. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of the day's work or pipe laying is not in progress.
- C. Do not allow debris, tools, clothing, rags, or other materials to enter the pipe. Precautions shall be taken to protect the interiors of pipes, fittings, and valves against contamination.
- D. Use effective measures to prevent uplifting or floating of the pipeline prior to completion of backfilling operations.
- E. Protect pipe and appurtenances against dropping and damage. Damaged pipe and appurtenances that are rejected shall be marked and removed from the site.
- F. Do not install pipe when the trench contains water or when the trench bottom is unstable as determined by the City. Water that is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade, permit connection to be made in dry conditions, and to prevent the entrance of water into the pipeline.
  - 1. Surface runoff shall be diverted as necessary to keep excavations and trenches free from water during construction.
  - 2. The excavation or trench shall be kept free from water until the structure, or pipe, to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
  - 3. The pipe shall not be used to dewater the trench.

## PART 2 – PRODUCTS

### 2.1 PIPE

- A. The same type of pipe material shall be used for each size pipe. Pipe material shall not be interchanged, except where another type of pipe material is specifically indicated.
- B. Reference construction specifications *Section 02512, Ductile-Iron Pipe* and *Section 02513, Polyvinyl Chloride (PVC) Pressure Pipe*.

### 2.2 MECHANICAL JOINT

- A. General
  - 1. This specification shall cover mechanical joint DIP in four-inch (4") through twenty-four inch (24") nominal diameters.
  - 2. All DIP shall be manufactured in accordance with AWWA C151.
- B. Pipe joint shall be "mechanical single gasket" type conforming to applicable requirements of AWWA C111.
- C. DIP shall have normal laying lengths of either eighteen (18) feet or twenty (20) feet. Random pipe lengths are not acceptable.

- D. All mechanical joint glands shall be sized and drilled in accordance with AWWA C111.
- E. Iron used in the manufacture of DIP for these specifications shall have:
  - 1. Minimum tensile strength – 60,000 psi
  - 2. Minimum yield strength – 42,000 psi
  - 3. Minimum elongation – 10%
- F. DIP shall have standard thickness cement mortar linings in accordance with AWWA C104.
- G. DIP shall have a bituminous coating, minimum one (1) mil thick, on the pipe exterior, unless otherwise specified.
- H. As shown in AWWA C151, mechanical joint DIP shall conform, at a minimum, to the following pressure classes:

**TABLE 2.2-H: Pressure Class and Wall Thickness – Mechanical Joint Pipe**

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
3	350	.25
4	350	0.25
6	350	0.25
8	350	0.25
12	350	0.28
16	250	0.30
20	250	0.33
24	250	0.33
Higher pressure class pipe will be required when the W&S Dept determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.		

- I. Corrosion resistant, high strength, low-alloy steel bolts and nuts shall be used where in contact with the soil, immersed, or in splash zones in accordance with ASTM F3125, Type 3. Acceptable bolts and nuts are:
  - 1. Cor-Ten
  - 2. Usalloy
    - 1. Romac Industries, Inc
    - 3. Or approved equivalent.

**2.3 MECHANICAL JOINT RESTRAINTS**

- A. General

1. Mechanical joint restraints shall be used for restraining fittings, valves, hydrants, and fire sprinkler lines.
  2. All mechanical joint pipe restraints shall be incorporated in a follower gland and shall include a restraining mechanism which, when actuated, imparts multiple wedging action against the pipe, increasing its resistance as the pressure increases. Twist-off nuts, sized same as tee-head bolts, shall be used to ensure proper actuating of restraining devices.
- B. Glands shall be manufactured of ductile-iron conforming to ASTM A536, grade 60-42-10. Restraining devices shall be of ductile-iron heated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to AWWA C153.
- C. Mechanical joint restraint devices shall have the following minimum working pressures and shall not be less than piping working pressure ratings:
1. 350 psi with a minimum safety factor of 2:1, for four-inch (4") through twenty-four inch (24") diameter.
  2. 250 psi with a minimum safety factor of 2:1, for larger than twenty-four inch (24") diameter.
- D. Acceptable manufacturers and styles are:
1. Mechanical Joint Restraint
    - a. EBAA Iron, Inc. – MEGALUG, SERIES 1100
    - b. Uni-Flange Corp. – SERIES 1400
    - c. Romac Industries, Inc.
  2. Slip Joint Restraint
    - a. EBAA Iron, Inc. – MEGALUG, SERIES 1700
    - b. Uni-Flange Corp. – SERIES 1450
    - c. Romac Industries, Inc.

## **2.4 VALVES**

Reference construction specification *Section 02515, Water Utility Distribution Valves.*

## **2.5 FIRE HYDRANTS**

Reference construction specification *Section 02516, Water Utility Distribution Fire Hydrants.*

## **2.6 BLOW-OFFS**

Reference City of Greeley Standard Drawing.

## **2.7 SERVICE LINES, METERS, AND APPURTENANCES**

Reference construction specification *Section 02514, Water Service Lines, Meters, and Appurtenances.*

## 2.8 TAPPING SLEEVES AND TAPPING VALVES

- A. Tapping sleeves and valves are required for connections to existing distribution mains unless otherwise indicated on the approved Construction Drawings.
- B. Tapping sleeves for PVC and ductile iron pipe shall have a cast iron or ductile iron body. Tapping sleeves for steel pipe shall be a weld-on type or fabricated steel.
- C. Accepted manufacturers are:
  - 1. ROMAC
  - 2. Ford
  - 3. Smith Blair
  - 4. JCM Industries, Inc.
  - 5. Or approved equivalent
- D. Tapping sleeves shall be rated at 200 psi, minimum, working pressure.
- E. Tapping sleeves shall provide a 100% leak-tight seal.
- F. Prior to ordering tapping sleeve, manufacturer's shop drawings and specifications shall be submitted to the City for review and acceptance.
- G. For tapping valves, reference construction specification *Section 02515, Water Utility Distribution Valves*.

## 2.9 TRACER WIRE AND TEST STATIONS

- A. Tracer wire:
  - 1. Tracer wire shall be solid or stranded copper clad steel 12-gauge wire, with watertight insulation for direct burial.
  - 2. Tracer wire color code shall follow the APWA uniform color code for the utility being served. All potable waterline tracer wire shall be denoted blue.
  - 3. Tracer wire manufacturers: Copperhead Industries or approved equal.
- B. Connectors:
  - 1. All mainline tracer wire shall be interconnected at mainline intersections, tees, and crosses with locking connectors with the appropriate number of branches. Three wires shall be joined with three-way locking connectors. Four wires shall be joined with two three-way locking connectors with a short jumper wire between them.
  - 2. All connectors shall be dielectric silicone filled to seal out moisture and prevent corrosion, and shall be installed in a manner as to prevent any uninsulated wire exposure to soil.

3. Connectors shall be installed in a manner that does not involve cutting or splicing the mainline tracer wire in any way. Service laterals may have up to two wire splices per service excluding connection to the mainline tracer wire.
  4. Acceptable connectors: Copperhead SnakeBite Locking Connectors or approved equivalent.
- C. Test stations:
1. Service Test Stations at ROW: Test station shall consist of a coil of 2 FT linear tracer wire secured to the top of the curb stop box, and placed inside the upper half of a standard valve box as specified in 02514. Standard valve box cover shall be lockable, cast-iron, with "WATER / TEST" cast in the cover.
  2. Service Test stations at Building: Test station access point to be mounted to structure directly above service line and according to building code. Test station shall be the Cobra Access Point with a 1-terminal from Copperhead Industries or approved equivalent.
  3. Fire Hydrant Test Stations: Test station to be flush-to-grade type complete with both an insulated terminal block with two (2) terminals, and an external grounding rod on an on/off switch.
    - a. Hydrant test station shall be the SnakePit Lite Duty Adjustable from Copperhead Industries or approved equivalent.
    - b. Test station section to be four-inch (4") inside diameter with an eighteen-inch (18") long flared plastic shaft to prevent removal.
    - c. Any test stations located in concrete or roadways shall be SnakePit Concrete/Driveway or SnakePit Roadway and shall be approved by City.
- D. Grounding:
1. For grounding requirements, intervals, and installation, refer to the Utility Locating ("UL") details in the Water & Sewer Standard Drawings, latest revision.
  2. 1.5 lb drive-in magnesium ground rod with HDPE cap and 20 feet of 12-AWG wire.
  3. Acceptable Manufacturers: Copperhead Industries or approved equivalent.

## **2.10 MECHANICAL COUPLINGS**

- A. All mechanical couplings shall be of a gasketed, sleeve-type, with diameter to properly fit the pipe. Tolerance on pipe and coupling, together with proper bolt and gasket arrangements, shall be sufficient to ensure permanent watertight joints under all conditions.
- B. Materials used in the manufacture of these couplings shall be new and shall conform to AWWA C219.
- C. Couplings shall be sufficiently wide, so that each type of pipe joined will have as much pipe end inserted in the coupling as is provided by the standard push-on mechanical joint for the pipe size and type involved.
- D. Acceptable manufacturers and styles of couplings are:



**TABLE 2.6-D: Couplings**

<b>Straight Couplings</b>		
Dresser	Style 138	all sizes
Romac	Style 501	4" through 12"
Romac	Style 400	16" and larger
Smith-Blair	Style 441	all sizes
<b>Insulating Couplings</b>		
Romac	Style IC501	4" through 12"
Romac	Style IC400	16" and larger
Smith-Blair	Style 416	all sizes
<b>Reducing Couplings</b>		
Dresser	Style 62	all sizes
Romac	Style RC501	4" through 12"
Romac	Style RC400	16" and larger
Smith-Blair	Style 415	all sizes
<b>Transition Coupling</b>		
Dresser	Style 162	all sizes

Or approved equivalent.

**2.11 FITTINGS**

- A. All fittings shall be manufactured in accordance with AWWA C104, C110, and C111.
- B. All fittings shall have either mechanical joint or flanged joint connections.
- C. All fittings shall be made of either gray-iron or ductile-iron, and have a minimum working pressure rating of 350 psi for four-inch (4") through twenty-four inch (24") diameter and 250 psi for larger than twenty-four inch (24") diameter.
- D. All sizes of ductile and gray iron fittings shall be furnished with a cement –mortar lining of standard thickness or fusion-bonded epoxy coating in accordance with AWWA C116.
- E. Iron used in the manufacture of fittings for these specifications shall have:
  - 1. Minimum tensile strength – 60,000 psi
  - 2. Minimum yield strength – 42,000 psi
  - 3. Minimum elongation – 10%

**PART 3 – EXECUTION**

**3.1 GENERAL**

- A. All materials used in the construction of potable water distribution shall be new.

- B. Construction Staking
  - 1. Reference construction specification *Section 02315, Excavation and Fill*.
  - 2. Tolerances:
    - a. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
    - b. Horizontal alignment shall not deviate from the City accepted Construction Drawings by more than 0.3 feet.
    - c. Vertical alignment shall not deviate from the City accepted Construction Drawings by more than 0.3 feet as measured from the top of pipe.
- C. The minimum effective area of thrust blocks shall be as specified in City of Greeley Standard Drawings.

### **3.2 INSPECTION**

- A. Pipe barrel and fittings shall be free of dirt or other foreign objects prior to installation.
- B. Pipe and fittings shall be inspected for cracks, dents, abrasions, or other flaws prior to installation.
- C. Damaged or flawed pipe or fittings shall be rejected, marked, and removed from the site.
- D. Operational Inspection: At the completion of the project and in the presence of the City, the Contractor shall operate all valves to ascertain that the entire facility is in good working order, all valve boxes are centered and valves are open, all hydrants operate and drain properly, all curb boxes are plumb centered and water is available at all curb stops. Any valves or hydrants that do not meet these requirements shall be satisfactorily repaired as directed by the City or removed and replaced with working and properly installed valves or hydrants at no expense to the City.

### **3.3 PREPARATION**

- A. Trenching, Backfilling, and Compaction
  - 1. Reference construction specification *Section 02315, Excavation and Fill*.
- B. Existing Utilities
  - 1. The horizontal and vertical location of existing utilities shall be field verified prior to start of construction.
  - 2. Any deviation from what is shown on the approved Construction Drawings shall be reported to the City immediately and documented on the As-Constructed Record Drawings.

### **3.4 CONNECTIONS TO EXISTING SYSTEM**

- A. When connecting to the existing potable water distribution, ONLY City Water and Sewer Department personnel shall operate existing system valves. The Contractor shall provide at least forty-eight (48) hours notification prior to needing any valve operated, except in the case of emergencies.
- B. At locations where connections to existing mains are to be made, the Contractor shall locate the

existing mains both vertically and horizontally and verify their exact size and material in advance of the time scheduled for making the connections.

1. Prior to connecting to existing mains, the Contractor shall have all labor, materials, and equipment ready to connect the fitting to the existing main, so as to keep the shutoff time to a minimum.
  2. The Contractor shall notify the City of Greeley 48 hours in advance to examine the existing pipe or appurtenance and specify any necessary adjustments in line, grade, or connection requirements to accomplish the connection. Contractor to make corrections as directed by the City.
  3. Use effective measures to prevent contamination to existing potable water lines.
  4. Refer to construction specification *Section 02511, Disinfection of Water Utility Distribution* for more information on disinfection prior to connecting to existing waterlines.
- C. The City shall not be responsible for valve water tightness on existing facilities. If existing valves leak, the City Water and Sewer Department may assist in reducing the influx of water, but the Contractor must use methods at his own disposal to dewater the trench and complete any required testing and disinfection of the potable water line.
- D. All connections shall have valves installed to separate new construction from the existing system. New construction shall not be connected to the existing system until the new system has been tested, disinfected, and accepted by the City.

### **3.5 PIPE INSTALLATION**

- A. Pipe Laying
1. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
  2. Measure for grade at top of pipe.
  3. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
  4. Lay pipe with the bells pointing in the direction the work is progressing.
  5. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    - a. Shorter pipe lengths.
    - b. Special mitered joints.
    - c. Standard or special fabricated bends.
  6. After joint has been made, check pipe alignment and grade.
  7. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.

8. Take effective measures to prevent opening of joints during bedding and backfilling operations.
9. Complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade as each length of pipe is placed in the trench. Make adjustments in line and grade by scraping away or filling pipe bedding under the entire length of the pipe, except at bells, and not by wedging, blocking, or mounding up the pipe or bells.
10. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints. Do not disturb the pipe after the jointing has been completed.
11. Install the pipeline so that a positive or negative grade is maintained between high and low points.
12. The minimum and maximum depth of cover shall be five (5) feet and six (6) feet respectively, for potable water mains unless otherwise indicated on the Construction Drawings.
13. No water pipe may be covered or backfilled until inspection of pipe and bedding has been made or City Inspector has given approval.
14. Tracing wire shall be installed with PVC pipe and ductile iron pipe (DIP).

B. Separation of Water Mains and Services in Relation to Other Utilities

1. Potable water services and distribution mains shall have a minimum ten (10) feet horizontal and eighteen-inches (18") vertical separation from all utilities measured from outside diameter.
2. Where sanitary sewer lines cross beneath potable water lines with less than eighteen-inches (18") clearance, sanitary sewer lines cross above potable water lines, or the ten (10) feet horizontal clearance between potable water lines and sanitary sewer lines cannot be maintained, pipe encasement shall be provided in accordance with construction specification *Section 02445, Casing Pipe – Borings and Encasements*.
3. Where storm water lines cross above potable water mains, storm water pipe joints shall be grouted a minimum ten (10) feet on either side of the crossed potable water main, measured from the outside diameter of the pipe.
4. Dry utility crossings shall be encased in high density polyethylene pipe (HDPE), Standard Dimension Ratio (SDR) 11 from edge to edge of the easement or right-of-way, or ten (10) feet on either side of the potable water main, whichever is greater.
5. Right angle only utility crossings are permitted above and below the potable water main. Parallel installation of other utilities in exclusive water easements is not permitted.
6. Bored utility crossings shall have a minimum twenty-four inches (24") of vertical clearance from the outside diameter of the utility casing to the outside diameter of the potable water line if the bored utility crosses above the potable water line and a minimum thirty-six inches (36") of vertical clearance from the outside diameter of the utility casing to the outside diameter of the potable water line if the bored utility crosses below the water line.
7. If there are horizontal or vertical clearance conflicts between the potable water line and a

utility, the City may require that the potable water main be lowered, raised, or realigned in order to maintain the required clearances.

8. For a potable water line crossing situation not specifically mentioned in this section, the crossing requirements provided in these Criteria shall be applied to that particular situation to the best extent possible.

C. Tracer Wire

1. Tape to top centerline of pipe every three (3') to four (4') feet with adhesive tape or plastic tie straps such that wire remains in place during embedding of pipe.
2. Tracing wire shall be brought to the surface on the inside of a test station behind every fire hydrant. Install manufactured flush-to-grade access box as specified in specification section 02510-2.9-C-3.
3. Tracer wire shall be installed per City of Greeley Standard Drawings.

D. Test Station

1. Test stations shall be installed per City of Greeley Standard Drawings.
2. Tracer wire and test station system shall be tested prior to City acceptance.

### 3.6 THRUST RESTRAINT

A. Anchorage and Blocking

1. Reference City of Greeley Standard Drawings.
2. Concrete thrust blocks and anchors for preventing movement shall be provided at all mechanical joint plugs, tees, crosses, reducers, valves, bends, and changes in direction of 11-¼° or more.
3. The minimum size of thrust blocks and thrust anchors shall be determined from the table provided on the City of Greeley Standard Drawings.
4. The concrete thrust block-bearing surface shall be excavated into undisturbed soil.
  - a. All loose soil shall be disposed of, and the location where the thrust block is to be poured shall be carefully shaped to provide a uniform bearing surface of the required size.
  - b. The concrete thrust block bottom shall be flat, and sides shall be vertical.
  - c. If soil is to be disturbed, making a concrete thrust block or thrust anchor unusable, alternate restraining systems must be approved for use by the Water and Sewer Department prior to pipeline installation.
5. The concrete thrust block shall be formed to provide access to fittings, valves, and hydrants. Care shall be taken not to block outlets or to cover bolts, nuts, clamps, or other fittings to make them inaccessible.
6. The concrete thrust block shall be extended from the fitting or valve to be blocked to undisturbed earth. Concrete thrust blocks shall be constructed so that joints and drain

holes are clear and accessible.

7. Concrete shall be separated from fittings, valves, and hydrants by eight (8) mil polyethylene film.
8. The City shall be notified a minimum twenty-four (24) hours prior to concrete being placed.

**B. Restraining Devices**

1. If concrete thrust blocks cannot be used for any reason, or if otherwise required, push-on and mechanical joints may be restrained with mechanical restraint systems.
2. The City shall determine the length of pipe to be restrained for each situation where mechanical restraint systems are to be installed. Refer to Construction Drawings or coordinate with City as necessary for location.
3. Reference construction specifications *Section 02512, Ductile-Iron Pipe* and *Section 01513, Polyvinyl Chloride (PVC) Pressure Pipe*.

**3.7 INSTALLATION OF PIPELINE APPURTENANCES**

- A. Install valves, hydrants, blow-offs, and other pipeline appurtenances at the locations shown on the Construction Drawings or as designated by the City to accommodate field conditions.
- B. Horizontal and Vertical record measurements of the actual location of fittings, valves, and appurtenant equipment prior to backfill and record for the As-Constructed Record Drawings.
- C. All dead-end potable water lines will have a hydrant blow-off at the end of the. Dead-end potable water lines that will be extended in the future shall have a valve which controls that section of potable water line left in the off position. The valve shall be positioned so no service will be left without water when the line is extended in the future.

**3.8 PROTECTION OF METAL SURFACES**

- A. Protect supplied material including coatings that have been damaged.
- B. For polyethylene encasement, reference construction specification *Section 02512, Ductile-Iron Pipe*.
- C. Apply two (2) coats of coal tar paint to ferrous metal rods, rebar, clamps, bolts, nuts and other accessories which are subject to submergence or contact with earth or fill material. Apply first coat of coal tar paint to a dry, clean surface. Allow first coat of coal tar paint to dry before the second coat is applied.

**3.9 DISSIMILAR METALS AND INSULATOR KITS**

- A. Whenever it is necessary to join dissimilar metals, a City approved insulated joint shall be installed.

**3.10 FIELD QUALITY CONTROL**

- A. Pipe Leakage Tests.
  1. Reference construction specification *Section 01713, Water Distribution System Testing*.

- B. Tracer Wire Testing.
  - 1. Pass current through wire and demonstrate that wire is capable of locating the pipe.
  - 2. If wire will not pass current, locate break in circuit and test until tracer wire works in accordance with its intended use.
- C. Soil Compaction.
  - 1. Reference construction specification *Section 02315, Excavation and Fill*.

**3.11 PIPELINE DISINFECTION**

- A. Reference construction specification *Section 02511, Disinfection of Water Utility Distribution*.

## SECTION 02511

### DISINFECTING OF WATER UTILITY DISTRIBUTION

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the filling and disinfection of potable water distribution lines.
- B. The Contractor is responsible for the disinfection and testing of water lines.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. B300, *Hypochlorites*, latest revision
  - 2. C651, *Disinfecting Water Mains*, latest revision.

##### 1.3 SUBMITTALS

- A. Procedure and plan for cleaning, disinfection, and testing of system. Plan shall include:
  - 1. Plan describing and illustrating conformance to appropriate AWWA standards and this Specification.
  - 2. Proposed locations within system where Samples will be taken.
  - 3. Type of disinfecting solution and method of preparation.
  - 4. Method of disposal for highly chlorinated disinfecting water.
- B. Certification that employees working with concentrated chlorine solutions have received appropriate safety training.
- C. Certification that independent testing agency is qualified to perform bacteriological testing in accordance with AWWA standards, agency requirements, and this Specification.
- D. Certified Bacteriological Test Results confirming area tested is free from coliform bacteria contamination. Forward results directly to City.

##### 1.4 QUALITY ASSURANCE

- A. Independent Testing Agency: Certified in the State of Colorado with 10 years of experience in the field of water sampling and testing. Agency shall use calibrated testing instruments and equipment and documented standard procedures for performing specified testing. The City may choose to self-perform the testing.

#### PART 2 – PRODUCTS

##### 2.1 WATER FOR DISINFECTION AND TESTING

- A. Clean, uncontaminated, and potable.



## **2.2 DISINFECTANT**

- A. Hypochlorite - Reference AWWA B300. Hypochlorite for use in swimming pools is not allowed.

## **PART 3 – EXECUTION**

### **3.1 GENERAL**

- A. Perform disinfection after completion of leakage testing and acceptance of results.
- B. The Contractor shall disinfect all pipe and fittings which will be installed in the main after the main has been chlorinated or installed at connections to existing mains, which will not be subjected to the chlorination procedure. The Contractor shall notify City of Greeley a minimum of 48 hours prior to the disinfection so the City can be onsite to observe.
- C. The Contractor shall flush and satisfactorily disinfect new water lines prior to acceptance of the lines by the City and placing them in service.
- D. New water lines shall not be connected to existing lines until the new lines have been flushed, tested, disinfected, and accepted by the City.
- E. Under NO circumstances shall a non-disinfected potable water main be connected to an existing disinfected potable water main without prior acceptance by the City.
- F. As soon as possible after making the connections, the Contractor shall flush the connection so as to prevent contamination of the existing facilities. The Contractor shall take every precaution necessary to prevent dirt or debris from entering the main.
- G. Complete flushing and disinfection in accordance with AWWA C651, except as modified in these Specifications.
- H. Contractor to furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
- I. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections and appropriate backflow preventer assembly as required by AWWA C651.
- J. Disinfect items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water.

### **3.2 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Reference the Forwards to AWWA B300 and AWWA C651.
- B. Exercise extreme care in handling hypochlorites, as they may be dangerous to health.

### **3.3 GROUNDWATER OR SURFACE RUNOFF CONTAMINATION**

- A. If it is not possible to keep the pipe and fittings dry during installation, every effort shall be made to assure that any of the water that may enter the pipe joint spaces contains an available chlorine concentration of approximately 25 mg/L. This may be accomplished by adding calcium hypochlorite granules to each length of pipe before it is lowered into a wet trench.
- B. If the main is flooded during construction, it shall be cleared of the flood water by draining and by

flushing with potable water until clean. The section exposed to the flood water shall then be filled with chlorinated potable water which at the end of a twenty-four (24) hour holding period shall have a free chlorine residual of not less than 25 mg/L. The chlorinated water may then be drained or flushed from the main. After construction is completed, the main shall be disinfected using the continuous feed or slug method.

- C. If dirt and debris enters the pipe that, in the opinion of the City, will not be removed by the flushing operation, the interior of the pipe shall be cleaned by mechanical means and then shall be swabbed with a 1% hypochlorite disinfection solution. Cleaning with the use of a pig, swab, or “go-devil” should be undertaken only when such operations will not force mud or debris into pipe joint spaces.

### **3.4 FILLING PIPE**

- A. Only City personnel shall operate existing City owned valves to prevent disinfecting solution from flowing back into the line supplying the water.
- B. Where permanent air release vents are not available, the Contractor shall install corporation stops at high points in the water line in order to evacuate trapped air.
  - 1. All corporation stops shall be installed using an approved tapping saddle. No direct taps will be allowed.
  - 2. All locations for corporation stops shall either be shown on the City accepted Construction Drawings or as directed in the field by the City.
  - 3. All corporation stops, which were installed to facilitate evacuation of air from the water main shall be removed and plugged with a brass “cc” threaded plug after the water main is filled, and prior to pressure testing. All tap locations shall be shown on the As-Constructed Record Drawings.
- C. Refer to specific method of disinfection in this Specification for maximum filling velocity.
- D. Water supplied from a temporary, backflow protected connection to the existing distribution system or other approved supply source, shall flow at a constant measured rate into the newly installed water main.
- E. Prior to application of disinfectants, clean all pipelines of loose and suspended material. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
- F. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
- G. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

### **3.5 METHODS**

- A. General
  - 1. The City, in accordance with AWWA C651, shall approve the chlorinating agent and

method of application. The City has the authority to restrict the method of disinfection on a case by case basis.

2. The City shall sample and test water from the pipe system extremities until clear, potable water is obtained.
3. The Contractor shall properly and legally dispose of flushing and heavily chlorinated water. Do not allow flow into a waterway without neutralizing disinfectant residual. See appendix of AWWA C651 for acceptable neutralization methods.
4. Operate new valves and other appurtenances while the lines are filled with heavily chlorinated water.

B. Tablet Method

1. The tablet method consists of placing calcium hypochlorite tablets in the water main as it is being installed and then filling the main with potable water when installation is complete. This method may be used only if the pipes and appurtenances are kept clean and dry during construction.
2. Placing Calcium Hypochlorite Tablets
  - a. During construction, 5-gram calcium hypochlorite tablets shall be placed in each section of pipe. Also, one tablet shall be placed in each hydrant, hydrant branch, and other appurtenance.
  - b. The number of 5 gram tablets required for each pipe section shall be

$$0.0012d^2L$$

rounded to the next higher integer, where d is the inside pipe diameter, in inches, and L is the length of the pipe section, in feet. Reference Table 2, AWWA C651 for commonly used sizes of pipes.

- c. Tablets shall be attached to the top of the pipe by a food-grade adhesive.
  - d. The adhesive shall be only on the broadside of the tablet attached to the surface of the pipe.
  - e. If the tablets are attached before the pipe section is placed in the trench, their position shall be marked on the section to indicate that the pipe has been installed with the tablets at the top.
3. Filling and contact
  - a. Introduce water into the pipes at a velocity no greater than one (1) foot per second (fps).
  - b. The chlorinated water shall be retained in the lines for a minimum of twenty-four (24) hours. If the water temperature is less than 41° F, the water shall remain in the pipe at least forty-eight (48) hours.
  - c. Detectable chlorine residual of not less than 10 mg/L shall be found at each sampling point after the twenty-four (24) hour or forty-eight (48) hour period.

C. Continuous-Feed Method

1. The continuous-feed method of disinfecting water mains consists of completely filling the main to remove all air pockets, flushing the completed main to remove the particulates, and filling the main with potable water.
2. Chlorinated water shall be introduced into the water lines at a point not more than ten (10) feet downstream from the beginning of the new main. Water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 25 mg/L free chlorine.
  - a. The entire main shall be filled with the chlorine solution.
  - b. Reference Table 4, AWWA C651 for required chlorine amounts.
  - c. Prior to and during the disinfection process, valves shall be positioned so that the chlorine solution in the newly constructed main will not flow into water mains in active service.
3. The chlorinated water shall be retained in the main for a minimum of twenty-four (24) hours, at which time the treated water in all portions of the main shall have a free chlorine residual of not less than 10 mg/L.

D. Slug Method

1. The slug method consists of placing calcium hypochlorite granules in the main during construction, completely filling the main to eliminate all air pockets, flushing the main to remove particulates, and slowly flowing through the main a slug of water dosed with chlorine to a concentration of 100 mg/L.
2. Placing Calcium Hypochlorite Granules
  - a. Calcium hypochlorite granules may only be used with prior written approval by the City.
  - b. During construction, calcium hypochlorite granules shall be placed at the upstream end of each section of pipe and at the upstream end of each branch main.
  - c. The quantity of granules used shall be as shown in Table 1, AWWA C651.
3. At a point not more than ten (10) feet downstream from the beginning of the new main, water entering the new main shall receive a dose of chlorine fed at a constant rate such that the water will not have less than 100 mg/L free chlorine.
4. The chlorine shall be applied continuously and for a sufficient period to develop a solid column, or "slug" of chlorinated water that will, as it moves through the main, expose all interior surfaces to a concentration of approximately 100 mg/L.
5. The free chlorine residual shall be measured in the slug as it moves through the main. If the free chlorine drops below 50 mg/L, the flow shall be stopped, chlorination equipment moved to the head of the slug, and as flow resumes, chlorine shall be applied to restore the free chlorine in the slug to not less than 100 mg/L.
6. Flow rate shall be set so that all interior surfaces are exposed to a chlorine concentration

of approximately 100 mg/L for a minimum of three (3) hours.

### **3.6 PIPE AND FITTING INSTALLED AFTER CHLORINATION**

- A. All pipes and fittings which will be installed after the pipe has been chlorinated or installed at connections to existing mains, which will not be subject to chlorination, shall be disinfected:
  - 1. The ends of the existing pipe shall be thoroughly cleaned both inside and outside before any new parts are installed.
  - 2. The ends of the existing pipe shall be sprayed with a concentrated chlorine solution (min. of 100 parts per million chlorine), both inside and outside. The inside of the pipe shall be sprayed as far back into the main as possible.
  - 3. All inside surfaces of any new material that will have contact with potable water shall be cleaned and sprayed with a concentrated chlorine solution (minimum of 100 parts per million chlorine). This includes middle rings and gaskets for mechanical couplings, punch joints, mechanical joints, and split sleeves.

### **3.7 FINAL FLUSHING**

- A. After the applicable retention period, the heavily chlorinated water shall be flushed from the water lines until chlorine measurement show that the concentration in the water leaving the main is no higher than that generally prevailing in the system, or less than 1 mg/L.
- B. The Contractor shall be responsible for all necessary permits and to ensure that no environmental damage occurs from the flushed water line. Reference Appendix B of AWWA C651 for a list of neutralizing chemicals.

### **3.8 BACTERIOLOGICAL TESTS**

- A. The Testing Agency shall collect water samples to test for bacteriological quality to show the absence of coliform and heterotrophic organisms in the pipeline. Testing shall be done after final flushing. Under no circumstances shall the main put in service prior to bacteriological testing.
- B. The Contractor shall schedule with the Testing Agency for sample collection upon notification of need from the Contractor.
- C. The Testing Agency, based upon AWWA C651, shall determine the number and frequency of samples.
- D. All test results shall be sent to the City for review and approval.
- E. Water mains shall not be placed in service until written release is obtained from the City.

### **3.9 REPETITION OF PROCEDURE**

- A. If the initial disinfection, or subsequent disinfections, fails to produce satisfactory samples, the main shall be reflashed and resampled. If the samples are still not satisfactory, the continuous-feed or the slug method of chlorination shall be used to rechlorinate the main until satisfactory results are obtained.

## SECTION 02512

### DUCTILE IRON PIPE

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section is a minimum guideline for furnishing and the installation of ductile-iron pipe (DIP) and fittings for water lines.
- B. Pipe shall be furnished complete with all fittings, flanges, specials, and other accessories.
- C. Refer to *Section 02510, Water Utility Distribution Piping*, for additional requirements.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C104/A21.4, *Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water*, latest revision.
  - 2. C105/A21.5, *Polyethylene Encasement for Ductile-Iron Pipe Systems*, latest revision.
  - 3. C110/A21.10, *Ductile-Iron and Gray-Iron Fittings*, latest revision.
  - 4. C111/A21.11, *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*, latest revision.
  - 5. C115/A21.15, *Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges*, latest revision.
  - 6. C116/A21.16-03, *Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service*, latest edition.
  - 7. C150/A21.50, *Thickness Design of Ductile-Iron Pipe*, latest revision.
  - 8. C151/A21.51, *Ductile-Iron Pipe, Centrifugally Cast, for Water*, latest revision.
  - 9. C153/A21.53, *Ductile-Iron Compact Fittings for Water Service*, latest revision.
  - 10. C219, Bolted, *Sleeve-Type Couplings for Plain-End Pipe*, latest revision.
  - 11. C600, *Installation of Ductile-Iron Water Mains and Their Appurtenances*, latest revision.
- B. American Society of Mechanical Engineers/American National Standards Institute (ASME/ANSI)
  - 1. B16.1, *Cast Iron Pipe Flanges and Flanged Fittings*, latest revision.
- C. ASTM International (ASTM)
  - 1. A153/A153M, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*, latest revision.

2. A536, *Standard Specification for Ductile Iron Castings*, latest revision.
  3. F3125/F3125M, *Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength*, latest revision.
- D. American Water Works Association (AWWA)
1. M41, *Manual of Water Supply Practices, Ductile-Iron Pipe and Fittings*, latest revision.

### **1.3 SUBMITTALS**

- A. See *Section 02510, Water Utility Distribution Piping* for Submittal Requirements.

### **1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. All DIP shall be supplied by one manufacturer.
- B. Handling
1. Use slings, pipe tongs or skids.
  2. Do not drop pipe or fittings including dropping on cushions.
  3. Do not skid or roll pipe into pipe already on the ground.
  4. Do not damage pipe coating or lining.
  5. Do not use hooks.
  6. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression, or abrasion.
- C. Storage
1. Store and use pipe lubricants in a manner which will avoid contamination.
  2. Pipe, gaskets, and all other installation materials shall be stored in accordance with the manufacturer's specifications.
  3. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell.
  4. Do not exceed maximum stacking heights listed in AWWA C600, Tables 6.

## **PART 2 – PRODUCTS**

### **2.1 GENERAL**

- A. Materials in contact with potable water shall conform to NSF 61 acceptance.
- B. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of the specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA A21.51 shall be conducted in testing and laboratory

facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).

**2.2 DUCTILE-IRON PIPE – SLIP JOINT**

- A. General
  - 1. This specification shall cover slip joint DIP in four-inch (4”) through twenty-four inch (24”) nominal diameters.
  - 2. DIP shall be manufactured in accordance with AWWA C151.
  - 3. DIP shall be zinc coated in accordance with ASTM A153/153M.
- B. Pipe joints shall be “push-on single gasket” type conforming to applicable requirements of AWWA C111.
- C. DIP shall have normal laying lengths of either eighteen (18) feet or twenty (20) feet. Random pipe lengths are not acceptable.
- D. Iron used in the manufacture of DIP for these specifications shall have:
  - 1. Minimum tensile strength – 60,000 psi
  - 2. Minimum yield strength – 42,000 psi
  - 3. Minimum elongation – 10%
- E. DIP shall have standard thickness cement mortar lining in accordance with AWWA C104.
- F. DIP shall have a bituminous coating, minimum one (1) mil thick, on the pipe exterior, unless otherwise specified.
- G. As shown in AWWA C151, slip joint DIP shall conform, at a minimum, to the following pressure classes:

**TABLE 2.1-G: Pressure Class and Wall Thickness – Slip Joint DIP**

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
3	350	0.25
4	350	0.25
6	350	0.25
8	350	0.25
12	350	0.28
16	350	0.34
20	300	0.36
24	300	0.40

Higher pressure class pipe will be required when the W&S Dept determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.



**2.3 DUCTILE-IRON PIPE – MECHANICAL JOINT**

A. See Section 02510, *Water Utility Distribution Piping*

**2.4 DUCTILE-IRON PIPE – FLANGED JOINT**

A. General

1. This specification shall cover flanged joint DIP in four-inch (4”) through twenty-four inch (24”) nominal diameters.
2. DIP shall be manufactured in accordance with AWWA C151.
3. DIP shall be zinc coated in accordance with ASTM A153/153M.

B. Pipe joints shall be “flanged single gasket” type conforming to applicable requirements of AWWA C111.

C. All pipe flanges shall be sized and drilled in accordance with ASME B16.1, Class 125.

D. Iron used in the manufacture of DIP for these specifications shall have:

1. Minimum tensile strength – 60,000 psi
2. Minimum yield strength – 42,000 psi
3. Minimum elongation – 10%

E. DIP shall have standard thickness cement mortar linings in accordance with AWWA C104.

F. DIP shall have a bituminous coating, minimum one (1) mil thick, on the pipe exterior, unless otherwise specified.

G. As shown in AWWA C115, flanged DIP shall conform, at a minimum, to pressure class 250:

**TABLE 2.3-G: Pressure Class and Wall Thickness – Flanged Joint DIP**

<b>Diameter (inch)</b>	<b>Pressure Class (psi)</b>	<b>Nominal Wall Thickness (inch)</b>
3	250	0.31
4	250	0.32
6	250	0.34
8	250	0.36
12	250	0.40
16	250	0.43
20	250	0.45
24	250	0.47

Higher pressure class pipe will be required when the W&S Dept determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.

- H. Corrosion resistant, high strength, low-alloy steel bolts and nuts shall be used where in contact with soil, immersed, or in splash zones in accordance with ASTM F3125, Type 3. Acceptable bolts and nuts are:
1. Cor-Ten
  2. Usalloy
  3. Or approved equivalent.

**2.5 DUCTILE-IRON PIPE – RESTRAINED JOINT**

- A. General
1. This specification shall cover restrained joint DIP in four-inch (4”) through twenty-four inch (24”) nominal diameters.
  2. DIP shall be manufactured in accordance with AWWA C151.
  3. DIP shall be zinc coated in accordance with ASTM A153/153M.
- B. Pipe joints shall be “restrained push-on single gasket” type conforming to applicable requirements of AWWA C111.
- C. Restrained ductile-iron pipe shall have normal laying lengths of either eighteen (18) feet or twenty (20) feet. Random pipe lengths are not acceptable.
- D. Iron used in manufacture of DIP for these specifications shall have:
1. Minimum tensile strength – 60,000 psi
  2. Minimum yield strength – 42,000 psi
  3. Minimum elongation – 10%
- E. DIP shall have standard thickness cement mortar linings in accordance with AWWA C104.
- F. DIP shall have a bituminous coating, minimum one (1) mil thick, on the pipe exterior, unless otherwise specified.
- G. As shown in AWWA C151, restrained joint DIP shall conform, at a minimum to the following pressure classes:

**TABLE 2.4-G: Pressure Class and Wall Thickness – Restrained Joint DIP**

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
3	350	0.25
4	350	0.25
6	350	0.25
8	350	0.25
12	350	0.28

16	350	0.34
20	300	0.36
24	300	0.40
Higher pressure class pipe will be required when the W&S Dept determines that excessive dead loads, pressures, or other conditions warrant increased wall thickness.		

H. Acceptable manufacturers for boltless, restrained joint pipe are:

1. U. S. Pipe - TR FLEX
2. Pacific States Pipe - TYTON AND FASTITE RESTRAINED JOINT
3. American D.I.P - FLEX-RING or Lok-Ring
4. Clow Corp. – Super-Lock
5. Or approved equivalent.

I. Bell type restrained joint pipe shall incorporate a mechanical joint type socket with a mechanical joint restraint.

## 2.6 MECHANICAL JOINT RESTRAINTS

A. Reference construction specification *Section 02510, Water Utility Distribution Piping* for additional requirements for mechanical joint restraints.

## 2.7 TRACER WIRE AND TEST STATIONS

A. Reference construction specification *Section 02510, Water Utility Distribution Piping* for additional requirements for tracer wire and test stations.

## 2.8 MECHANICAL COUPLINGS

A. Reference construction specification *Section 02510, Utility Distribution Piping* for additional requirements for couplings.

## 2.9 FITTINGS

A. Reference construction specification *Section 02510, Utility Distribution Piping* for additional requirements for fittings.

## 2.10 GASKETS

A. Gaskets in contact with potable water shall be NSF 61 certified.

B. Gasket pressure rating to equal or exceed the system hydrostatic test pressure.

## 2.11 POLYETHYLENE ENCASEMENT

A. All buried ductile-iron pipe and fittings shall be encased in polyethylene in accordance with

AWWA C105, Method A.

- B. Polyethylene encasement shall be eight (8) mil minimum thickness.

### **PART 3– EXECUTION**

#### **3.1 INSPECTION**

- A. Examine pipe and fittings for cracks, flaws, broken or loose lining, dents, abrasions, and other defects. Damaged or flawed pipe shall be rejected, marked, and removed from the site.
- B. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines.

#### **3.2 PREPARATION**

- A. Trenching, backfilling, and compaction.
  - 1. Reference construction specification *Section 02315, Excavation and Fill*.
- B. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.
- C. Cutting the pipe.
  - 1. Cut pipe smooth, straight and at right angles to the pipe axis.
  - 2. Do not damage the pipe or cement lining.
  - 3. Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
  - 4. Grind cut ends and rough edges smooth.
  - 5. Dress cut ends as required for the type of joint to be made, as recommended by pipe manufacturer. Bevel the cut end for push-on joints.

#### **3.3 INSTALLATION**

- A. Install buried pipe in accordance with these specifications, City of Greeley accepted Construction Drawings, and AWWA M41.
- B. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.
- C. Pipe Laying:
  - 1. See *Section 02510, Water Utility Distribution Piping* for information on pipe laying.
- D. Tolerances:
  - 1. See *Section 02510, Water Utility Distribution Piping* for allowable tolerances.
- E. Field Joints

1. Use push-on joints for buried pipe except where indicated otherwise on the Construction Drawings.
2. Use flanged joints at unburied locations unless indicated otherwise on the Construction Drawings.
3. All joints shall be watertight and free from leaks.
4. Use Mega-Lug, or approved equivalent, retainer gland on all exposed mechanical joints for restraint.
5. Block, anchor, or harness all mechanical couplings, push-on or mechanical joints.
6. Install concrete blocking against undisturbed earth in a manner to allow access to joints.

F. Polyethylene Encasement

1. Repair rips, punctures or other damage with adhesive tape or with a short length of polyethylene encasement wrapped around pipe and secured in place.
2. Maintain a sealed encasement on pipe with the polyethylene. Tape to existing lines and the ends of encasement sections.
3. Use loose polyethylene encasement at all buried locations including fittings with flanged or mechanical joints.
4. Polyethylene encasement shall be installed per City of Greeley Standard Drawings.

G. Curves in Trench Alignments

1. See *Section 02510, Water Utility Distribution Piping* for allowable joint deflection.

### 3.4 JOINT INSTALLATION

A. Push-On Joints

1. Remove all dirt, oil, grit, excess coating and other foreign matter from the inside of the bell and the outside of the spigot.
2. Insert the gasket.
3. Apply a thin film of pipe lubricant to either the inside surface of the gasket, the spigot end of the pipe or both.
4. Do not permit the joint surfaces to come in contact with the ground.
5. Make sure the pipe is marked with a depth mark before assembly to ensure that the spigot is inserted to the depth mark according to manufacturer's recommendations.
6. Do not stab pipe.

B. Mechanical Joints

1. Remove all dirt, oil, grit, excess coating and other foreign matter from the inside of the bell and the outside of the spigot.

2. Insert the gasket.
3. Apply a thin film of pipe lubricant to either the inside surface of the gasket, the spigot end of the pipe or both.
4. Do not permit the joint surfaces to come in contact with the ground.
5. Make sure the pipe is marked with a depth mark before assembly to ensure that the spigot is inserted to the depth mark according to manufacturer's recommendations.
6. Do not stab pipe.
7. Tighten nuts alternately on opposite sides of the pipe to produce equal pressure on all parts of the gland.
8. Use a torque limiting wrench with the following ranges:

**TABLE 3.4-B: Torque Wrench Ranges**

Pipe Diameter (in)	Bolt Diameter (in)	Torque (ft-lb)
4"-24"	¾"	75-90

9. Holes in mechanical joint bells shall straddle the top (or side for vertical piping) centerline.

C. Flanged Joints

1. Extend pipe completely through screwed-on flanges.
2. Machine finish the pipe end and flange face in a single operation.
3. Eliminate any restraints on pipe that would prevent uniform gasket compression or cause unnecessary stress in the flanges.
4. Do not assemble mechanical connections until all flanged joints have been tightened.
5. Alternately tighten bolts spaced on opposite sides of the pipe to assure uniform gasket compression.
6. Holes in flanges shall straddle the top (or side for vertical piping) centerline.

**3.5 FIELD QUALITY CONTROL**

- A. Reference *Section 02510, Water Utility Distribution Piping*.

**3.6 PIPELINE DISINFECTION**

- A. Reference *Section 02511, Disinfection of Water Utility Distribution*.

## SECTION 02513

### POTABLE POLYVINYL CHLORIDE (PVC) PRESSURE PIPE

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section includes materials and installation procedures for polyvinyl chloride (PVC) pressure pipe for potable water distribution.
- B. Pipe shall be furnished complete with all fittings, specials, and other accessories.
- C. Refer to specification section 02510 Water Utility Distribution Piping, for additional requirements.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C900, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In., For Water Distribution*, latest revision.
- B. ASTM International (ASTM)
  - 1. D1784, *Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds*, latest revision.
  - 2. F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*, latest revision.
- C. American Water Works Association (AWWA)
  - 1. M23, *Manual of Water Supply Practices, PVC Pipe: Design and Installation*, latest revision.
- D. National Sanitation Foundation (NSF)
  - 1. Standard No. 61 – *Drinking Water System Components – Health Effects*, latest revision.
- E. Plastic Pipe Institute (PPI)
  - 1. TR-3 – *Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe*, latest revision.

##### 1.3 SUBMITTAL REQUIREMENTS

- A. See Section 02510, *Water Utility Distribution Piping* for general submittal requirements.
- B. Additional submittal requirements for PVC include:
  - 1. Pipe Manufacturer
  - 2. Pipe Class / Pressure Rating

3. Color
4. Recommended Minimum bending Radius
5. Recommended Maximum Safe Pull Force (For Fusible PVC)
6. Fusion Technician qualifications indicating conformance with this specification. (For Fusible PVC)

#### **1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. All PVC pipe shall be supplied by one manufacturer.
- B. Handling.
  1. Use wide fabric choker slings.
  2. Do not drop pipe or fittings including dropping on cushions.
  3. Do not use hooks.
  4. Polyvinyl chloride (PVC) pipe has reduced flexibility and impact resistance as temperatures approach and drop below freezing. Extra care should be used in handling and installing PVC pipe during cold weather.
  5. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression, or abrasion.
- C. Storage.
  1. Store and use pipe lubricants in a manner that will avoid contamination.
  2. Pipe shall be stored in accordance with the manufacturer's specifications.
  3. Pipe, gaskets, and all other installation materials shall be stored in accordance with the manufacturer's specifications.
    - a. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell.
    - b. No pipe stored outside and exposed to sunlight shall exceed the manufacturer's recommended exposure time. This time shall begin from the date of manufacture.
    - c. If the exposure time will be greater than the manufacturer's recommended time, the pipe shall be covered with an opaque material. Air circulation shall be provided under the covering.
    - d. Pipe that exhibits excessive ultraviolet deterioration and cracking, which in the opinion of the City degrades the pipe quality, shall not be used.



## **PART 2 – PRODUCTS**

### **2.1 POLYVINYL CHLORIDE (PVC) PIPE – SLIP JOINT**

- A. General.
  - 1. This specification shall cover slip joint PVC pipes in 6-inch (6”) through 24-inch (24”) nominal diameters with cast iron equivalent outside diameters.
  - 2. All PVC pipe shall be manufactured in accordance with AWWA C900.
  - 3. Pipe shall be blue in color.
- B. Pipe joints shall be made using an integral bell with elastomeric gasket push-on type joint or using machined couplings of a sleeve type with rubber ring gaskets and machined pipe ends to form a push-on type joint.
- C. All sizes of pipe under these specifications shall be pressure class as shown on the City accepted Constructed Drawings. Pressure Class 235 (DR-18) shall be the minimum pipe class accepted.
- D. Each length of pipe shall be a standard laying length of twenty (20) feet. Random lengths are not acceptable.
- E. Polyvinyl chlorine (PVC) pipe materials shall be made from Class 12454A of 12454B virgin compounds as defined in ASTM D1784. All compounds shall qualify for a rating of 4000 psi for water at 73.4°F (23°C) per the requirements of Plastic Pipe Institute (PPI), *TR-3*, and complies with the National Sanitation Foundation Standard, *No. 61*, for water service.
- F. Elastomeric gaskets shall conform to ASTM F477.

### **2.2 POLYVINYL CHLORIDE PIPE (PVC) – RESTRAINED JOINT**

- A. General.
  - 1. This specification shall cover restrained joint PVC pipe in 6-inch (6”) through 24-inch (24”) nominal diameters with cast iron equivalent outside diameters.
  - 2. All PVC pipe shall be manufactured in accordance with AWWA C900.
  - 3. Pipe shall be blue in color.
- B. Pipe joints shall be non-metallic restrained joint design by utilizing precision-machined grooves on the pipe and in the coupling. When aligned, a nylon spline is inserted, resulting in a fully circumferential restrained joint that locks the pipe and coupling together. A flexible elastomeric seal (o-ring) in the coupling provides a hydraulic pressure seal.
- C. All sizes of pipe under these specifications shall be pressure class as shown on the City accepted Constructed Drawings. Pressure Class 235 (DR-18) shall be the minimum pipe class accepted.
- D. Each length of pipe shall be a standard laying length of twenty (20) feet. Random lengths are not acceptable.
- E. Polyvinyl chlorine pipe materials shall be made from Class 12454A of 12454B virgin compounds as defined in ASTM D1784. All compounds shall qualify for a rating of 4000 psi for water at

73.4°F (23°C) per the requirements of Plastic Pipe Institute (PPI), *TR-3*, and complies with the National Sanitation Foundation Standard, *No. 61*, for water service.

- F. Elastomeric gaskets shall conform to ASTM F477.
- G. Acceptable restrained joint PVC manufacturers are:
  - 1. Certain Teed – CERTA-LOK C900/RJ
  - 2. Or approved equivalent.
- H. Acceptable high deflection restrained joint PVC manufacturers are:
  - 1. Certain Teed – HD (High Deflection)
  - 2. Or approved equivalent.

### **2.3 POLYVINYL CHLORIDE (PVC) PIPE – FUSED**

- A. General.
  - 1. This specification shall cover slip joint PVC pipes in 6-inch (6”) through 24-inch (24”) nominal diameters with cast iron equivalent outside diameters.
  - 2. All PVC pipe shall be manufactured in accordance with AWWA C900.
  - 3. Pipe shall be blue in color.
- B. All sizes of pipe under these specifications shall be pressure class as shown on the City accepted Constructed Drawings. Pressure Class 235 (DR-18) shall be the minimum pipe class accepted.
- C. Each length of pipe shall be a standard laying length of twenty (20) feet or more. Random lengths are not acceptable
- D. Polyvinyl chlorine (PVC) pipe materials shall be made from Class 12454A of 12454B virgin compounds as defined in ASTM D1784. All compounds shall qualify for a rating of 4000 psi for water at 73.4°F (23°C) per the requirements of Plastic Pipe Institute (PPI), *TR-3*, and complies with the National Sanitation Foundation Standard, *No. 61*, for water service.
- E. Fusion Technician
  - 1. Fusion Technician shall be fully qualified by the pipe supplier to install Fusible PVC of the type(s) and size(s) being used. Qualifications shall be current as of the actual date of fusion performance on the project.
- F. Fusion Joints
  - 1. Unless otherwise specified, fusible PVC pipe lengths shall be assembled in the field with butt-fused joints. Contractor shall follow the pipe suppliers written guidelines for this procedure. All Fusion joints shall be completed as described in these specifications.

### **2.4 MECHANICAL JOINT PIPE RESTRAINTS**

- A. Refer to construction specification *Section 02510, Water Utility Distribution Piping* for additional requirements for mechanical joint pipe restraint.

- B. Acceptable manufacturers for PVC pipe are:
  - 1. Mechanical joint Restraint:
    - a. EBAA Iron, Inc. – MEGALUG, SERIES 2000 PV
    - b. Uni-Flange Corp. – SERIES 1500 Slip joint restraint:
    - c. EBAA Iron, Inc. – MEGALUG, SERIES 1500
    - d. Uni-Flange Corp. – SERIES 1390
    - e. ROMAC Industries, Inc

## **2.5 TRACER WIRE AND TEST STATIONS**

- A. Reference construction specification *Section 02510, Utility Distribution Piping* for additional requirements for tracer wire and test stations.

## **2.6 FITTINGS AND COUPLINGS**

- A. Reference construction specification *Section 02510, Utility Distribution Piping* for additional requirements for fittings and couplings.

## **PART 3– EXECUTION**

### **3.1 INSPECTION**

- A. In addition to any deficiencies covered by AWWA M23, PVC pipe which has any of the following visual defects will be rejected:
  - 1. Pipe which is sufficiently out-of-round to prohibit proper joining or be able to pass a mandrel test.
  - 2. Improperly formed bell and spigot ends.
  - 3. Fractured, cracked, chipped, dented, abrasions, or otherwise damaged pipe.
  - 4. Pipe that has been damaged during shipment or handling. Acceptance of the pipe at point of delivery will not relieve the Contractor of full responsibility for any defects in material of the completed pipeline.
- B. Damaged or flawed pipe shall be rejected, marked, and removed from the site.

### **3.2 PREPARATION**

- A. Trenching, backfilling, and compaction.
  - 1. Reference construction specification *Section 02315, Excavation and Fill*.

### **3.3 FUSION PROCESS**

- A. General

1. Fusible PVC pipe to be handled in a safe and non-destructive manner before, during and after the fusion process and in accordance with this specification and the pipe's supplier's guidelines
2. Fusible PVC pipe will be fused by a qualified fusion technician, as documented by the pipe supplier
3. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine
4. Only appropriately sized and outfitted fusion machines that have been approved by the pipe manufacturer shall be used in the fusion process. Fusion machines must incorporate the following elements:
  - a. Heat Plate – Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.
  - b. Carriage – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
  - c. General Machine – Overview of machine body shall yield to obvious defects, missing parts, or potential safety issues during fusion.
  - d. Data Logging Device – An approved data logging device with current version of pipe supplier's recommendation and compatible software shall be used. Datalogging device operation and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110 V power source shall be available to extend battery life.
5. Other equipment specifically required for the fusion process shall include the following:
  - a. Pipe rollers shall be used for support of the pipe to either side of the machine
  - b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and / or windy weather, per the pipe supplier's recommendations
  - c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
  - d. Fusing machine operations and maintenance manual shall be kept with the fusion machine at all times.
  - e. Face blades specifically designed for cutting fusible PVC pipe shall be used.

**B. Joint Recording**

1. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and / or record the parameters required by the

supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

### **3.4 FUSION PIPE INSTALLATION**

#### **A. General Installation**

1. Installation guidelines from the pipe supplier shall be followed for all installations.
2. The fusible PVC pipe will be installed in a manner so as not to exceed the recommended bending radius.
3. Where fusible PVC pipe is installed by pulling in tension, the recommended Safe Pulling Forces established by the pipe supplier shall not be exceeded.

#### **B. Connections to Existing and New Piping Systems**

1. Approximate locations for existing piping systems are shown in the construction documents. Prior to making connection into existing piping systems, the contractor shall:
  - a. Field verify locations, size, piping material, and piping system of the existing pipe.
  - b. Obtain all required fittings, which may include saddles, sleeve type couplings, flanges, tees, or other as shown in the construction documents.
  - c. Allow all piping that has been installed to relax for a period of 24 hours or longer before making final connections.
  - d. Have installed all temporary pumps and / or pipes in accordance with the established connection plans.
2. Unless otherwise approved, new piping systems shall be completely assembled and successfully tested prior to making connections into existing pipe systems.

#### **C. Cutting the pipe.**

1. Cut pipe smooth, straight and at right angles to the pipe axis with saws or pipe cutters designed specifically for the material.
2. Remove burrs and wipe off all dust from the jointing surfaces.
3. Bevel the cut end in accordance with manufacturer's recommendation.
4. Do not disturb previously installed joints during cutting operations.

#### **D. Field joints.**

1. Use push-on joints for buried pipe except where indicated otherwise on the Construction Drawings.
2. Dirt, oil, grit, and other foreign matter shall be removed from the inside of the bell and the outside of the spigot.

3. A thin film of lubricant shall be applied to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.

4. The lubricated joint surface shall be kept clean until joined.

E. Bending

1. Bending of pipe can be up to 75% of manufacturers recommendation.

**3.5 INSTALLATION**

A. Reference construction specification *Section 02510, Water Utility Distribution Piping* for additional requirements for installation of pipe.

B. Install buried pipe in accordance with these specifications, City of Greeley accepted Construction Drawings, and AWWA M23.

C. Joints.

1. The pipe shall be joined to the tolerances recommended by the manufacturer (i.e. home line).

2. Stabbing of the pipe shall not be allowed.

3. Previously completed joints shall not be disturbed during the jointing operation.

4. All joints shall be watertight and free from leaks.

5. Test all pipe under concrete and asphalt construction prior to placing concrete to asphalt.

6. Install concrete blocking against undisturbed earth in a manner to allow access to joints.

D. Curves in Trench Alignment.

1. PVC pressure pipe may be curved to change alignment or grade or to avoid obstructions. The allowable joint offset for PVC pressure pipe is provided in the table below:

**TABLE 3.3-D: Maximum PVC Pipe Joint Deflection**

Pipe Diameter (in)	Maximum Joint Deflection (°)
8"	2.5°
12"	2.0°
HD Couplings	5.0°

2. In making the pipe conform to the curve, the pipe lengths should first be assembled in a straight line and then curved as they are lowered into the trench.

**3.6 FIELD QUALITY CONTROL**

A. Reference construction specification *Section 02510, Water Utility Distribution Piping* for additional requirements for field quality control.

**3.7 PIPELINE DISINFECTION**

- A. Reference construction specification *Section 02511 Disinfection of Water Utility Distribution* for additional requirements for pipeline disinfection.

## SECTION 02514

### WATER SERVICE LINES, METERS, AND APPURTENANCES

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section is a minimum guideline for furnishing and installation of corporation stops, service lines, meters, meter setters, and meter pits.
- B. Service lines are from the water main to the property line.
- C. All services shall be metered with the exception of fire sprinkler lines.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C800, Underground Service Line Valves and Fittings, latest revision.
- B. ASTM International (ASTM)
  - 1. F876, *Standard Specification for Crosslinked Polyethylene (PEX) Tubing*, latest revision.
  - 2. F2080, *Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Crosslinked Polyethylene (PEX) Pipe and SDR 9 Polyethylene of Raised Temperature (PE-RT) Pipe*.

##### 1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. The products shall be handled, stored and protected in a manner that will prevent damage to materials, coatings, and finishes.
- B. All material shall be kept free from dirt, oil, and grease.
- C. All material shall be new.

##### 1.4 INSTALLATION OF SERVICES

- A. All water services 1 ½-inch (1 ½”) and 2-inch (2”) shall be fitted with an approved backflow prevention device.
  - 1. Any case where a cross-connection potential exists, all taps must be fitted with a backflow prevention device.
  - 2. Backflow prevention devices shall be installed according to the Colorado Department of Public Health and Environment (CDPHE), Water Quality Control Division’s Cross-Connection Control Manual, latest edition, and tested upon installation and every year thereafter by a certified cross-connection control technician.
    - a. Product information sheets for proposed backflow prevention devices shall be submitted to the Water and Sewer Department for acceptance during the building review process and prior to requesting building permits.



- b. Test reports shall be forwarded to the Water and Sewer Department.
  - c. The Water and Sewer Department reserves the right to enhance the requirements of the CDPHE based on City requirements.
- B. There shall be no physical connection between any potable water service line, inside or outside of any property or building, and any pipes, pumps, hydrants, or tanks, whereby any unsafe or contaminated water (including steam condensation or cooling water) could be discharged or drawn into the potable water system.
- C. Pressure reducing valves may be required according to the plumbing regulations.
- D. No pressure booster shall be allowed unless adequate backflow protection is used.

**PART 2 – PRODUCTS**

**2.1 TAPPING SADDLES**

- A. ¾-inch (¾”) inclusive through two-inch (2”) tapping saddles shall be constructed of materials in accordance with one of the following descriptions.
- 1. Bronze body.
  - 2. Nuts, bolts, and accessories shall be in accordance with the manufacturer’s specifications.
  - 3. Acceptable manufacturers and models of ¾-inch (¾”) inclusive through two-inch (2”) tapping saddles are:

**TABLE 2.1-A: ¾” – 2” Tapping Saddles**

Manufacturer	Model	Pipe Material
Mueller	BR 2 B CC	DIP, CIP
Mueller	H-13000 CC	C900 PVC
Ford	Style 202B CC	DIP, CIP
Ford	Style S90 CC Hinged	C900 PVC

Or approved equivalent.

- B. Four-inch (4”) and larger taps on new construction shall use tees.
- C. Four-inch (4”) and larger taps on existing water mains may be tapped with approval from the City.
- 1. Tapping saddles shall be a cast-iron or ductile iron mechanical joint tapping sleeve with totally confined end gaskets.
  - 2. Reference the City of Greeley Standard Drawings for tapping sleeve requirements.
  - 3. Acceptable manufacturers and models of four-inch (4”) and larger tapping saddles are:

**TABLE 2.1-C: 4” and Larger Tapping Saddles**

<b>Manufacturer</b>	<b>Model</b>
Mueller	H-615 for centrifugal CI, DI, PVC
Mueller	H-616 for pit cast CI pipe

Or approved equivalent.

**2.2 CORPORATION STOPS**

- A. All corporation stops shall conform to AWWA C800 and be capable of operating at a working pressure of 150 psi.
  - 1. All corporation stops shall be full opening plug type and constructed of no-lead brass.
  - 2. Corporation stop inlet threads for tapping saddles shall be “cc” type only.
  - 3. All corporation stop outlets shall use a compression connection.
- B. Corporation stops shall be used for all taps which are two-inch (2”) and smaller.
- C. Tap sizes shall match line sizes, i.e. one-inch (1”) corporation tap with a one-inch (1”) line.
- D. Acceptable manufacturers and models of corporation stops are:

**TABLE 2.2-C: Corporation Stops**

<b>Manufacturer</b>	<b>Model</b>
Mueller	H-15013
Ford	F1000

No substitutions allowed.

**2.3 SERVICE LINES**

- A. Two-inch (2”) and smaller service lines shall be Municipex®, or Uponor and conform to AWWA C800.
  - 1. Municipex®
    - a. The pipe shall be Municipex® SDR 9 Pipe only, conforming to ASTM F2080
    - b. All connections shall be Municipex® compression only.
  - 2. Uponor
    - a. The pipe shall be Uponor AquaPEX® conforming to ASTM F876
    - b. All connections shall be Uponor ProPEX® compression only.
- B. Three-inch (3”) and larger service lines shall be zinc coated ductile iron pipe and conform to construction specification *Section 02512, Ductile-Iron Pipe*. Three-inch (3”) service lines shall

use a four-inch (4") tap/tee and reduce to three-inches (3") immediately after the tap/tee.

- C. Fire service lines shall be a minimum of four-inch (4") diameter and shall be restrained zinc coated ductile iron pipe and conform to construction specification *Section 02512, Ductile-Iron Pipe*.

## 2.4 COUPLINGS

- A. All couplings shall be compression x compression only.
- B. Acceptable manufacturers and models of couplings are:

**TABLE 2.4-B: Couplings**

Manufacturer	Model
Mueller	H-15433
Ford	C44

No substitutions allowed.

## 2.5 CURB STOPS

- A. Curb stops ¾-inch (¾") inclusive to two-inches (2") shall conform to AWWA C800.
  - 1. All curb stops shall have FIP x FIP connections at both ends.
  - 2. Curb stops shall be plug type, full opening, Minneapolis pattern.
  - 3. Acceptable manufacturers and models of one-inch (1") curb stops are:

**TABLE 2.5-A.3: ¾" and 1" Curb Stops**

Manufacturer	Model
Mueller	H-10228
Ford	Z11-333 or Z11-444

No substitutions allowed.

- 4. Acceptable manufacturers and models of 1 ½-inch (1 ½") and two-inch (2") curb stops are:

**TABLE 2.5-A.4: 1 ½" and 2" Curb Stops**

Manufacturer	Model
Mueller	H-10228

No substitutions allowed.

- B. Curb stops three-inches (3") and larger shall be gate valves and conform to construction specification *Section 02515, Water Utility Distribution Valves*.

**2.6 CURB STOP BOXES**

- A. Curb stop boxes are required with all curb stops.
- B. Acceptable manufacturers and models of one-inch (1") curb stop boxes are:

**TABLE 2.6-B: ¾" and 1" Curb Stop Boxes**

Manufacturer	Model
Mueller (1")	H-10300-99002 (6 ft)
Ford	EM2-50-47-42R or EM2-55-46-48R (6 ft)

Or approved equivalent.

- C. Acceptable manufacturers and models of 1 ½"-inch (1 ½") and two-inch (2") curb stop boxes are:

**TABLE 2.6-C: 1 ½" and 2" Curb Stop Boxes**

Manufacturer	Model
Mueller	H-10300-99002 (6 ft)
Ford	EM2-50-57 (6 ft)

Or approved equivalent.

- D. Curb stop boxes for three-inches (3") and larger shall be in street valve box and conform to construction specification *Section 02515, Water Utility Distribution Valves*.

**2.7 METERS**

- A. All water meters shall be purchased from the Water and Sewer Department. No exceptions.

**2.8 METER SETTERS**

- A. Meter setters to be installed as shown in the City of Greeley Standard Drawings.
- B. All ¾-inch (¾") and one-inch (1") meter setters shall have a meter stop inlet valve with a locking wing. Note that the lay lengths listed do not account for gasket thickness. The acceptable manufacturers and models of meter setters are:

**TABLE 2.8-A: ¾" and 1" Meter Setters**

Meter Size	Setter Manufacturer	Setter Model	Total Lay Length (in)
¾" x ¾" Meter	Ford	VV-83W-22-33-NL	9 3/8"
¾" x ¾" Meter	Mueller	H-1489N	9 3/8"
1" Meter	Ford	V84-10W-22-44-NL	11 1/8"
1" Meter	Mueller	H-1489N	11 1/8"

No substitutions allowed.

- C. All 1 ½"-inch (1 ½") and two-inch (2") meter setters shall have a meter stop inlet valve with a lockwing, and a built-in locking by-pass. Note that the lay lengths listed do not account for gasket thickness. The acceptable manufacturers and models of meter setters are:

**TABLE 2.8-B: 1 ½" and 2" Meter Setters**

Meter Size	Setter Manufacturer	Setter Model	Total Lay Length (in)
1 ½" Meter	Ford Meter	V76-12B-11-66-NL	13 3/8"
1 ½" Meter	Mueller	H-1423N	13 1/4"
2" Meter	Ford Meter	V77-12B-11-77-NL	17 3/8"
2" Meter	Mueller	H-1423N	17 1/4"

No substitutions allowed.

## 2.9 METER PITS AND VAULTS

- A. ¾-inch (¾") meters and one-inch (1") meters:
1. Meter pits shall be twenty inches (20") in diameter and shall be constructed of rigid High Density Polyethylene (HDPE).
  2. Meter pit covers shall be constructed of aluminum with cap type top lid and frost-proof rubber inner lids.
    - a. The minimum allowable opening for meter pit covers shall be eleven-inches (11") diameter.
    - b. All meter pit covers shall have a 27/32-inch worm-lock with a Standard Waterworks pentagon head.
- B. 1 ½ -inch (1 ½") and two-inch (2") meters:
1. Meter pits shall be forty-eight inches (48") diameter.
  2. Meter vaults shall be a pre-cast concrete manhole in accordance with construction specification *Section 03400, Precast Concrete*. All vault openings shall have modular sealing units and be grouted with non-shrink grout between the modular sealing unit and the vault inside and outside wall.
  3. Meter vault covers shall be a cast iron ring and aluminum manhole cover with a twenty-four-inch (24") diameter opening unless approved otherwise, in writing, by the City Water and Sewer Department. All meter vault covers shall have the word "WATER" cast in the lid.
  4. Reference City of Greeley Standard Drawings.
- C. Three-inch (3") and larger meters:
1. Meter vaults shall be a pre-cast concrete in accordance with construction specification *Section 03400, Precast Concrete*.
  2. All vault openings shall be link-sealed.

3. All joints shall be watertight.
4. Meter vault covers shall be a cast iron ring and cast iron or aluminum manholes cover with a thirty-six inch (36") diameter opening unless approved otherwise by the City. All potable water meter vault covers shall have the word "WATER" cast in the lid.
5. Include gravel sump
6. Reference City of Greeley Standard Drawings for vault size and layout.

### **PART 3– EXECUTION**

#### **3.1 GENERAL**

- A. Only those Contractors licensed and bonded with the City of Greeley will be permitted to install water service connections.
- B. The Contractor shall make all taps on new lines, with approved equipment, and install the service line to the curb stop prior to disinfection and pressure testing of the water main.
- C. The Contractor shall adjust meter pits to the horizontal location and to the final grade as determined by grade stakes.
  1. Grade stakes shall be placed a minimum five (5) feet from the location of the meter pit.
  2. The grade shall be determined from the top of sidewalk elevation to top of building finished floor.
  3. Grade stakes shall not be disturbed prior to service inspection by the City.
- D. The Contractor shall mark the location of water services and fire sprinkler lines with a stamped "W" and "F", respectively, four-inches (4") high, three-inches (3") wide into the face of the curb and gutter.

#### **3.2 TRENCHING, BACKFILLING, AND COMPACTION**

- A. Reference construction specification *Section 02315, Excavation and Fill*.

#### **3.3 TAPS**

- A. Unless prior approval is given by the City, only City personnel shall make service taps on mains which have been accepted by the City. Contractor to bolt everything prior to the City personnel making the service taps.
- B. The Contractor shall not make any taps without permission from the City.
- C. All taps shall be made with a tapping saddle in accordance with these specifications and the manufacturer's recommendations.
- D. Service taps on mains will be made only under the direct supervision of the City. The Contractor shall give forty-eight (48) hours advance notice to the City before any taps are made.
- E. The City reserves the right to make taps in lieu of the Contractor and the right to deny permission for any main to be tapped.

- F. Tapping equipment shall be of good quality, used for the purpose intended, and used in accordance with the manufacturer's instructions.
- G. Taps shall not be made within two (2) feet of any joint, fitting, or valve.
- H. Taps shall be separated by at least two (2) feet, measured along the pipe length, even when taps are made on opposite sides of the pipe.
- I. Taps shall be made at the 2:00 or 10:00 location on the pipe circumference. Taps that are made on the same side of the pipe and within ten (10) feet of each other, measured along the pipe length shall be staggered by fifteen degrees (15°).

### **3.4 SERVICE LINES**

- A. All water service lines and fire sprinkler lines shall be a minimum five (5) feet and a maximum six (6) feet below the final grade unless otherwise approved by the City.
  - 1. Water Service
    - a. There will be a maximum of one (1) coupling per service, between the main and the curb stop. The coupling shall be used only for repair situations and not for utilizing short pieces of tubing during construction. Couplings shall be compression x compression for services two-inches (2") and smaller.
    - b. Service lines shall be uniform in size from the corporation stop to five (5) feet past the meter pit.
    - c. The expansion loop shall not be installed higher than the top of the main being tapped. When backfilling the service trench, bedding shall be used under and six-inches (6") above the expansion loop at the service connection to the main.
  - 2. Fire Service
    - a. Fire sprinkler services shall be uniform in size from the main to the structure being serviced.
    - b. Fire Sprinkler lines shall be a minimum of four-inches (4") in diameter.
    - c. A resilient seat gate valve the same diameter as the fire sprinkler service pipe shall be installed at the main and restrained back to the mainline tee by use of restrained joint pipe or mechanical joint restraint.
    - d. Fires sprinkler lines are not metered.
- B. A two-inch by four-inch (2" x 4") wood post shall be placed at the end of the service line.
  - 1. All wooden posts shall extend from the end of the service to a point two (2) feet, minimum, above the ground surface and shall be painted blue.
  - 2. Locator balls/rings or adequate steel to be located by a ferrous metal detector should be placed at the end of the service at an adequate depth so it will not be disturbed by grading and construction operations.
  - 3. Maintenance of the marker posts shall be the responsibility of the Contractor until the City accepts the project. After acceptance by the City the maintenance of the marker

posts shall be the responsibility of the property owner.

- C. Service trenches shall be subject to compaction specifications. Reference construction specification *Section 02315, Excavation and Fill*.
- D. Where a water service or fire service line crosses another utility or any underground structure, the service shall preferably pass above the other utility or structure.
  - a. In no instance shall there be less than eighteen-inches (18") clearance between the water service or fire service line and any other utility or structure.
  - b. The space between the water or fire service line and the other utility or structure shall be backfilled with compacted bedding material or flow-fill concrete.

### **3.5 CURB STOPS**

- A. Reference City of Greeley Standard Drawings for curb stop location.
- B. Reference construction specification *Section 02510, Water Utility Distribution Piping*, for tracer wire test station requirements.
- C. Curb stop boxes shall be placed inside the upper half of standard valve box. The Contractor shall adjust the curb stop box to ½-inch (1/2") below valve box lid prior to final inspections.
- D. The Contractor shall adjust the valve box to ½-inch (1/2") above final grade prior to final inspections.
- E. The Contractor shall adjust the curb stop box to ½-inch (1/2") above final grade prior to final inspections.
- F. Curb stop boxes shall not be placed in driveways or sidewalks.
- G. Curb stop boxes shall be plumb.
- H. Contractor shall demonstrate to the City that curb stops are operable prior to City acceptance.

### **3.6 LANDSCAPE SPRINKLER SYSTEMS**

- A. Underground sprinkler systems shall be designed in strict conformance with the City of Greeley Building Inspection guidelines for the installation of underground sprinkling systems and shall receive approval by permit prior to start of construction. The sprinkler system installer shall be responsible for the submittal of a permit application and the scheduling of inspections prior to installation and operation. A copy of the guidelines is available at the City of Greeley Building Inspection Department.
- B. Each irrigation system shall have appropriate backflow protection.
- C. With the exception of single family houses, all sprinkler irrigation systems shall have their own separate irrigation services and meters.

### **3.7 METER PITS AND VAULTS**

- A. Meter pits or vaults shall not be installed in any street, parking area, driveway, or sidewalk unless prior written permission is obtained from the Water and Sewer Department. If a meter pit or vault is permitted to be located in any traffic area, the pit/vault shall be required to be designed to



withstand HS-20 traffic loading.

- B. There shall be no major landscaping (trees, boulder, shrubs over three (3) feet in mature height, etc.) or structure (retaining wall, etc.) within ten (10) feet of the meter pit or vault. All shrubs less than three (3') feet in mature height shall be located no closer than five (5) feet to a meter pit or vault.
- C. The finished ground around the meter pit or vault shall slope away from the lid at a minimum grade of two percent (2%).
- D. There shall be no plumbing connections inside the meter pit or vault.
- E. All tees, connections, and couplings shall be a minimum five feet (5') from the meter pit or vault wall, and be on the outlet side.
  - 1. There shall be no tees, connections, or couplings installed between the curb stop and the meter setter or meter horn.
  - 2. All pipes coming into any meter vault or pit three-inches (3") or larger shall be flanged pipe only.
- F. The meter pit or vault shall be adjusted to ½-inch (1/2") above final grade if the surrounding grade is changed.

### **3.8 INSPECTION**

- A. The Contractor shall ensure that the curb stop, corporation stop, and any couplings remain exposed until after inspection and the City gives the approval for backfill.
- B. All tap and service inspections shall be scheduled with the City a minimum forty-eight hours (48) prior to desired time of inspection.
- C. The water shall be turned on at the curb stop by the Water and Sewer Department, only after the service line, curb stop, stop box, and meter setter are installed.
- D. Contact the City of Greeley Meter Shop a minimum forty-eight (48) hours prior to requesting final meter pit inspection. Refer to City of Greeley Standard Drawings.
- E. Meter pits and stop boxes shall be at finished grade at time of acceptance of subdivision improvements. If the stop box or meter pit is damaged, bent, or otherwise unacceptable to the City, the builder will be responsible for replacing the damaged stop box or meter pit prior to issuance of a Certificate of Occupancy.

## SECTION 02515

### WATER UTILITY DISTRIBUTION VALVES

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section covers water system valves, valve operators, valve boxes, and other valve appurtenances.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Society of Mechanical Engineers (ANSI/ASME)
  - 1. B16.1, Grey Iron Pipe Flanges and Flanged Fittings, latest revision.
- B. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C207, Steel Pipe Flanges for Waterworks Service – Size 4 in. through 144 in., latest revision.
  - 2. C500, Metal-Seated Gate Valves for Water Supply Service, latest revision.
  - 3. C508, Swing-Check Valves for Waterworks Service, 2-in. Through 24-in., latest revision.
  - 4. C509, Resilient-Seated Gate Valves for Water Supply Service, latest revision.
  - 5. C512, Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service, latest revision.
  - 6. C550, Protective Interior Coatings for Valves and Hydrants, latest revision.
- C. ASTM International (ASTM)
  - 1. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings, latest revision.
  - 2. B62, Standard Specification for Composition Bronze or Ounce Metal Castings, latest revision.

##### 1.3 SUBMITTAL REQUIREMENTS

- A. Information to be provided should include:
  - 1. Valve Manufacture
  - 2. Valve Pressure Rating
  - 3. Valve Construction Materials
- B. Two (2) sets of Shop Drawings for each valve size and type shall be furnished to the City for acceptance prior to start of construction.

#### **1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Take precautions so as not to damage materials during delivery or storage.
- B. Store valves off the ground and away from materials that could contaminate water systems.
- C. Take precautions to keep joints and internal parts clean.

#### **PART 2 – PRODUCTS**

##### **2.1 GENERAL**

- A. All water distribution valves shall open clockwise (right). (Valves on water transmission lines open counter-clockwise (left)).
- B. All valves shall be the same size as the main unless approved otherwise by the City.
- C. Valves shall be either mechanical or flanged joint as required.
  - 1. Exposed locations shall use flanged joints.
  - 2. Buried locations shall use mechanical joints.
- D. The interior and exterior of all buried valves shall be epoxy coated in accordance with AWWA C550.
- E. All buried valves shall have a two-inch (2”) square-operating nut. The manufacturer shall paint all open right operating nuts red.
- F. The operating nut on buried valves shall be between four (4) feet and six (6) feet below the finished grade. If, in order to achieve the operating nut depth, it is necessary to use a riser stem, the riser shall be double pinned. The riser stem shall be a solid stem coated to prevent corrosion.

##### **2.2 GATE VALVES**

- A. General
  - 1. Four-inch (4”) through twelve-inch (12”) diameter gate valves shall be designed for a minimum working pressure of 200 psi and a test pressure of 400 psi. Sixteen-inch (16”) diameter gate valves shall be designed for a minimum working pressure of 150 psi and a 300 psi test pressure.
  - 2. Sixteen-inch (16”) bonnets shall be set vertically.
  - 3. Water distribution line gate valves shall be resilient seat gate valves.
- B. Resilient Seat Gate Valves
  - 1. Resilient seat gate valves shall be manufactured in accordance with AWWA C509.
  - 2. Valve stems shall be non-rising.
  - 3. Stem seals shall be provided with two (2) o-ring type stem seals in accordance with AWWA C509.

4. Acceptable manufacturers of resilient seat gate valves are:
  - a. Mueller
  - b. Kennedy
  - c. American AVK Company

### **2.3 VALVE BOXES**

- A. Valve boxes shall be cast-iron or ductile iron, buffalo type, two (2) piece boxes with round bases.
  1. Valve boxes shall have a five and ¼-inch (5-¼”) screw type shaft suitable for depth of cover as required.
  2. Valve boxes shall be capable of future adjustment for street overlays.
- B. The word “WATER” shall be cast into the box lid for potable water.
- C. Acceptable manufacturers of valve boxes are:
  1. Tyler 6850 series with drop lid
  2. Or approved equivalent.

### **2.4 AIR RELEASE, AIR/VACUUM, AND COMBINATION AIR VALVES**

- A. Air Release (AR) valves, Air/Vacuum (A/V) valves, and combination air valves shall be manufactured in accordance with AWWA C512.
- B. Air Release and Air/Vacuum Valves
  1. All AR and A/V valves shall be rated a minimum working pressure of 150 psi and a hydrostatic test pressure equal to 150% of the actual rated working pressure of the valve.
  2. The working parts and seat of the AR and A/V valves shall be brass, stainless steel, or other non-corroding material unless otherwise approved by the City.
- C. Combination air valves shall have features of both the AR and A/V valve.
- D. The size of the AR valve, A/V valve, or combination air valve shall be as noted on the approved Construction Drawings.
- E. Acceptable manufacturers of Air Release, Air/Vacuum, and Combination Air Valves are:
  1. ¾-inch (¾”), one-inch (1”), and two-inch (2”) Combination Air Valve – A.R.I. D-040
  2. Two-inch (2”) to ten-inch (10”) Combination Air Valve – A.R.I. D060-C HF
  3. Or approved equivalent.

### **2.5 SWING CHECK VALVES**

- A. All swing check valves shall be manufactured in accordance with AWWA C508.

- B. Swing check valves shall have an epoxy coated interior in accordance with AWWA C550.
- C. Swing check valves shall be ductile-iron, of the resilient-to-coated seat construction, have a resilient hinge arm, and be of the clear waterway design.
- D. The closure assembly shall assume the closed position by gravity under no-flow conditions.
- E. Swing check valves shall be designed for a minimum working pressure of 200 psi and 400 psi test pressure for check valves with diameters of four-inch (4") through twelve-inch (12"). Sixteen-inch (16") diameter check valves shall be designed for a minimum working pressure of 150 psi and 300 psi test pressure.
- F. Acceptable manufacturers of swing check valves are:
  - 1. Mueller
  - 2. American Flow Control
  - 3. M & H
  - 4. Clow
  - 5. Kennedy
  - 6. Or approved equivalent.

## **2.6 PRESSURE REGULATING VALVES**

- A. The function of the Pressure Regulating Valve (PRV) is to reduce an existing high pressure to a pre-adjusted lower downstream pressure for varying rates of flow without causing shock of water hammer on the system.
- B. The PRV shall be hydraulically operated with a free floating guided piston having a seat diameter equal to the size of the valve.
- C. Materials and Construction
  - 1. Flanges and covers shall conform to ASTM A126, Class B.
  - 2. The PRV shall be fully bronze-mounted with bronze castings or parts conforming to ASTM B62.
  - 3. All PRVs shall be furnished with flanged ends sized and drilled in accordance with ANSI/ASME B16.1, Class 125 specifications.
    - a. Flanges shall be machined to a flat face with a finish of 250 micro inches, or machined to a flat surface with a serrated finish in accordance with AWWA C207.
  - 4. The PRV shall be purchased from the manufacturer as an assembly and shall include a main valve, pilot valve system which controls operation of the main valve, and other operational components.
    - a. The pilot valve shall be a single seated, diaphragm operated, spring loaded type.

- b. The pilot valve shall be attached to the main valve with piping and isolation valves arranged for easy access to make adjustments and for its removal from the main valve while the main valve is under pressure.
- 5. All PRVs shall be rated a minimum working pressure of 150 psi and a hydrostatic test pressure equal to 150% of the actual rated working pressure of the valve.
- 6. Allow sufficient room around the PRV for assembly and to make adjustments and for servicing.
- 7. The standard PRV size is eight-inches (8') unless otherwise approved by the City.
- D. Acceptable manufacturers of pressure regulating valves are:
  - 1. Cla-Val – 90-01
  - 2. Or approved equivalent.

### **PART 3 – EXECUTION**

#### **3.1 INSPECTION**

- A. Valves and valve boxes shall be examined for cracks, dents, abrasions, and other flaws prior to installation.
- B. Damaged or flawed valves shall be rejected, marked, and removed from the site.

#### **3.2 INSTALLATION**

- A. Valves
  - 1. With the exception of tapping valves, flanged valves shall not be buried.
  - 2. Valves shall be installed in such a manner that the operating nut is perpendicular to the pipe.
  - 3. Buried valves shall be supported on concrete as shown in the City of Greeley Standard Drawings.
- B. Tapping Valves
  - 1. Tapping valves shall be installed per the manufacturer's recommendation.
  - 2. Tapping valves and sleeves are to be hydraulically pressure tested to 150 psi for twenty (20) minutes, with no leakage, prior to proceeding with a wet tap.
  - 3. Tapping valves and sleeves shall be equipped with a threaded test hole.
- C. Valve Boxes
  - 1. All buried valves shall be provided with a valve box, including fire hydrant valves, unless indicated otherwise on the approved Construction Drawings.
  - 2. Install the valve box so that no stress is transmitted to the valve.

3. Set the valve box plumb and directly over the valve's operating nut. Valve operators that are mounted to one (1) side of the valve shall be located to the south or west of the valve.
  4. The soil around the valve box shall be carefully compacted around the barrel, with hand equipment, to minimize misalignment and settling of the backfill.
- D. Air Release, Air/Vacuum, and Combination Air Valves
1. AR, A/V, and combination air valves shall be installed at the locations shown on the Construction Drawings.
  2. Air relief and vacuum relief valves shall be installed in accordance with City of Greeley Standard Drawings.
- E. Swing Check Valves
1. Swing check valves shall only be used in four-inch (4") or larger service meter settings and shall be installed downstream of the meter.
  2. Swing check valves shall be installed in a horizontal, level setting.
  3. Swing check valves shall be installed in accordance with City of Greeley Standard Drawings.
- F. Pressure Regulating Valves
1. PRVs shall be installed as shown on the Construction Drawings, per the manufacturer's recommendations, and in accordance with City of Greeley Standard Drawings.

### **3.3 OPERATION**

- A. Prior to requesting water system acceptance, the Contractor shall operate all valves in the presence of City personnel.
- B. Only City personnel shall operate valves that have been accepted by the City.

## SECTION 02516

### WATER UTILITY DISTRIBUTION FIRE HYDRANTS

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section is a minimum guideline for furnishing and installation of dry-barrel fire hydrants.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C502, *Dry-Barrel Fire Hydrants*, latest revision.

##### 1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Fire hydrants shall be handled, stored, and protected in such a manner as to prevent damage to materials, coatings, and finishes.
- B. All fittings and joints shall be kept free from dirt, oil, and grease.

#### PART 2 – PRODUCTS

##### 2.1 FIRE HYDRANTS

- A. All fire hydrants shall be purchased from the City of Greeley Water and Sewer Department. No exceptions.
  - 1. Requests for fire hydrants shall be made a minimum two (2) weeks prior to requested hydrant pickup date.
  - 2. A twenty-four (24) hour notice, with number of requested hydrants, shall be given to the Water and Sewer Department prior to Contractor picking up the fire hydrants.
  - 3. Fire hydrants may be picked up on normal business days between 7:30 a.m. and 8:30 a.m.
- B. Fire hydrants purchased from the City shall be of the following, approved manufacturer:
  - 1. Kennedy Valve, Guardian K-81D
  - 2. City approved equal
- C. Specifications for fire hydrants purchased from the City are as follows:
  - 1. Type and Size of Hydrant
    - a. Dry-barrel type manufactured in accordance with AWWA C502.
    - b. Main valve opening size – 5 ¼-inch (5 ¼")
    - c. Three-way type with one (1) pumper nozzle and two (2) hose nozzles all located on the same horizontal plan.



2. Design and Testing
  - a. Minimum rated working pressure – 150 psi.
  - b. Minimum factory test pressure for assembled hydrants – 300 psi in both the open and closed positions.
  - c. Under test conditions, leakage through drain valve not to exceed five (5) fluid ounces (fl. oz.) per minute. No leakage allowed through the castings, main valve, joints, or stem packing.
3. Pumper Nozzle
  - a. Size – 4 ½-inch (4 ½”) in diameter.
  - b. Threads – left handed, six (6) threads per inch (1”), National Standard threads.
4. Hose Nozzle
  - a. Size – 2 ½-inch (2 ½”) in diameter.
  - b. Threads – left-handed, National Standard threads.
5. Nozzle Cap
  - a. Contains a synthetic rubber gasket installed in a retaining groove.
  - b. Dimensions and shape of the nozzle cap nut are the same as the operating shaft nut.
  - c. Attached to the hydrant with non-kinking type steel chains.
6. Operating Nut and Shaft
  - a. Nut material – bronze.
  - b. Nut shape – pentagon and tapered.
  - c. Nut size – 1 5/16-inch (1 5/16”) from point to flat base of the nut; 1 ¼-inch (1 ¼”) at the top.
  - d. Nut height – not less than 1-inch (1”).
  - e. Nut operation – Right turn (clockwise direction). An arrow on top of hydrant bonnet designates the direction of opening.
  - f. Hydrants contain an oil reservoir that provides permanent lubrication of the operating nut threads.
  - g. “O” rings protect operating mechanism from the waterway.
7. Barrel
  - a. Component connections – bolted flange type

- b. Ground line connection – manufactured to allow positioning of the top section at increments not greater than fifteen degrees (15°).
- 8. Hydrant Base (Shoe)
  - a. Four (4) mil minimum, epoxy lined, including lower valve (plant) and retainer.
  - b. Inlet provided with a mechanical joint to accommodate six-inch (6”) diameter DIP.
- 9. Drain Valve/Openings – One (1) or more provided.
- 10. Traffic Features – breakaway traffic flange.
- 11. Color – Orange
- 12. Certification – An affidavit of compliance shall be provided to the City of Greeley Water and Sewer Department from the hydrant manufacturer stating that all fire hydrant standard and supplemental specifications have been met.

## 2.2 EXTENSIONS

- A. All fire hydrants extensions shall be purchased from the City of Greeley Water and Sewer Department. No exceptions.
  - 1. Requests for fire hydrant extensions shall be made a minimum two (2) weeks prior to requested hydrant extension pickup date.
  - 2. A twenty-four (24) hour notice, with number of requested hydrant extensions, shall be given to the Water and Sewer Department prior to Contractor picking up the fire hydrant extensions.
  - 3. Fire hydrant extensions may be picked up on normal business days between 7:30 a.m. and 8:30 a.m.
- B. No more than one (1) six-inch (6”) or one (1) twelve-inch (12”) hydrant extension section may be used.
- C. The extension manufacturer shall be the same as the fire hydrant manufacturer.
  - 1. Kennedy Valve, K-8150
- D. For extensions greater than twelve-inches (12”), a grade adjustment fitting shall be used. Acceptable manufacturers are:
  - 1. Assured Flow Sales, Inc. - GRADELOK™
  - 2. Or approved equivalent.
- E. Extension sections must be available to allow the fire hydrant to be raised to a new grade without shutting off the water.

### **2.3 FIRE HYDRANT LATERAL – PIPE AND MAIN CONNECTION**

- A. Fire hydrant lateral piping shall be restrained DIP or PVC. Pipe shall be restrained by either restrained joint pipe or mechanical joint restraints.
- B. The hydrant tee on the potable water main line shall be a swivel tee. Tapping sleeves are acceptable when connecting to an existing potable water distribution main.
- C. Reference construction specification *Section 02512, Ductile-Iron Pipe* and *Section 02513 Potable Polyvinyl Chloride (PVC) Pressure Pipe*.

### **2.4 FIRE HYDRANT LATERAL – MAIN VALVE**

- A. The main valve on the fire hydrant lateral shall be a six-inch (6”), resilient seat gate valve located at the main.
- B. The valve shall be provided with a H-20 traffic rated valve box.
- C. Reference construction specification *Section 02515, Water Utility Distribution Valves* for valve installation.

### **2.5 DRAIN GRAVEL**

- A. Fire hydrant drain gravel shall be 1 ½-inch (1 ½”) washed rock.

## **PART 3- EXECUTION**

### **3.1 INSPECTION**

- A. Examine fire hydrants and all appurtenances, including valves and piping, for cracks, dents, abrasions, and other flaws.
- B. Mark defective pipe and fittings and store on site at a separate location from work until after City acceptance at which time it shall be removed from the site.

### **3.2 PREPARATION**

- A. For trenching, backfilling, and compaction, reference construction specification *Section 02315, Excavation and Fill*.
- B. Reference construction specification *Section 02512, Ductile-Iron Pipe* for pipe installation preparation.

### **3.3 INSTALLATION**

- A. All fire hydrants shall stand plumb and be installed in accordance with City of Greeley Standard Drawings.
- B. The minimum depth of bury shall be five feet six-inches (5’-6”) and the maximum depth of bury shall be six (6) feet for restrained DIP fire hydrant laterals.
- C. All fire hydrants shall be connected to the potable water distribution main by a six-inch (6”) restrained DIP lateral line. A six-inch (6”) main valve shall be installed in the lateral line and be restrained back to the main line tee by use of restrained joint pipe or mechanical joint restraints.

- D. All fire hydrants shall be supported on a minimum of one (1) cubic yard of compacted drain gravel with a concrete thrust block.
  - 1. The concrete thrust block, with a minimum bearing area of 4.5 square feet (sq. ft.), shall be placed behind the hydrant base (shoe) against undisturbed soil.
  - 2. A sheet of eight (8) mil polyethylene film shall be placed between the hydrant base (shoe) and concrete thrust block, and the barrel shall be polywrapped up to final ground line.
  - 3. After the concrete thrust block is poured and has ample time to cure, drain gravel shall be placed a minimum six-inches (6") above the lower buried flange per City of Greeley Standard Drawings. The concrete thrust block shall cure enough so that the drain gravel will not penetrate the concrete.
  - 4. Cover the gravel drain pit with polyethylene film or a City approved felt material.
- E. Keep hydrant drain holes free of obstructions.
- F. Fire hydrants that are placed in pavement areas, shall maintain twelve-inches (12") of horizontal clearance between the concrete and the hydrant barrel. The twelve-inch (12") space between the concrete and the barrel shall be filled with drain gravel.
- G. After fire hydrant installation is complete, the oil reservoir shall be checked to ensure that it is full. If it is necessary to fill the reservoir, it shall be filled with the oil that is specified by the hydrant manufacturer.

### **3.4 LOCATION**

- A. All hydrants shall be field staked for both vertical and horizontal location.
- B. Vertical
  - 1. The vertical distance from any finished surface to the centerline of the pumper nozzle shall not be less than eighteen-inches (18") or greater than twenty-one-inches (21")
  - 2. If a hydrant is raised, no more than one (1) six-inch (6") or one (1) twelve-inch (12") extension section may be used. If the extension is greater than twelve-inches (12"), a grade adjustment extension fitting shall be used.
  - 3. Extensions shall be installed per manufacturer's recommendations.
- C. Horizontal
  - 1. Fire hydrants shall be located at least one (1) foot outside of the property line and shall conform to one of the following conditions:
  - 2. When placed behind the curb when no sidewalk is to be installed, the hydrant barrel shall be set so that no portion of the pumper or hose nozzle cap will be less than twenty-four inches (24") or more than thirty-inches (30") horizontal distance from the gutter face of the curb.
  - 3. When placed in a landscaped area between the curb and the sidewalk or between the sidewalk and the property line, no portion of the hydrant or nozzle cap shall be within six-inches (6") of the sidewalk or greater than eighteen-inches (18") from the sidewalk.

4. A three (3) foot radius in all directions of the hydrant shall be clear of obstructions, which shall include, but is not limited to, posts, fencing, vehicles, trash, storage, shrubs, trees, or other plants with mature growth greater than one (1) foot in height.

### **3.5 OPERATION**

- A. Only City personnel shall operate fire hydrants and associated valves that have been accepted by the City unless written permission from the Water and Sewer Department is obtained. If written permission is received, an approved backflow prevention device and water meter shall be installed on the hydrant per City of Greeley Water and Sewer Department requirements.

## SECTION 02530

### SANITARY UTILITY SEWERAGE PIPING

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the installation of sanitary sewer collection mains and includes the acceptable products, materials, and construction practices that may be used in the installation of sanitary sewer collection systems.

##### 1.2 SUBMITTALS

- A. Shop Fabricated Piping:
  - 1. Pipe Manufacturer.
  - 2. Pipe Size.
  - 3. Pipe Dimensions.
  - 4. Pipe Class / Pressure Rating.
  - 5. Color (For PVC).
  - 6. Manufacturer's Recommended Joint Deflection.
  - 7. Recommended Maximum Safe Pull Force (For Fusible PVC).
  - 8. Fusion Technician qualifications indicating conformance with specification *Section 02533, Polyvinyl Chloride (PVC) Non-Pressure Pipe* (For Fusible PVC).
  - 9. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
  - 10. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
- B. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
- C. Pipe Corrosion Protection: Product data.

##### 1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Pipe shall be handled and stored per manufacturer's recommendations.
- B. Handling
  - 1. Use wide fabric choker slings when lifting pipe.
  - 2. Do not drop pipe or fittings including dropping on cushions.
  - 3. Do not use hooks or bare cable.

4. Polyvinyl chloride pipe has reduced flexibility and impact resistance as temperatures approach and drop below freezing. Extra care should be used in handling and installing PVC pipe during cold weather. Do not install pipe when temperature is below 40 degrees F.
  5. Care must be taken to prevent damage to the pipe and fittings and coating and lining (when applicable) by impact, bending, compression, or abrasion. If damage does occur due to manufacturers handling recommendations not being followed, Contractor is to replace the damaged piece(s) at no cost to the City.
- C. Storage
1. Store and use pipe lubricants in a manner which will avoid contamination.
  2. Pipe, gaskets, and all other installation materials shall be stored in accordance with the manufacturer's specifications.
  3. Pipe shall be stored on a surface that provides even support for the pipe barrel. Pipe shall not be stored in such a way as to be supported by the bell.
  4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
- D. Pipe delivered for construction shall be strung so as to minimize entrance of foreign material.
- E. All openings in the pipeline shall be closed with watertight plugs when pipe laying is stopped at the close of a day's work or for extended periods at inspectors discretion.
- F. Do not allow debris, tools, clothing or other materials to enter the pipe. Precautions shall be taken to protect the interior of pipes against contamination.
- G. Use effective measures to prevent uplifting or floating of the pipeline prior to completion of backfilling operations.
- H. Protect pipe and appurtenances against dropping and damage. Damaged pipe and appurtenances that are rejected shall be marked and removed from the site.
- I. Do not install pipe when the trench contains water. Water that is encountered in the trench shall be removed to the extent necessary to provide a firm subgrade and to prevent the entrance of water into the pipeline.
1. Surface runoff shall be diverted as necessary to keep excavations and trenches free from water during construction.
  2. The excavation or trench shall be kept free from water until the structure and/or pipe to be installed is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.
  3. The installed pipe shall not be used to dewater the trench.

## **PART 2 – PRODUCTS**

### **2.1 MANHOLES**

- A. Reference construction specification *Section 02535, Sanitary Utility Sewerage Manholes, Frames, and Covers.*

## **2.2 PIPE**

- A. Reference construction specification *Section 02533, Polyvinyl Chloride (PVC) Non-Pressure Pipe*.

## **2.3 SANITARY SEWER SERVICE LINES**

- A. Reference construction specification *Section 02534, Sanitary Sewer Service Lines*.

## **2.4 UNDERDRAINS**

- A. Reference construction specification *Section 02622, Pipe Underdrains*.

## **PART 3– EXECUTION**

### **3.1 GENERAL**

- A. All piping shall be supplied by one manufacturer.
- B. All materials used in the construction of gravity sanitary sewer collection systems shall be new.
- C. Construction Staking
  - 1. Reference construction specification *Section 02315, Excavation and Fill*.
  - 2. Horizontal alignment shall remain uniform between consecutive manholes and shall not deviate from the City accepted Construction Drawings by more 2-inch.
  - 3. Vertical alignment shall remain uniform between consecutive manholes and shall not deviate from the City accepted Construction Drawings by more than ¼-inch, as measured from the pipe invert.
  - 4. Joint Deflection: Maximum of 75 percent of manufacturer’s recommendation.

### **3.2 INSPECTION**

- A. Pipe barrel and manholes shall be free of dirt or other foreign objects prior to installation.
- B. Pipe and manholes shall be inspected for cracks, dents, abrasions, or other flaws prior to installation.
- C. Damaged or flawed pipe or manholes shall be rejected, marked, and removed from the site.
- D. Operational Inspection: At the completion of the project, in the presence of the City, and as required by the City, the Contractor shall open all manholes and lamp all lines to ensure that no debris is left in the lines/manholes and the lines are not plugged.

### **3.3 PREPARATION**

- A. Trenching, Backfilling, and Compaction.
  - Reference construction specification *Section 02315, Excavation and Fill*.
- B. Existing Utilities
  - 1. The horizontal and vertical location of existing utilities shall be field verified prior to start



of construction.

2. Contractor to protect all existing utilities and all damaged item shall be repaired or replaced to the satisfaction of the City at the Contractor's expense.
3. Any deviation from what is shown on the approved Construction Drawings shall be reported to the City immediately for approval and documented on the As-Constructed Record Drawings.

C. Underdrains

1. If underdrain installation is required, underdrains shall be completely installed by the Contractor and accepted by the City prior to any pipe or manhole installation for the sanitary sewer collection system.

### **3.4 CONNECTIONS TO EXISTING SYSTEM**

- A. Connections to the City's existing sanitary sewer collection system shall be made at an existing manhole or by setting a new manhole on the existing line. A watertight plug shall be installed in the new line to prevent any material from entering the existing system until the City accepts the new system.
- B. At locations where a connection to an existing sanitary sewer collection main is to be made, the Contractor shall locate the existing main both vertically and horizontally and verify its exact size and material prior to start of construction. Report the information to the City immediately for confirmation of the design.
- C. The Water and Sewer Department personnel will examine the existing pipe or manhole. Any necessary adjustments in line, grade, or connection requirements to accomplish the connection shall be reviewed and accepted by the City prior to making the connection.

### **3.5 PIPE INSTALLATION**

- A. The only acceptable methods for laying sanitary sewer lines shall be with a laser.
- B. Pipe Laying
  1. Pipe shall be installed per manufacturer's recommendations.
  2. Pipe installation shall begin at the lowest elevation and proceed upstream to the highest, unless prior written approval is obtained from the Water and Sewer Department.
    - a. Pipe shall be installed so that the bells are pointing uphill.
    - b. Lay pipe true to line and grade.
  3. Take effective measures to prevent opening of joints during bedding and backfilling operations.
  4. Complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade as each length of pipe is placed in the trench. Make adjustments in line and grade by scraping away or filling pipe bedding under the entire length of the pipe, except at bells, and not by wedging, blocking, or mounding up the pipe or bells.

5. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints.
    - a. Do not disturb the pipe after the jointing has been completed.
    - b. Do not use mechanical compacting equipment in the zone above the horizontal centerline of the pipe and below a plane one (1) foot above the top of the pipe.
  6. Do not walk on pipe or otherwise disturb pipe after the jointing has been completed.
  7. PVC piping placement:
    - a. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
    - b. Shield ends to be joined from direct sunlight prior to and during the laying operation.
- C. Sewer Crossing
1. Where sanitary sewer lines cross beneath potable water lines with less than eighteen-inches (18") clearance, sanitary sewer lines cross above potable water lines, or the ten (10) feet horizontal clearance between potable water lines and sanitary sewer lines cannot be maintained, pipe encasement shall be provided in accordance with construction specification *Section 02445, Casing Pipe – Borings and Encasements*.

### **3.6 MANHOLE INSTALLATION**

- A. Reference construction specification *Section 02535, Sanitary Utility Sewerage Manholes, Frames, and Covers*.
- B. Manholes shall be installed at the location and to the elevation shown on the approved Construction Drawings or as approved by the Water and Sewer Department to accommodate field conditions.
- C. Measurements of the actual location and elevation of sanitary sewer inverts and rim shall be made for the As-Constructed Record Drawings.

### **3.7 SANITARY SEWER SERVICE CONNECTIONS**

- A. Reference construction specification *Section 02534, Sanitary Sewer Service Lines*.

### **3.8 FIELD QUALITY CONTROL**

- A. Pipe Deflection Tests
  1. Refer to construction specification *Section 01715, Sewer and Manhole Testing*.
- B. Pipe Leakage Tests
  1. Refer to construction specification *Section 01715, Sewer and Manhole Testing*.
- C. Soil Compaction
  2. Reference construction specification *Section 02315, Excavation and Fill*.

## SECTION 02533

### POLYVINYL CHLORIDE (PVC) NON-PRESSURE PIPE

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section is a minimum guideline for furnishing and the installation of polyvinyl chloride (PVC) pipe and fittings for lines without hydraulic pressure.
- B. Pipe shall be furnished complete with all fittings, specials, and other accessories.
- C. Refer to specification *Section 02530 Sanitary Utility Sewerage Piping*, for additional requirements.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C900, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In (100 mm Through 1,500 mm)*, latest revision.
- B. ASTM International (ASTM)
  - 1. D1784, *Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds*, latest revision.
  - 2. D3034, *Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings*, latest revision.
  - 3. D3139, *Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals*, latest revision.
  - 4. D3212, *Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals*, latest revision.
  - 5. F477, *Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe*, latest revision.

#### PART 2 – PRODUCTS

##### 2.1 POLYVINYL CHLORIDE (PVC) PIPE - GASKETED

- A. All PVC pipe shall be manufactured from components which conform to ASTM D1784.
- B. All four-inch (4") through fifteen-inch (15") PVC non-pressure sewer pipe and all fittings shall be manufactured in accordance with ASTM D3034.
- C. The standard dimension ratio (SDR) of PVC non-pressure sewer pipe shall not exceed 35.
- D. The maximum pipe length shall be twenty (20) feet and no shorter than twelve feet, six inches (12'-6"), except at service tees and closure pieces.

## 2.2 POLYVINYL CHLORIDE (PVC) PIPE – SLIP JOINT

- A. General.
1. This specification shall cover slip joint PVC pipes in 6-inch (6") through 24-inch (24") nominal diameters with cast iron equivalent outside diameters.
  2. All PVC pipe shall be manufactured in accordance with AWWA C900.
  3. Pipe shall be green in color.
- B. Pipe joints shall be made using an integral bell with elastomeric gasket push-on type joint or using machined couplings of a sleeve type with rubber ring gaskets and machined pipe ends to form a push-on type joint.
- C. All sizes of pipe under these specifications shall be pressure class as shown on the City accepted Constructed Drawings. Pressure Class 235 (DR-18) shall be the minimum pipe class accepted.
- D. Each length of pipe shall be a standard laying length of twenty (20) feet. Random lengths are not acceptable.
- E. Polyvinyl chlorine (PVC) pipe materials shall be made from Class 12454A of 12454B virgin compounds as defined in ASTM D1784. All compounds shall qualify for a rating of 4000 psi for water at 73.4°F (23°C) per the requirements of Plastic Pipe Institute (PPI), *TR-3*, and complies with the National Sanitation Foundation Standard, *No. 61*, for water service.
- F. Elastomeric gaskets shall conform to ASTM F477.
- G. If bury depth is shallower than four (4) feet, pipe shall be manufactured in accordance with AWWA C900 or city approved equal.
1. Bedding design is to be submitted per manufacturers requirements.

Commented [CH1]: Is there anything else that would require C900?

## 2.3 POLYVINYL CHLORIDE (PVC) PIPE – FUSED

- A. General.
1. This specification shall cover slip joint PVC pipes in 6-inch (6") through 24-inch (24") nominal diameters with cast iron equivalent outside diameters.
  2. All PVC pipe shall be manufactured in accordance with AWWA C900.
  3. Pipe shall be green in color.
- B. All sizes of pipe under these specifications shall be pressure class as shown on the City accepted Constructed Drawings. Pressure Class 235 (DR-18) shall be the minimum pipe class accepted.
- C. Each length of pipe shall be a standard laying length of twenty (20) feet or more. Random lengths are not acceptable.
- D. Polyvinyl chlorine (PVC) pipe materials shall be made from Class 12454A of 12454B virgin compounds as defined in ASTM D1784. All compounds shall qualify for a rating of 4000 psi for water at 73.4°F (23°C) per the requirements of Plastic Pipe Institute (PPI), *TR-3*, and complies with the National Sanitation Foundation Standard, *No. 61*, for water service.

- E. Fusion Technician
  - 1. Fusion Technician shall be fully qualified by the pipe supplier to install Fusible PVC of the type(s) and size(s) being used. Qualifications shall be current as of the actual date of fusion performance on the project.
- F. Fusion Joints
  - 1. Unless otherwise specified, fusible PVC pipe lengths shall be assembled in the field with butt-fused joints. Contractor shall follow the pipe suppliers written guidelines for this procedure. All Fusion joints shall be completed as described in these specifications.

## **2.4 JOINTS**

- A. For pipe manufactured in accordance with ASTM D3034 joints shall be of the push-on bell and spigot type, and shall be manufactured in accordance with ASTM D3212.
- B. For pipe manufactured in accordance with AWWA C900 joints shall be of the push-on bell and spigot type, and shall be manufactured in accordance with ASTM D3139.
- C. All gaskets shall be of an o-ring type in accordance with ASTM F477.
- D. All bells shall be formed integrally with the pipe and shall contain a factory installed elastomeric gasket, which is positively retained.
- E. Only lubricant that is specified by the pipe manufacturer shall be used.
- F. Solvent cement joints are strictly prohibited.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. In addition to any deficiencies covered by ASTM D3034 and AWWA C900, PVC pipe which has any of the following visual defects will not be accepted:
  - 1. Straight pipe, measured from the concave side, shall not deviate from straight greater than 1/16-inch per foot of pipe length.
  - 2. Pipe which is sufficiently out-of-round to prohibit proper joining or be able to pass a mandrel test.
  - 3. Improperly formed bell and spigot ends.
  - 4. Fractured, cracked, chipped, dented, abrasions, or otherwise damaged pipe.
  - 5. Pipe that has been damaged during shipment or handling. Acceptance of the pipe at point of delivery will not relieve the Contractor of full responsibility for any defects in material of the completed pipeline.
- B. Damaged or flawed pipe shall be rejected, marked, and removed from the site.

### **3.2 PREPARATION**

- A. Reference construction specifications *Section 02315, Excavation and Fill*.

B. Cutting Pipe

1. Cut pipe smooth, straight and at right angles to the pipe axis with saws or pipe cutters designed specifically for the material.
2. Remove burrs and wipe off all dust from the jointing surfaces.
3. Bevel the cut end in accordance with manufacturer's recommendation.
4. Do not disturb previously installed joints during cutting operations.

C. Joints

1. Dirt, oil, grit, and other foreign matter shall be removed from the inside of the bell and the outside of the spigot.
2. A thin film of pipe lubricant shall be applied to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.
3. The lubricated joint surface shall be kept clean until joined.

**3.3 INSTALLATION**

A. Sanitary sewer pipe construction shall be done in accordance with these specification section, City of Greeley accepted Construction Drawings and construction specifications *Section 02530, Sanitary Utility Sewerage Piping* and *Section 02315, Excavation and Fill*.

B. No sanitary sewer pipe may be covered or backfilled until inspection of pipe and bedding has been made or City Inspector has given approval.

C. Joints

1. The pipe shall be joined to the tolerances recommended by the manufacturer (i.e. home line).
2. Stabbing of the pipe is not allowed.
3. Previously completed joints shall not be disturbed during the jointing operation.
4. All joints shall be watertight and free from leaks.
5. Test all pipe under concrete and asphalt construction prior to placing concrete or asphalt.
6. Support and block pipe as necessary to prevent flotation in high groundwater.

### 3.4 FUSION PROCESS

#### A. General

1. Fusible PVC pipe to be handled in a safe and non-destructive manner before, during and after the fusion process and in accordance with this specification and the pipe's supplier's guidelines
2. Fusible PVC pipe will be fused by a qualified fusion technician, as documented by the pipe supplier
3. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine
4. Only appropriately sized and outfitted fusion machines that have been approved by the pipe manufacturer shall be used in the fusion process. Fusion machines must incorporate the following elements:
  - a. Heat Plate – Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly; cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused, per the pipe supplier's guidelines.
  - b. Carriage – Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
  - c. General Machine – Overview of machine body shall yield to obvious defects, missing parts, or potential safety issues during fusion.
  - d. Data Logging Device – An approved data logging device with current version of pipe supplier's recommendation and compatible software shall be used. Datalogging device operation and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110 V power source shall be available to extend battery life.
5. Other equipment specifically required for the fusion process shall include the following:
  - a. Pipe rollers shall be used for support of the pipe to either side of the machine
  - b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and / or windy weather, per the pipe supplier's recommendations
  - c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
  - d. Fusing machine operations and maintenance manual shall be kept with the fusion machine at all times.
  - e. Face blades specifically designed for cutting fusible PVC pipe shall be used.

B. Joint Recording

1. Each fusion joint shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and / or record the parameters required by the supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report.

**3.5 FUSION PIPE INSTALLATION**

A. General Installation

1. Installation guidelines from the pipe supplier shall be followed for all installations.
2. The fusible PVC pipe will be installed in a manner so as not to exceed the recommended bending radius.
3. Where fusible PVC pipe is installed by pulling in tension, the recommended Safe Pulling Forces established by the pipe supplier shall not be exceeded.

B. Connections to Existing and New Piping Systems

1. Approximate locations for existing piping systems are shown in the construction documents. Prior to making connection into existing piping systems, the contractor shall:
  - a. Field verify locations, size, piping material, and piping system of the existing pipe.
  - b. Obtain all required fittings, which may include saddles, sleeve type couplings, flanges, tees, or other as shown in the construction documents.
  - c. Allow all piping that has been installed to relax for a period of 24 hours or longer before making final connections.
  - d. Have installed all temporary pumps and / or pipes in accordance with the established connection plans.
2. Unless otherwise approved, new piping systems shall be completely assembled and successfully tested prior to making connections into existing pipe systems.

C. Cutting the pipe.

1. Cut pipe smooth, straight and at right angles to the pipe axis with saws or pipe cutters designed specifically for the material.
2. Remove burrs and wipe off all dust from the jointing surfaces.
3. Bevel the cut end in accordance with manufacturer's recommendation.
4. Do not disturb previously installed joints during cutting operations.

D. Field joints.

1. Use push-on joints for buried pipe except where indicated otherwise on the Construction



Drawings.

2. Dirt, oil, grit, and other foreign matter shall be removed from the inside of the bell and the outside of the spigot.
3. A thin film of lubricant shall be applied to the inside surface of the gasket and the spigot end of the pipe, per the manufacturer's recommendation.
4. The lubricated joint surface shall be kept clean until joined.

E. Bending

1. Bending of pipe can be up to 75% of manufacturers recommendation.

### **3.6 FIELD QUALITY CONTROL**

A. Refer to construction specification *Section 02530, Sanitary Utility Sewerage Piping*.

## SECTION 02535

### SANITARY UTILITY SEWERAGE MANHOLES, FRAMES, AND COVERS

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses sanitary sewer manholes and includes the acceptable products, materials, and construction practices to be used in the construction and installation of manholes.
- B. Manholes shall be furnished with all accessories, including base, cone section, gaskets, and ring and cover.

##### 1.2 REFERENCES

- A. American Concrete Institute (ACI)
  - 1. 350-06, *Code Requirements for Environmental Engineering Concrete Structures & Commentary*, latest revision.
  - 2. 440.1R-15, *Guide for the Design and Construction of Structural Concrete Reinforced with Fiber-Reinforced Polymer (FRP) Bars*, latest revision.
  - 3. 548.6R-96, *Polymer Concrete-Structural Applications State-of-the-Art Report*, latest revision
- B. ASTM International (ASTM)
  - 1. A48, *Standard Specification for Gray Iron Castings*, latest revision.
  - 2. A615, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement*, latest revision.
  - 3. A996, *Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement*, latest revision.
  - 4. A1064, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete*, latest revision.
  - 5. B108, *Standard Specification for Aluminum-Alloy Permanent Mold Castings*, latest revision.
  - 6. B179, *Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Castings Processes*, latest revision.
  - 7. C33, *Standard Specification for Concrete Aggregates*, latest revision.
  - 8. C144, *Standard Specification for Aggregate for Masonry Mortar*, latest revision.
  - 9. C150, *Standard Specification for Portland Cement*, latest revision.
  - 10. C207, *Standard Specification for Hydrated Lime for Masonry Purposes*, latest revision.

11. C443, *Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets*, latest revision.
12. C478, *Standard Specification for Circular Precast Reinforcement Concrete Manhole Sections*, latest revision.
13. C497, *Standard Test Method for Concrete Pipe, Manhole Sections, or Tile*, latest revision.
14. C579, *Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic, Surfacing, and Polymer Concretes*, latest revision.
15. C580, *Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing, and Polymer Concretes*, latest revision.
16. C857, *Standard Practice for Minimum Structural Design Loading for Underground Utility Structures*, latest revision.
17. C923, *Standard Specifications for Resilient Connectors between Concrete Manholes Structures and Pipe*, latest revision.
18. C990, *Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants*, latest revision.
19. D648, *Test Method for Deflection Temperature of Plastics Under Flexural Load in Edgewise Position*, latest revision.
20. D1248, *Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable*, latest revision.
21. D 2584, *Test Method for Ignition Loss of Cured Reinforced Resins*, latest revision.
22. D4101, *Standard Specification for Polypropylene Injection and Extrusion Materials*, latest revision.
23. D4976, *Standard Specification for Polyethylene Plastics Molding and Extrusion Materials*, latest revision.
24. D6783, *Standard Specification for Polymer Concrete Pipe*, latest revision.

### **1.3 SUBMITTAL REQUIREMENTS**

- A. Conform to bid document requirements
- B. Submit manufacturer's data and details of following items for approval:
  1. Shop drawings of manhole sections, base units and construction details, jointing methods, materials, and dimensions
  2. Summary of criteria used in manhole design including, as minimum, material properties, loading criteria, and dimensions assumed. Include certification from manufacturer that polymer concrete manhole design meets or exceeds the load and strength requirements of ASTM C478 and ASTM C857, reinforced in accordance with ACI 440.1R-15.

3. Frames, grates, rings, and covers
  4. Materials to be used in fabricating pipe drop connections
  5. Materials to be used for pipe connections
  6. Materials to be used for stubs and stub plugs, if required
- C. Submitted sealed drawings by a registered Professional Engineer in the State of Colorado

#### **1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Manholes shall be delivered, handled, stored, and protected in such a manner as to prevent damage to materials. Rubber gaskets shall be stored in a clean area away from grease, oil, ozone producing electric motors, heat and direct rays of the sun.
- B. All joint surfaces shall be free from dirt, oil, and grease at the time of installation.

### **PART 2 – PRODUCTS**

#### **2.1 GENERAL**

- A. AASHTO HS-20 design or as required loading applied to manhole cover and transition and base slabs

#### **2.2 PRECAST CONCRETE MANHOLES**

- A. Precast manhole bases, barrels, and cone sections shall be manufactured in accordance with ASTM C478, and shall be made with Type I/II cement. All cone sections shall be the eccentric type with the exception of shallow (flat top) manholes
- B. Concrete and Reinforcing Materials
1. All reinforcing materials shall conform to ASTM A1064, ASTM A615, and ASTM A996.
  2. Reference construction specifications *Section 03400, Precast Concrete*.

#### **2.3 POLYMER CONCRETE MANHOLES**

- A. Provide polymer concrete manhole sections, monolithic base sections and related components referencing to ASTM C 478. ASTM C 478 material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product
- B. Provide base riser section with monolithic floors, unless shown otherwise
- C. Provide riser sections joined with bell and spigot / ship-lap design seamed with butyl mastic and or rubber gaskets (ASTM C990) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure
- D. Construct riser sections for polymer concrete manholes from standard polymer concrete manhole sections of the diameter indicated on drawings. Use various lengths of polymer concrete manhole sections in combination to provide correct height with the fewest joints

- E. Design wall sections for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer
- F. Provide tops to support AASHTO HS-20 loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings
- G. Acceptable manufactures:
  - 1. Armorock LLC
  - 2. Or approved equivalent.

## **2.4 POLYMER MANHOLE DESIGN CRITERIA**

- A. Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet the intent of ASTM C 478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.
  - 1. AASHTO HS-20 design or as required loading applied to manhole cover and transition and base slabs
  - 2. Polymer manholes will be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06
  - 3. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections
  - 4. Internal liquid pressure based on unit weight of 63 pcf
  - 5. Dead load of manhole sections fully supported by polymer concrete manhole base

## **2.5 POLYMER MANHOLE DESIGN**

- 1. Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet loading requirements of ASTM C 478, ASTM C 857 and ACI 350-06 as modified for polymer concrete manhole design as follows:
- 2. Polymer Concrete Mix Design shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment
- 3. Reinforcement – Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design
- 4. The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness
- 5. Thermosetting Resin - The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete manhole structures will be exposed
- 6. Each polymer concrete manhole component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature

and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection. The nominal internal diameter of manhole components shall not vary more than 2%. Variations in height of two opposite sides of risers and cones shall not be more the 5/8 inch. The under run in height of a riser or cone shall not be more than ¼ in/ft of height with a maximum of ½ inch in any one section

7. Marking and Identification - Each manhole shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location and Production Date
8. Manhole joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity
9. Minimum clearance between wall penetrations and joints shall be per manufacturer's design
10. Construct invert channels to provide smooth flow transition with minimal disruption of flow at pipe-manhole connections. Invert slope through manhole is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all polymer concrete material. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material
11. Provide resilient connectors conforming to requirements of ASTM C 923 or other options as available. All connectors are to be watertight. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions

## **2.6 CAST-IN-PLACE MANHOLES**

- A. All fine and course aggregate shall conform to ASTM C33. Fine aggregate shall be clean, sharp, natural sand. Coarse aggregate shall be clean, strong crushed gravel or stone.
- B. All deformed reinforcing bars shall conform to ASTM A615 or ASTM A996. All bars shall be Grade 60.
- C. All welded steel wire fabric shall conform to ASTM A1064.
- D. Concrete used in cast-in-place manholes shall develop a minimum compressive strength of 3,500 psi after 28 days. Concrete shall have a maximum allowable water/cement ratio of 0.50, by weight.
- E. Reference construction specification *Section 03300, Cast-in-Place Concrete*.

## **2.7 GRADE ADJUSTMENT RINGS**

- A. Precast grade adjustment rings shall be manufactured in accordance with ASTM C478, and shall be made with Type I/II cement.
- B. Grade adjustment rings shall be minimum of 12-inch (12") and a maximum of 18-inch (18").
- C. High Density Polyethylene (HDPE) grade adjustment rings shall be manufactured in accordance with ASTM D4976. Acceptable manufacturers are:

1. LADTECH, Inc.
2. Or approved equivalent.

## **2.8 GROUT – CONCRETE MANHOLE**

- A. Grout shall be pre-mixed or job-mixed nonshrink and nonmetallic.
- B. The acceptable types and manufacturers for pre-mixed, non-shrink, non-metallic grout are:
  1. QUIKRETE® - Hydraulic Water – Stop Cement #1126
  2. DAYTON Superior – Re-Crete 20 Minute Set
  3. Or approved equivalent.

## **2.9 GROUT – POLYMER MANHOLE**

- A. All materials needed for grouting and patching will be a polyester mortar compound provided by the manufacturer or an approved equal by the manufacturer

## **2.10 RING AND COVER**

- A. All rings shall be maximum eight-inch (8”) in height.
- B. Standard iron ring and covers shall be HS-20 load capable gray iron conforming to ASTM A48 Class 305B, with a black bituminous finish.
  1. The word “SEWER” shall be cast in the cover.
  2. Horizontal bearing surfaces of all rings and covers shall be machined to eliminate any rocking action or non-uniform bearing.
  3. Pick-hole shall be one and on-half inch (1 ½”) wide by one-half inch (½”) deep.
  4. Covers shall be bolt down
  5. Acceptable rings and covers are:
    - a. Castings, Inc. - MH-250-24 Bolt Down CI with rubber gasket
    - b. Or approved equivalent.
- C. Covers shall be non-perforated checker pattern with maximum 3/16 inch (3/16”) raised pattern in non-pedestrian traffic areas and non-perforated, non-skid pattern complying with American with Disabilities Act (ADA) requirements in pedestrian traffic areas. Acceptable ADA covers are:
  1. Castings, Inc. - MH-310-24CI
  2. Or approved equivalent.
- D. Manhole covers located within designated 100-year floodplains and areas subject to frequent water inundation shall be the non-perforated, lock down, gasket type cover.

1. Ring and covers shall be HS-20 load capable gray iron conforming to ASTM A48 Class 30, with black coat finish.
2. The word "SEWER" shall be cast in the cover.
3. Cover shall not rock under traffic.
4. Acceptable manufacturers are:
  - a. Pamrex
  - b. Rexus
  - c. Or approved equivalent.

#### **2.11 MANHOLE ENCAPSULATION SYSTEM**

- A. Manhole encapsulation is required when groundwater is present or expected to be present in the area.
- B. Heat-shrinkable sleeves shall be high shrink irradiated and cross-linked polyethylene impermeable backing, coated with protective heat activated adhesive.
- C. A separate closure seal shall be provided to secure the sleeve in place during installation and seal overlap area.
- D. Approved sleeve manufacturers are:
  1. WrapidSeal
  2. Or approved equivalent.
- E. Approved primer manufacturers are:
  1. WrapidSeal "G" Primer
  2. Or approved equivalent.

#### **2.12 STEPS**

- A. Steps in manholes shall not be installed unless approved otherwise by the Water and Sewer Department.

#### **2.13 PREFORMED MASTIC GASKETS**

- A. All preformed mastic gaskets shall conform to Federal specifications SS-S-00210 (210-A). Type I, rope form.
- B. The diameter of the preformed mastic gasket shall be 1.5 inches (1.5").
- C. The application temperature range shall be between 40°F and 110°F.
- D. Gasket is to be pliable.
- E. Approved gasket manufacturers are:



1. Hamilton-Kent Manufacturing Co. - Kent Seal
2. Con Seal - CS-202
3. RAM-NEK – RN101
4. Or approved equivalent.

**2.14 MODULAR SEALING UNITS**

- A. Link-Seal®
- B. Or approved equivalent.

**2.15 DROP MANHOLE BOWL**

- A. Reliner®
- B. Or approved equivalent.

**2.16 INTERIOR MANHOLE COATING**

- A. See construction specifications *Section 02957 A, Sewer Manhole Rehabilitation* and *Section 02957 B, Sewer Manhole Coating* for additional information.
- B. Coating is required for first two (2) manholes after a lift station.
- C. Approved manhole coating manufacturers are:
  1. SewperCoat®
  2. Or approved equivalent.

**PART 3 – EXECUTION**

**3.1 INSPECTION**

- A. Manholes and accessories shall be inspected for cracks, abrasions, or other flaws prior to installation.
- B. Damaged or flawed manholes and accessories shall be rejected, marked, and removed from the site.

**3.2 PREPARATION**

- A. Reference construction specification *Section 02315, Excavation and Fill*.

**3.3 MANHOLE INSTALLATION**

- A. Manholes shall be installed in accordance with Standard Drawings and be constructed in accordance with the approved Construction Drawings.
- B. Flat-top manholes are required whenever the distance between the finished ground surface and the manhole barrel section does not allow room for a cone section.

1. Access holes for flat-top manholes shall be offset from center.
  2. If the distance from the manhole cover to the invert of the sanitary sewer line main is less than 3 feet, the access hole shall be centered.
- C. Cast-In-Place Concrete Base
1. Invert channels shall be smooth and semi-circular in shape conforming to the inside of the adjacent sanitary sewer pipe section.
  2. Form inverts directly in the concrete of the base, or for a straight through manhole with no other inlets the channel may be constructed by laying a full pipe section through the manhole and cutting out the top half of the pipe after the surrounding concrete has hardened.
  3. Changes in direction of flow shall be made with a smooth curve having as large a radius as the manhole will permit.
  4. The floor of the manhole outside of the channels shall have a smooth trowel finish and shall slope toward the channels at one-inch (1") per foot.
  5. Pipe size changes shall be accomplished by matching the pipe crowns and forming the channel to accommodate the pipe size differential.
  6. Where shown on the approved Construction Drawings, a piece of pipe of the proper size shall be built into the manhole where future laterals may be connected. The stub-out shall be sealed with a plug at its outer end and an invert shall be built into each manhole for such lateral connections.
  7. Manhole bases shall be thoroughly bonded to the barrel of the pipe.
    - a. Install an approved rubber gasket on the pipe barrel.
    - b. All connections with the pipe shall be made without projections or voids.
    - c. Inverts must meet the requirements of the City.
- D. Manholes shall be constructed at the location and to the elevation indicated on the accepted Construction Drawings, or as stated by the City to accommodate field conditions.
1. Reference construction specification *Section 02530, Sanitary Utility Sewerage Piping*.
  2. All buried manhole covers shall be referenced to a minimum of two (2) permanent surface references and recorded on the As-Constructed Record Drawings.
- E. The manhole shall be set plumb.
- F. Manhole sections shall be joined to each other using preformed flexible plastic gaskets on both interior and exterior shiplaps. The manhole section shall be joined to the base using a double row of preformed flexible plastic gaskets.
1. All joint surfaces shall be kept clean and dry during installation.
  2. Gaskets shall be pliable at the time of installation.

3. Primer shall be used on both section/base surfaces unless otherwise directed by the City.
- G. Adjustment rings, and ring covers shall be joined to the manhole section and to each other using flexible plastic gaskets.
1. All joint surfaces shall be kept clean, dry, and warm during installation.
  2. Manhole section shall be grouted to ring and covers on the inside.
- H. All lifting holes, joints, and other imperfections shall be filled with non-shrink grout, to provide a smooth finished appearance.

### **3.4 CONNECTIONS TO EXISTING MANHOLES**

- A. Construct in such a manner that the finished work conforms to the requirements specified for new manholes.
- B. Connections shall be made by core-drilling as small a hole as necessary to insert the new pipe and modular sealing unit. Chipping or breaking out manhole walls is not allowed. Use of a rotary hammer is not acceptable.
- C. Grind the existing manhole base to the cross-section of the new pipe and finish with grout to form a smooth continuous invert. Chipping or breaking out the manhole base is not acceptable.
- D. Seal the annular space between the pipe and existing manhole wall with a modular sealing unit and smooth finish inside the manhole wall with non-shrink grout.
- E. Flow is to be maintained through temporary pumping. Prior approval of the proposed pumping plan shall be obtained from the City.

### **3.5 MANHOLE TESTING**

- A. Testing to be completed in compliance with construction specification *Section 01715, Sewer and Manhole Testing*

## SECTION 02957 A

### SANITARY SEWER MANHOLE REHABILITATION

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. This Section covers work necessary for construction of miscellaneous manhole rehabilitation work associated with, and in preparation for, construction specification *Section 02957 B, Sewer Manhole Coating*.

##### 1.2 SUBMITTALS

- A. Submittal procedures as required by contract documents.

#### PART 2 - PRODUCTS

##### 2.1 MATERIALS

- A. Material requirements as specified by construction specification *Section 02957 B, Sewer Manhole Coating*.

#### PART 3 - EXECUTION

##### 3.1 GENERAL

- A. The Contractor shall comply with the contract documents for surface preparation and application.
- B. If necessary, temporary bypassing shall be used to maintain flow while working on existing sanitary structures.

##### 3.2 PREPARATION

- A. Cover all inverts to prevent debris from entering the sewer main.
- B. Wash the interior surface with a high-pressure water blast sufficient to remove all laitance and loose material and flush debris downward. The manhole surfaces must be entirely free of oil, grease, wax, paint, detergents, rust, dirt, or other surface contaminants.
- C. Any spalled, unsound or loose concrete should be removed to sound concrete.
- D. Manhole floors scheduled for removal and replacement shall be cleaned of all oil, grease, wax, paint, detergents, rust, dirt, sludge, or other surface contaminants. Care shall be taken to avoid flushing anything removed from entering the sewer system.
- E. Joints which are to be sealed shall be thoroughly cleaned prior to the application of any material. Protruding mastic shall be removed a minimum of one inch into the joint.

- F. Once the manhole has been cleaned, the Contractor shall inform the City if there are any active hydrostatic leaks which need to be stopped prior to application of any rehabilitation materials. See construction specification *Section 02957 B, Sewer Manhole Coating*.

### **3.3 APPLICATION**

- A. The Contractor shall complete the manhole rehabilitation for each manhole as indicated in the Construction Drawings. The Contractor shall submit a schedule for the proposed manhole rehabilitation work to the City prior to the start of work. The following paragraphs describe in more detail the application of the following work:
  - 1. Stop Active Leaks
  - 2. Repair Manhole Floor, Bench, Invert
  - 3. Seal Manhole Base to Manhole Wall
  - 4. Manhole Joint Sealing
  - 5. Seal Manhole Joints and around Pipe Penetrations
  - 6. Fill Holes in Manhole Wall
  - 7. Structural Restoration
- B. Stop Active Leaks: The Contractor shall identify any active hydrostatic leaks and plug them using watertight cement plug material as indicated in the contract documents. Once the leak has been stopped and the plug has been cured in accordance with the manufacturer's instructions, apply cementitious coating over the plug to provide an additional watertight seal.
- C. Repair or Reconstruction of Manhole Floor, Bench, Invert: The Contractor shall remove loose concrete or brick from the existing floor until sound material is reached. Once the floor is cleaned and the excess concrete has been disposed of, apply a bonding agent to the surface of the existing concrete or patching material as indicated in the contract documents. The new floor shall match the existing invert elevations with construction of bench with suitable materials as necessary. Prior to the installation of the new floor, the Contractor shall stop all leaks around the influent and effluent line as well as through the base by sealing the manhole base to wall as described, and then placing the new floor.
- D. Seal Manhole Base to Manhole Wall: The Contractor shall seal water infiltration using pressure chemical grouting. The chemical grout shall be used to stop all leaks between the wall and base of the manhole and around the influent and effluent lines. Application shall be in accordance with the contract documents. The grout shall be applied around the entire base and the influent and effluent lines. The chemical grout shall be dyed to aid in tracing the flow of the grout. Injection holes shall be drilled through the manhole as per the manufacturer's instruction. The injection probes shall be suitable for the application and the pressure used shall not cause damage to the manhole structure. Upon completion of the injection, the injection ports shall be removed, and the remaining holes filled with non-shrink grout, covered with cementitious coating, and troweled flush with the surface of the manhole walls.
- E. Seal Manhole Joints and around Pipe Penetrations: The Contractor shall clean the joints and around the pipe penetrations to remove protruding mastic, spalled concrete, mortar, etc. Existing

mastic must be removed from the joints a minimum of one inch in depth into the joint. Once the area has been cleaned and prepared according to the manufacturer's recommendations, the Contractor shall seal the joints and around pipe penetrations using non-shrink grout or injected chemical grout. After the grout has cured, an 18" band of cementitious coating shall be applied to provide a watertight seal.

- F. Fill Holes in Manhole Wall: The Contractor shall fill holes in the manhole walls such as lifting holes and manhole stub-outs using non-shrink grout. Once the grout has cured, cementitious coating shall be applied over the hole to provide a watertight seal.
- G. Structural Restoration: Structures shall be prepared following the procedures described in this section followed by the application of a cementitious liner system as specified in construction specification *Section 02957 B, Sewer Manhole Coating*.
- H. Upon completion of the manhole rehabilitation work, the base covering shall be removed, and any debris properly disposed of.
- I. Flow is to be maintained through temporary pumping. Prior approval of the proposed pumping plan shall be obtained from the City.

### **3.4 FINAL ACCEPTANCE TESTING**

- A. Contractor shall provide all testing equipment. Equipment shall be in good condition and shall be calibrated as defined by applicable standards.
- B. Contractor shall notify the City prior to performing testing so a representative may be present. All testing shall follow the manufacturer's recommendation allowing for appropriate cure times.
- C. A test report shall be completed for every manhole.
- D. Testing shall be conducted by the Contractor as directed by the City. Unless otherwise specified, all rehabilitated manholes shall be tested for infiltration/exfiltration. A visual inspection shall be made to verify the absence of leaks. All visible leaks shall be repaired by the Contractor prior to testing.
- E. As directed by the City, testing shall be as specified in construction specification *Section 01715, Sewer and Manhole Testing*.

## SECTION 02957 B

### SEWER MANHOLE COATING

#### PART 1 - GENERAL

##### 1.1 SCOPE

- A. Manhole lining with cementitious liner including preparation, build back and corrosion protection.

##### 1.2 REFERENCES

- A. ASTM International (ASTM)
  1. C94/C94M, *Standard Specification for Ready-Mixed Concrete*, latest revision.
  2. C109/C109M, *Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in or [50 mm] Cube Specimens)*, latest revision.
  3. C267, *Standard Test Method for Chemical Resistance of Mortar, Grout, and Monolithic Surfacing and Polymer Concrete*, latest revision.
  4. C348, *Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars*, latest revision.
  5. C496/C496M, *Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens*, latest revision.
  6. C596, *Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement*, latest revision.
  7. C666/C666M, *Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing*, latest revision.
  8. C882/C882M, *Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete by Slant Shear*, latest revision.

##### 1.3 SYSTEM DESCRIPTION

- A. Manhole lining under this specification shall govern all work, materials, and equipment required for the following:
  1. Substrate rehabilitation for the purpose of eliminating infiltration, providing corrosion protection, repair of voids, and restoration of the structural integrity of the substrate as a result of the applying a monolithic fiber reinforced structural/structurally enhanced cementitious liner to the wall and the bench surfaces of brick, concrete, or any other masonry construction material.
- B. Manhole lining shall be applied by an applicator who is approved and trained by the manufacturer of the lining system materials. All aspects of the installation shall be in accordance with the manufacturers recommended and per the following specification.
- C. Manhole lining as referred to on the Drawings and specified herein shall include:

1. The removal of any loose unsound materials.
2. Cleaning of the area to be sprayed with high pressure water.
3. The repair and filling of voids.
4. The repair and sealing of the pipe seals, pipe invert, and benches.
5. The elimination of active infiltration prior to making the application.
6. The spray application of a cementitious mix to form a structural/structurally enhanced monolithic liner.

#### **1.4 SUBMITTALS**

- A. Work Plan: Prior to the pre-construction conference, the Contractor shall submit a work plan for review and acceptance by the City. The following items shall be addressed in the work plan, as a minimum:
1. Written description of construction procedures, including bypassing of sewage flow and reconnection of service laterals.
  2. The locations, dimensions, and number of equipment staging areas and working areas.
  3. Product data for review by City. Detailed and complete data pertaining to the manhole lining products and installations
  4. Applicator shall provide to City 3 references from Municipal projects completed in the last 12 months.
  5. Certificate of “Compliance with Specifications” for the manhole rehabilitation material and installation.
  6. Certificates for each applicators experience with installation of the proposed product from the manufacturer of the manhole lining product.
  7. Manufacturer’s certifications indicated in Section 1.6.
- B. Manhole rehabilitation product testing reports which shall include but not be limited to:
1. Compressive strength
  2. Bond Strength
  3. Tensile Strength
  4. Flexural Strength
  5. Shrinkage
  6. Freeze/Thaw
- C. Manhole acceptance testing reports



**1.5 QUALITY ASSURANCE**

- A. Perform Work in accordance with manufacturer's instructions.

**1.6 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience.
- B. Applicator: Material manufacturer shall provide owner with current written certification that applicator's current employees have been trained and approved in handling mixing and application of the product to be used.
- C. Applicator shall initiate and enforce quality control procedures consistent with applicable ASTM, NACE and SSPC together with the manufacturer's recommendations.
- D. Applicator shall have completed and follow all OSHA confined space regulations along with having completed all hazard communication training.
- E. Contractor shall provide to City 3 references from Municipal projects completed in the last 12 months indicating successful application of products to be used by application method generally used for the product.
- F. Equipment: Certification that the equipment to be used for applying the products has manufacturer approval and applicator personnel have been trained and certified for proper use of equipment by manufacturer.

**1.7 FIELD MEASUREMENTS**

- A. Verify that field measurements are as indicated on shop drawings.

**PART 2 - PRODUCTS**

**2.1 PRODUCTS**

- A. Manhole Lining Products: Products shall be manufactured by SewperCoat or City preapproved equal. Labor, equipment, and materials, including the machinery specially designed for the application, shall be provided by the applicator.
- B. Patching Material: A quick setting corrosion resistant cementitious material shall be used as a patching material, and is to be mixed and applied according to manufacturer's recommendations, and shall have the following minimum requirements:

1.	Compressive Strength	ASTM C109	>1800 psi, 1 hr. >2600 psi, 24 hrs.
2.	Bond	ASTM C882	>1600 psi, 28 days
3.	Applied Density		105 pcf ± 5 lbs.
4.	Shrinkage	ASTM C596	0% at 90% R.H.
5.	Cement		Sulfate resistant

- 6. Placement Time 5 to 10 minutes
- 7. Set Time 15 to 30 minutes
- 8. Patching material shall equal or exceed requirements for the liner material.
- 9. Material shall be:
  - a. Strong Seal “QSR”
  - b. City Approved Equal.

C. Infiltration Control Material: A rapid setting cementitious product, specifically formulated for leak control, shall be used to stop minor water infiltration, shall be mixed and applied according to the manufacturer’s recommendations and shall have the following minimum requirements:

- 1. Compressive Strength ASTM C109 >1000 psi, 1 hour  
>2500 psi, 24 hours
- 2. Sulfate Resistance ASTM C267 No weight loss after 15 cycles @ 2000 ppm
- 3. Freeze Thaw ASTM C666 Method A 100 Cycles
- 4. Pull Out Strength 14,000 lbs.
- 5. Set Time <1.0 minute
- 6. Material shall be:
  - a. Strong Seal “Strong-Plug”
  - b. City Approved Equal.

D. Grouting Material

- 1. Chemical or grouts may be used for stopping very active infiltration and shall be mixed and applied per manufacturer’s recommendations. Grout for this purpose shall be volume stable and have a minimum 28-day compressive strength of 250 psi.
- 2. If pressure grouting is required the material shall be:
  - a. Avanti A-220, Deneef
  - b. City-Approved Equal.

E. Liner Material: A cementitious product shall be used to form a structural/structurally enhanced monolithic liner covering all interior substrate surfaces. The liner material shall be applied with machinery specially designed for the application, and shall have the following minimum requirements at twenty-eight (28) days:

Compressive Strength	ASTM C109	>7000 psi
Tensile Strength	ASTM C496	>700 psi
Flexural Strength	ASTM C348	>1300 psi
Shrinkage @ 90% R.H.	ASTM C596	0.07%
Bond	ASTM C882	>2000 psi
Density, when applied		151 +/- 4 lbs./ft <sup>3</sup> pcf
Freeze/Thaw	ASTM C666	300 previous cycles no visible damage

1. Liner material shall be the following:

- a. SewperCoat
- b. City Approved Equal

F. Water: Water used to mix product shall be clean and potable. A laboratory shall test questionable water in accordance per ASTM C-94 procedure. Potable water need not be tested.

G. Other Materials: No other material shall be used with the mixes described above without prior approval or recommendation of the City.

### **PART 3 - EXECUTION**

#### **3.1 MANHOLE LINING**

A. Equipment Application equipment shall be as recommended by materials manufacturer.

B. Application:

1. Preparation:

- a. Provide means, labor and equipment to dam, plug, and/or divert or bypass the flow from services entering the manhole.
- b. Place covers over invert to prevent extraneous material from entering the sanitary sewer. Adequately sized pumps shall be provided and used by the Contractor continuously to protect the work.
- c. All foreign material shall be removed from the manhole wall and bench using a high pressure water spray (minimum 3,500 psi). Loose and protruding brick, mortar, and concrete shall be removed using a mason's hammer and chisel and/or scraper. Detergent water cleaning and hot water blasting may be necessary to remove oils, grease or other hydrocarbon residues from the manhole surface. Cleaned surface shall be a sound uniform neutralized and are not excessively damaged.
- d. Fill any large voids with patching material as specified herein. Submit proposed method of discovering voids and proposed product to fill voids.
- e. A mild chlorine solution may be used to neutralize the surface to diminish microbiological bacteria growth unless it is not acceptable to the manufacture of the product to be supplied. Provide manufacturer's acceptance.

- f. Surface preparation shall produce a cleaned, abraded and sound surface with evidence of laitance, loose concrete, brick or mortar, contaminants or debris, and shall display a surface profile suitable for application of liner system.
    - i. If required, sandblasting or abrasive blasting may be used to create a roughened surface.
  - g. Active leaks shall be stopped using infiltration control material according to manufacturer's recommendations. Some leaks may require weep holes to localize the infiltration during the application. After application, the weep holes shall be plugged with infiltration control material prior to the application of the final coat. When severe infiltration exists, drilling may be required in order to pressure grout using a cementitious grout or chemical grout, as specified herein for grouting material. Manufacturer's recommendations shall be followed when pressure grouting is required.
  - h. All manhole steps shall be removed and the wall repaired prior to lining.
  - i. Structure to be lined shall be wetted per the manufacturer's recommendations prior to applying lining material.
  - j. Manhole frames and covers that are shifted or are not flush with pavement elevation shall be reset.
    - i. Center the manhole frame and cover over the manhole opening
    - ii. Adjust the frame and cover top elevation to City standards.
2. Invert, pipe seal, and bench repair:
- a. After all preparations have been completed, remove all loose material and wash wall again.
  - b. Any bench, invert, pipe seal and/or service line repairs shall be made at this time using patching material and shall be used per manufacturer's recommendations.
  - c. Invert repair shall be performed on all inverts with visible damage or where infiltration is present, or when vacuum testing is specified. After blocking through the manhole, and thoroughly cleaning invert, the patching material shall be applied to the invert in an expeditious manner. The material shall be troweled uniformly onto the damaged invert at a minimum thickness of ½ inch at the invert extending out onto the bench of the manhole sufficiently to tie into the structural/structurally enhanced monolithic liner to be applied. The finished invert surfaces shall be smooth and free of ridges. The flow may be reestablished in the manhole within thirty (30) minutes after placement of the material.
3. Mixing:
- a. Mixing shall be done in strict accordance with the material manufacturer's instructions.
  - b. Addition of water to the mix shall be in strict accordance with the manufacture's recommendations.

- c. Re-mixing or tempering shall not be permitted. Rebound material shall not be reused.
  - d. The mixer shall be cleaned to remove all adherent materials for the mixing valves and from the drum at regular intervals.
4. Spraying:
- a. The surface shall be clean and free of all foreign material and shall be damp without noticeable free water droplets or running water, but totally saturated, just prior to application. Materials shall be spray applied up to one (1) inch thick in one or more passes from the bottom of the frame, however, minimum total thickness shall not be less than ½ inch to insure that all cracks, crevices, and voids are filled and a relatively smooth surface remains after light troweling. The light troweling is performed to compact the material into voids and to set the bond.
  - b. Bench application: The covers shall be removed at this time and the bench sprayed with materials mixed as specified in Part 2 and spray applied in such a manner that a gradual slope is produced from the walls to the invert with the thickness at the edge of the invert to be no less than 1 inch. The wall/bench intersection shall be rounded to a uniform radius the full circumference of the intersection.
  - c. Operations: Manufacturer recommended equipment shall control the actual amounts of material applied.
  - d. Surface Defect Repair:
    - i. Continual inspection during coating application shall be maintained
    - ii. Any imperfections shall be removed and replaced with sound material.
- C. Curing:
- 1. Care should be taken to minimize exposure of applied product to sunlight and air movement. At no time should the finished product be exposed to sunlight or air movement for longer than fifteen (15) minutes before covering or closing access. In extremely hot and arid climates, manhole should be shaded while application is in process. Contact manufacturer for curing compound recommendations.
    - a. The application shall have a minimum of four (4) hours cure time before being subjected to active flow.
    - b. For traffic areas, calcium aluminate based products shall be used. Traffic shall be deferred for a maximum of six (6) hours.
- D. Weather: No application shall be made to frozen surfaces or if freezing is expected to occur within the substrate within twenty-four (24) hours after application. If ambient temperatures are in excess of 95 degrees F, precautions shall be taken to keep the mix temperature at time of application below 90 degrees F. Mix water temperature shall not exceed 85 degrees F. Chill with ice if necessary.
- E. Product Testing: Four two inch cube specimens shall be cast each day or from every fifty (50) bags of product used and shall be properly packaged, labeled, and returned to manufacturer for

testing in accordance with the Owner's or manufacturer's directions for compression strength testing as described in ASTM C109.

- F. Acceptance Testing: Contractor shall test rehabilitated manholes as follows:
1. Visually verify the absence of leaks. Visible leaks shall be corrected immediately.
  2. Vacuum tests in accordance with construction specification *Section 01715, Sewer and Manhole Testing* shall be conducted on all manholes
  3. Visual inspection shall be made by the Owner. Any deficiencies in the finished liner system shall be marked and repaired according to the procedures set forth by the Manufacturer.

## SECTION 03300

### CAST-IN-PLACE CONCRETE

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses cast-in-place concrete for thrust restraints, sanitary sewer manhole bases, and cut-off walls, including forms, reinforcing steel, finishing and curing, and other appurtenant work.
- B. All other concrete work shall conform to the Design Criteria and Construction Specifications Streets Volume I (*SDC*).

##### 1.2 REFERENCES

- A. American Concrete Institute (ACI):
  - 1. 117, *Specifications for Tolerances for Concrete Construction and Materials*, latest revision.
  - 2. 301, *Specifications for Structural Concrete*, latest revision.
  - 3. 305.1, *Hot Weather Concreting*, latest revision.
  - 4. 306.1, *Cold Weather Concreting*, latest revision.
  - 5. 309, *Guide for Consolidation of Concrete*, latest revision.
  - 6. 350.1, *Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures*, latest revision.
- B. ASTM International (ASTM):
  - 1. A185, *Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete*, latest revision.
  - 2. A615, *Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement*, latest revision.
  - 3. A996, *Standard Specification for Rail-Steel and Axle –Steel Deformed Bars for Concrete Reinforcement*, latest revision.
  - 4. C31/C31M, *Standard Test Practice for Making & Curing Concrete Test Specimens in the Field*, latest revision.
  - 5. C33, *Standard Specification for Concrete Aggregates*, latest revision.
  - 6. C39/C39M, *Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens*, latest revision.
  - 7. C94/C94M, *Standard Specification for Ready-Mixed Concrete*, latest revision.

8. C143/C143M, *Standard Test Method for Slump of Hydraulic Cement Concrete*, latest revision.
9. C150, *Standard Specification for Portland Cement*, latest revision.
10. C157/C157M, *Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete*, latest revision.
11. C231, *Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method*, latest revision.
12. C260, *Standard Specification for Air-Entraining Admixtures for Concrete*, latest revision.
13. C494/C494M, *Standard Specification for Chemical Admixtures for Concrete*, latest revision.
14. A1064, *Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete*, latest revision.
15. C618, *Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete*, latest revision.
16. C1218/C1218M, *Standard Test Method for Water-Soluble Chloride in Mortar and Concrete*, latest revision.
17. C1260, *Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)*, latest revision.
18. C1315, *Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete*, latest revision.
19. C1602/1602M, *Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete*, latest revision.

### **1.3 SUBMITTALS**

- A. When requested by the City, submit batch tickets for each load at the time of delivery indicating the following:
  1. Identification name and number.
  2. Date.
  3. Quantity delivered.
  4. Mix design.
  5. Mix time.
  6. Time at which the water was added.
  7. Amount of water added at job site.
- B. Mix Designs:



1. Submitted to the City for review and approval not less than two (2) weeks prior to first concrete placement.
  2. Concrete mix designs shall contain proportions of materials and admixtures to be used on work, signed by mix designer.
  3. Documentation of average strength for each proposed mix design in accordance with ACI 301.
  4. Letter of Certification that Concrete Producer has verified compatibility of constituent materials in design mix.
  5. Test Reports:
    - a. Cement: Chemical analysis report.
    - b. Supplementary Cementitious Materials: Chemical analysis report and report of other specified test analyses.
    - c. Water-Soluble Chloride-Ion Content in Hardened Concrete: Unless otherwise permitted, in accordance with ASTM C1218 at an age between 28 and 42 days.
    - d. Shrinkage Test Results: In accordance with ASTM C157 as modified herein.
  6. Aggregates:
    - a. Gradation for coarse aggregates. List gradings and percent passing through each sieve.
    - b. Gradation for fine aggregates. List gradings and percent passing through each sieve.
    - c. Percent of fine aggregate weight to total aggregate weight.
    - d. Deleterious substances in fine aggregate per ASTM C33, Table 1.
    - e. Deleterious substances in coarse aggregate per ASTM C33, Table 3.
    - f. Manufacturer's Letter of Certification that the aggregate conforms to the specified class designation for coarse aggregate.
    - g. Test Reports:
      - i. Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.
  7. Admixtures:
    - a. Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.
    - b. Manufacturer's Letter of Certification of conformance to specified standards.
- C. Product Data: Specified ancillary materials.

- D. Detailed plan for curing and protection of concrete placed and cured in cold weather. The details shall include, but not be limited to, the following:
1. Procedures for protecting the subgrade from frost and the accumulation of ice or snow on reinforcement and other metallic embeds or forms prior to placement.
  2. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.
  3. Methods for temperature protection during placement.
  4. Types of covering, insulation, housing, or heating to be provided.
  5. Curing methods to be used during and following the protection period.
  6. Use of strength accelerating admixtures.
  7. Methods for verification of in-place strength.
  8. Procedures for measuring and recording concrete temperatures.
  9. Procedures for preventing drying during dry, windy conditions.
- E. Detailed plan for hot weather placements including curing and protection for concrete placed in ambient temperatures over 80 degrees F. The plan shall include, but not be limited to, the following:
1. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.
  2. Use of retarding admixture.
  3. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.
  4. Types of shading and wind protection to be provided.
  5. Curing methods (including use of evaporation retardant).
  6. Procedures for measuring and recording concrete temperatures.
  7. Procedures for preventing drying during dry, windy conditions.
- F. Manufacturer's application instructions for bonding agent and bond breaker.
- G. Manufacturers' Letter of Certification of conformance to specified standards:
1. Portland cement.
  2. Fly ash.
  3. Aggregates.
  4. Admixtures.

5. Bonding agent.
  6. Bond breaker.
- H. Statement of Qualification:
1. Batch Plant: Certification as specified herein.
  2. Mix designer.
  3. Installer.
  4. Testing Agency.
- I. Field test reports.
- J. Results of tightness tests.
- K. Concrete Delivery Tickets:
1. For each batch of concrete before unloading at Site.
  2. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
  3. Indicate amount of mixing water withheld, and maximum amount that may be permitted to be added at Project site.
- L. Curing
1. Manufacturers' data for the following products:
    - a. Evaporation retardant.
    - b. Curing compound.
    - c. Clear sealer.
    - d. Clear floor hardener.
  2. Curing methods proposed.
  3. Curing Compound
    - a. Manufacturer's Certificate of Compliance showing moisture retention requirements.
- M. Submittal Drawing
1. Submitted to the City for review and approval not less than two (2) weeks prior to placement and must include information on steel placement, sizing, compressive strength, and grade of steel reinforcement. Steel placement and sizing are to meet the City of Greely Standard Drawing.

## 1.4 QUALITY ASSURANCE

- A. See the quality assurance requirements in the City of Greeley Design Criteria and Construction Specifications Streets Volume I.

## PART 2 – PRODUCTS

### 2.1 CEMENT

- A. All cement shall be Portland Cement. No other cement shall be used without prior written permission of the City.
- B. Portland Cement shall conform to ASTM C150, Type I/II.

### 2.2 AGGREGATES

- A. Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
  - 1. Normal-Weight Aggregates:
    - a. In accordance with ASTM C33, except as modified herein.
      - i. Class Designation: 4S unless otherwise specified.
    - b. Free of materials and aggregate types causing pop outs, discoloration, staining, or other defects on surface of concrete.
    - c. Alkali Silica Reactivity: See Article Concrete Mix Design.
  - 2. Fine Aggregates:
    - a. Clean, sharp, natural sand.
    - b. ASTM C33.
    - c. Limit deleterious substances in accordance with ASTM C33, Table 1 and as follows:
      - i. Limit material finer than 75-µm (No. 200) sieve to 5 percent mass of total sample.
      - ii. Limit coal and lignite to 0.5 percent.
  - 3. Coarse Aggregate:
    - a. Natural gravels, combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
    - b. Limit deleterious substances in accordance with ASTM C33, Table 3 for specified class designation.

## 2.3 WATER

- A. Mixing water for concrete shall be potable. Alternative sources of water may be permitted with prior approval from the City.
  - 1. If approved by the City, water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and the concentration of chemicals in combined mixing water shall be less than:
    - a. 1,000 ppm chloride content.
    - b. 3,000 ppm sulfate content as SO<sub>4</sub>
    - c. 600 ppm alkalis as (Na<sub>2</sub>O + 0.658 K<sub>2</sub>O).
    - d. Total solids by mass less than 50,000 ppm.

## 2.4 ADMIXTURES

- A. Admixtures shall be certified to be compatible with each other.
- B. Admixtures shall not contain calcium chloride.
- C. Air-Entraining Admixture
  - 1. An air entraining agent shall be used in all concrete. All air entraining agents shall conform to ASTM C260.
- D. Water Reducing Admixture
  - 1. A water reducing admixture may be used, if approved by the City.
  - 2. A water reducing admixture shall conform to ASTM C494 for Type A or Type D chemical admixture.
  - 3. The water reducing admixture shall be compatible with the cement being used and shall not contain any calcium chloride (CaCl<sub>2</sub>).
- E. Accelerators shall conform to ASTM C494 and ACI 306.
- F. Fly Ash
  - 1. When fly ash is used in concrete, the cement replacement shall not exceed 20%.
  - 2. Fly ash shall conform to ASTM C618, Class C or F. Class C fly ash will not be permitted where sulfate resistant concrete is required.
- G. Any admixture including air entraining agents, accelerators, and retarders must be approved by the City.

## 2.5 REINFORCING MATERIALS

- A. All deformed reinforcing bars shall conform to ASTM A615 or ASTM A996. All bars shall be Grade 60.

- B. All welded steel wire fabric shall conform to ASTM A1064 and ASTM A185.
- C. Reinforcement supports and spacers shall be plastic coated steel or heavy duty plastic of design and strength to hold reinforcement accurately in place before and during placement of concrete.

## **2.6 FORMWORK**

- A. Forms
  - 1. Forms shall be designed to produce hardened concrete having the shape, lines, and dimensions shown on the approved Construction Drawings.
  - 2. Plywood shall be PSI, waterproof, resin-bonded, exterior type, Douglas Fir.
  - 3. Lumber shall be straight, uniform width and thickness, free from knots, offsets, holes, dents and other surface defects.
  - 4. Form oil shall be light colored paraffin oil or other non-staining material.
  - 5. Forms shall be coated with a form releasing agent before the form or reinforcement is placed in final position. The coating shall be used in accordance with the manufacturer's instructions.
  - 6. Commercial formulation form coating compounds shall not bond with, stain, nor adversely affect the concrete surface's bond or adhesion, and shall not impede wetting of surfaces to be cured with water or curing compounds. Surplus coating on form surfaces and coating on reinforcing steel and construction joints shall be removed before placing concrete.
- B. Form Ties
  - 1. Commercially manufactured, removable or snap-off metal form ties designed to withstand applied stresses, prevent spreading of forms during concrete placement, and prevent concrete from spalling upon removal.
  - 2. Use of wire ties is prohibited.

## **2.7 MIX DESIGN**

- A. Concrete shall develop a minimum field compressive strength of 4000 psi after 28 days, unless otherwise specified by the City (i.e. thrust blocks).
- B. The water/cement ratio shall not exceed 0.50 by weight.
  - 1. The water/cement ratio may be increased to 0.56, by weight, if a water reducing agent is used.
  - 2. High early or rapid set concrete may be allowed in high traffic situations.
- C. Slump: 4 inches plus or minus 1 inch.
- D. Air entrainment: between 6% and 9% as tested from the truck prior to pumping, or between 5% and 8% as tested in place.

## **2.8 Curing Compound:**

- A. Water-based, high solids content non-yellowing curing compound meeting requirements of ASTM C309 and ASTM C1315.
  - 1. Moisture Loss: 0.40 kg/m<sup>2</sup>/72 hours maximum.
  - 2. Capable of meeting moisture retention at manufacturer's specified application rate.
- B. Manufacturers and Products:
  - 1. BASF; Masterkure.
  - 2. Euclid Chemical Co.; Super Diamond Clear VOX.
  - 3. WR Meadows, Inc.; VOCOMP-30.
  - 4. Vexcon Chemical, Inc.; Starseal 1315.
  - 5. Dayton Superior.
- C. Water: Clean and potable, containing less than 500 ppm of chlorides.

## **PART 3 – EXECUTION**

### **3.1 TESTING CONCRETE**

- A. Testing procedures and testing frequency shall be in accordance with the *SDC*.
- B. Making and curing concrete cylinders, ASTM C31.
- C. Testing concrete cylinders, ASTM C39.
- D. Slump, ASTM C143.
- E. Slump Tolerance, ACI 117
- F. Air content, ASTM C231.

### **3.2 MIXING AND TRANSPORTING READY-MIXED CONCRETE**

- A. In accordance with ACI 301, except as modified herein.
- B. The maximum elapsed time from the time water is added to the mix until the concrete is in place shall not exceed 1 ½ hours when concrete is transported in revolving drum truck bodies.
- C. The temperature of the concrete shall never exceed 90° F.

### **3.3 PROTECTION**

- A. Cold Weather Concrete
  - 1. Concrete shall not be placed unless the air temperature adjacent to the concrete placement is 30° F and rising, unless prior written acceptance for cold weather concrete operations is obtained from the City.

2. If cold weather concrete operations are accepted by the City, when daily low temperatures are below 40° F or when temperatures are predicted to be below 40° F within three (3) days of concrete placement, comply with ACI 306.1.
3. Water shall not be heated to a temperature greater than 150° F.
4. If hot air heaters are used, cover exposed surfaces of concrete with impervious sheet material or curing compound to prevent dehydration of concrete.
5. Do not place concrete against frozen ground or against surfaces with frost or ice present.
6. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout the work to allow monitoring of concrete surface temperatures representative of the work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during the specified curing period.

**B. Hot Weather Concrete**

1. Concrete shall not be placed if the daily high temperature exceeds 90° F unless otherwise accepted by the City.
2. When daily high temperature is 90° F or above, or hot weather conditions exist that would impair quality and strength of concrete, comply with ACI 305.1.
3. Temperature of concrete immediately before placement in forms shall be between 50° F and 90° F.
4. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
5. To facilitate the placement of concrete in hot weather, the aggregate or the water may be cooled.

**3.4 FORMS**

- A. Brace or tie forms to maintain desired position, shape and alignment before, during, and after placement.
- B. Do not remove or disturb forms until the concrete has attained sufficient strength to safely support all dead and live loads.
- C. Remove forms with care to avoid surface gouging, corner or edge breakage, and other damage to the concrete.

**3.5 REINFORCING**

- A. Prior to pouring concrete, accurately place reinforcing steel. Maintain in proper position while concrete is being placed and vibrated.

**3.6 CONCRETE PLACEMENT**

- A. In accordance with ACI 301, except as modified herein.
- B. Convey concrete to the point of final deposit by methods which will prevent the separation or loss of concrete components.



- C. Height of concrete freefall shall be limited to four (4) feet.
- D. During and immediately after placement, concrete shall be thoroughly consolidated by mechanical vibrating equipment supplemented by handspading, rodding or tamping worked around reinforcements and embedments, and worked into all corners of the forms. Use equipment and procedures for consolidating concrete in accordance with ACI 309.
- E. Notify City at least 1 full working day in advance before starting to place concrete.
- F. Hot Weather Placement:
  - 1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
    - a. Maintain concrete temperature below 95 degrees F at time of placement, or furnish test data or provide other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
    - b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
  - 2. Cure concrete as specified in Section 3.8, Concrete Curing.
- G. Cold Weather Placement:
  - 1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
    - a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
    - b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth must be thawed to the acceptance of the City.
    - c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F. This requirement is applicable to all surfaces including reinforcement and other embedded items.
    - d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.
    - e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.
    - f. Cure concrete as specified in Section 3.8, Concrete Curing. Protect concrete from freezing until the end of the curing period and until the concrete has attained a compressive strength of 3,500 psi (or the design compressive strength if less than 3,500 psi).

### **3.7 FINISHING UNFORMED SURFACES**

- A. Screed and give an initial float finish as soon as concrete has stiffened sufficiently for proper working.
- B. Initial floating shall produce a surface of uniform texture and appearance.
- C. Follow with a second floating at the time of initial set. This floating shall produce a finish of uniform texture and color.
- D. In areas where concrete is to remain exposed, the final finish shall be obtained with a light brooming.
- E. Manhole inverts shall be true to line and grade and smooth.

### **3.8 CURING**

- A. Finished concrete shall be cured by protecting it against moisture loss, rapid temperature change, precipitation, flowing water, and mechanical injury for a minimum of seventy-two (72) hours after placement.
- B. Concrete shall be maintained at a minimum of 50° F during the curing period.
- C. Curing compound shall be used on all flat exposed surfaces.
- D. The Contractor shall be responsible for protecting the concrete from traffic and the elements.

### **3.9 CARE AND REPAIR OF CONCRETE**

- A. The Contractor shall protect all concrete against injury or damage from excessive heat, lack of moisture, overstress, or any other cause until final acceptance by the City.
- B. All concrete structures shall not have backfill placed against them until the concrete has reached sufficient strength so as not to have any damage caused by the backfill or backfill operations.
- C. Any concrete found to be damaged, or that may have been originally defective, or that becomes defective after any time prior to the final acceptance of the completed work, or that departs from the established line or grade, or that, for any other reason, does not conform to the requirements of the City shall be satisfactorily repaired as directed by the City or removed and replaced with acceptable concrete at no expense to the City.

### **3.10 FIELD QUALITY CONTROL**

- A. General:
  - 1. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
  - 2. Unless otherwise specified, sample concrete for testing for making test specimens, from the point of delivery.
  - 3. When concrete is pumped, sample and test air content at point of delivery and at the point of placement.

- a. For Each Concrete Mixture: Provided the results of the air content tests for the first load of the day are within the specified limits, testing need only be performed at the point of delivery for subsequent loads of that concrete mixture except that testing should be performed at the point of placement every four hours.
  4. Evaluation will be in accordance with ACI 301 and Specifications.
  5. Test specimens shall be made, cured, and tested in accordance with ASTM C31/C31M and ASTM C39/C39M.
  6. Frequency of testing may be changed at the discretion of City.
  7. Pumped Concrete: Take concrete samples for slump (ASTM C143/ C143M) and test specimens (ASTM C31/C31M and ASTM C39/C39M) and shrinkage specimens (ASTM C157/C 157M) at placement (discharge) end of line.
  8. If measured air content at delivery is greater than the specified limit, a check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, the concrete has failed to meet requirements of Contract Documents. If measured air content is less than the lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If the check test of the adjusted mixture fails, the concrete has failed to meet requirements of Contract Documents. Concrete that has failed to meet requirements of Contract Documents shall be rejected.
- B. Concrete Strength Test:
1. Unless otherwise specified, one specimen at age of 7 days for information, and two 6-inch diameter or when permitted three 4-inch diameter test specimen at age of 28 days for acceptance.
  2. If result of 7-day concrete strength test is less than 50 percent of the specified 28-day strength, extend the period of moist curing specified in Section 3.8, Concrete Curing, by 7 additional days.
  3. Provide a minimum of one spare test specimen per sample. Spare cylinder shall be tested as directed by City.
- C. Shrinkage Tests:
1. When required to conform to shrinkage limits, collect actual concrete materials being batched and before liquids have been added to the mix. Mix sampled material in a laboratory at proportions matching the batched concrete. Test shrinkage characteristics every 5,000 cubic yards of concrete used on job and every 3 months during construction when compression test cylinders are made.
  2. Concrete Shrinkage Limits: Test in accordance with ASTM C157/ C157M, with the following modifications:
    - a. Prisms shall be moist cured for 7 days prior to the 28-day drying period.
    - b. Comparator reading at the end of the 7-day moist cure shall be used as the initial length in the length change calculation.

- c. Reported results shall be the average of three prisms.
  - d. If drying shrinkage of any specimen departs from the average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
  - e. Results at the end of the 28-day drying period shall not exceed 0.040 percent if 3-inch prisms are used, or exceed 0.038 percent if 4-inch prisms are used.
  - f. If the 7-day or 14-day shrinkage tests results exceed the shrinkage limits established by the design mix testing, furnish an additional 14 days of water curing beyond the original curing period, for concrete surfaces of hydraulic structures represented by prisms. Modify the concrete mix design to reduce shrinkage prior to casting additional concrete for the work.
- D. High Range Water Reducer (Superplasticizer) Admixture Segregation Test: Test each truck prior to use on job.
- 1. Segregation Test Objective: Concrete with a 4-inch to 8-inch slump must stay together when slumped. Segregation is assumed to cause mortar to flow out of mix even though aggregate may stay piled enough to meet slump test.
  - 2. Test Procedure: Make slump test and check for excessive slump and observe to see if mortar or moisture flows from slumped concrete.
  - 3. Reject concrete if mortar or moisture separates and flows out of mix.
- E. Cold Weather Placement Tests:
- 1. During cold weather concreting, cast cylinders for field curing as follows. Use a method that will produce a greater number of specimens:
    - a. Six extra test cylinders from the last 100 cubic yards of concrete.
    - b. Minimum of three specimens for each 2 hours of placing time or for each 100 cubic yards.
  - 2. These specimens shall be in addition to those cast for lab testing.
  - 3. Protect test cylinders from weather until they can be placed under the same protection provided for the concrete structure that they represent.
  - 4. Keep field test cylinders in the same protective environment as the parts of structure they represent to determine if specified strength has been obtained.
  - 5. Test cylinders in accordance with applicable sections of ASTM C31/ C31M and ASTM C39/C39M.
  - 6. Use test results to determine the specified strength gain prior to falsework removal or for prestressing.
- F. Tolerances:
- 1. Slab Finish Tolerances and Slope Tolerances:

- a. Floor flatness measurements shall be made the day after the floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
- b. Support 10-foot-long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
- c. Compliance with the designated limits in four of five consecutive measurements is satisfactory, unless defective conditions are observed.

G. Liquid Tightness Tests:

1. Purpose: To determine integrity and liquid-tightness of finished exterior and interior concrete surfaces of liquid containment structures.
2. All liquid-containing concrete structures are to be tested for liquid-tightness as specified, unless otherwise noted on the Drawings.
3. Water for the initial tightness test shall be from a city approved source. Contractor shall provide means to transport water to the structure to be tested. If additional tightness tests are required due to failure to meet criteria, the Contractor shall provide water for the subsequent tests.
4. After testing has been completed, dispose of test water in a manner approved by the City.  
Requirements for Liquid-Tightness Test:
  - a. Perform tightness tests in accordance with ACI 350.1 and as specified herein.
  - b. Do not place backfill, coatings, or other work that will cover concrete surfaces until tightness testing has been completed and approved.
5. Measure water surface at two points 180 degrees apart when possible where attachments, such as ladders exist, at 24-hour intervals.
6. Acceptance Criteria:
  - a. Volume loss shall not exceed 0.050 percent of contained liquid volume per 24-hour period, adjusted for evaporation, precipitation, and temperature
  - b. Acceptance that the structure has passed the tightness test shall be based on the total volume loss at the end of the specified test period.
7. Repairs When Test Fails: Dewater structure; fill leaking cracks with crack repair epoxy. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until the structure successfully passes the test.

### 3.11 PROTECTION OF INSTALLED WORK

- A. After curing as specified in Section 3.8, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.
- B. Repair areas damaged by construction, using specified repair materials and approved repair methods

## SECTION 03400

### PRECAST CONCRETE

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses precast concrete products (manholes, vaults, etc.).

##### 1.2 REFERENCES

- A. American Concrete Institute (ACI);
  - 1. 304R, *Guide for Measuring, Mixing, Transporting, and Placing Concrete*, latest revision.
  - 2. 350, *Environmental Structures: Code Requirements*, latest revision.
- B. ASTM International (ASTM)
  - 1. C31, *Standard Practice for Making and Curing Concrete Test Specimens in the Field*, latest revision.
  - 2. A36, *Standard Specification for Structural Steel*, latest revision.
- C. Precast/Prestressed Concrete Institute (PCI)
  - 1. MNL-117, *Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products*, latest revision.
  - 2. MNL-120, *Design Handbook for Precast and Prestressed Concrete*, latest revision.

##### 1.3 SUBMITTALS

- A. Sealer for Exterior Surfaces
  - 1. Product data with mixing/application instructions.
- B. Calculations and Technical Data
  - 1. Proposed details and design calculations for stresses in all critical sections of precast members for all loading conditions including transportation, handling, and erection.
- C. Precasting Manufacturers
  - 1. Experience record on production of precast concrete as shown, with information on precasting plant, that will indicate capability to satisfactorily perform the work.
  - 2. Evidence of current PCI plant certification.
- D. Certificate of Compliance
  - 1. Certify admixtures and concrete do not contain calcium chloride.

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PRECAST CONCRETE

- E. Test Reports
  - 1. For precast manufacturer's concrete test cylinders.
  - 2. Inspection of installed panels.
- F. Submittal Drawing
  - 1. Submitted to the City for review and approval not less than two (2) weeks prior to placement and must include information on steel placement, sizing, compressive strength, and grade of steel reinforcement. Steel placement and sizing are to meet the City of Greely Standard Drawing.

#### **1.4 QUALITY ASSURANCE**

- A. Qualifications of Precasting Manufacturers:
  - 1. Precast Concrete: Product of manufacturer with a minimum of 3 years' experience producing precast concrete products of quality specified.
  - 2. Precast Plant: PCI certified plant with current certification.
  - 3. Calculations shall be stamped by an engineer registered in the State of Colorado.

### **PART 2 - PRODUCTS**

#### **2.1 MATERIALS**

- A. Reference construction specification *Section 03300, Cast-In-Place Concrete*, for precast concrete minimum requirements for mix design (cement, aggregate, water, admixtures, and reinforcement).
- B. Formwork:
  - 1. One-piece, full length and without seams.
- C. Embedded Items:
  - 1. ASTM A36 steel.
  - 2. Anchor Studs: Headed anchor studs (HAS), deformed bar anchors (DBA), or threaded studs as manufactured by Nelson Stud Welding Co., Lorain, OH.
  - 3. Furnish inserts for lifting precast slabs, and as otherwise required.
- D. Sealer for Exterior Surfaces:
  - 1. Silane Sealer: One-component penetrating sealer, hydrophilic (isopropyl alcohol as a carrier) with 40 percent active ingredients.
  - 2. Manufacturers:

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- a. Master Builders Co.
- b. Euclid Chemical Co.

## **2.2 DESIGN REQUIREMENTS**

- A. Structural Precast Members
  - 1. Meet applicable sections of PCI MNL-120.
  - 2. Design for all loading conditions including transportation, handling, and erection.
  - 3. Minimum reinforcing steel cover to be 2 inches conforming to ACI 350.
  - 4. Any structure to be installed in a roadway shall be designed for an AASHTO HS-20 loading.

## **2.3 FABRICATION**

- A. Comply with PCI MNL-117.
- B. Reinforcing Steel: Place in position before concrete is cast and keep clean and free from form oil or other substances harmful to bond.
- C. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of ACI 304R.
- D. Sealer:
  - 1. Apply to precast panels at precast plant site after sandblasting panels, in accordance with manufacturer's instructions.
  - 2. Protect surface until installed in the Work.
  - 3. Repair damage as approved by manufacturer.

## **2.4 SOURCE QUALITY CONTROL**

- A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.
- B. Test and record concrete strengths.

## **PART 3 - EXECUTION**

### **3.1 INSPECTION**

- A. Examine each precast section upon arrival to the job site for cracks and other unsightly imperfections or structural defects. Record location and condition of damaged sections.
- B. Resolution:
  - 1. Repair damage to satisfaction of City.

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2. Remove panels with damage or repairs not acceptable to City and install new acceptable panels in place of those removed.
3. Perform reinspection and obtain acceptance by City.

### **3.2 INSTALLATION**

- A. Set precast sections in accordance with the manufacturer's erection drawings.

### **3.3 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle all materials to ensure installation in sound and undamaged condition.
- B. Do not deliver precast sections to the job site until the concrete has attained at least 80% of specified design strength.
- C. Precast concrete members shall be lifted and supported during manufacturing, stockpiling, transportation, and erection operations only at the lifting or supporting point, or both, as shown on shop drawings.
- D. Transportation and on-site handling shall be performed with acceptable equipment and methods, as well as by qualified personnel.
- E. Care shall be taken to avoid tensional stresses during transportation.
- F. Place units so that identification markings are discernible.
- G. Stack so that lifting devices are acceptable and undamaged.

### **3.4 CLEANING**

- A. After installation, clean soiled precast concrete surfaces with detergent and water, using fiber brush and sponge. Rinse thoroughly with clean water immediately after using cleaner.
- B. Use extreme care to prevent damage to precast concrete surfaces and to adjacent materials.

### **3.5 FIELD QUALITY CONTROL**

- A. Inspection:
  1. Inspect panels with City for cracks or damage. Record location and condition of damaged panels.
- B. Resolution:
  1. Repair damage to satisfaction of City.
  2. Remove panels with damage or repairs not acceptable to City.
  3. Install new acceptable panels in place of those removed.
  4. Perform reinspection and obtain acceptance by City.

SECTION 03400

PRECAST CONCRETE

## SECTION 15140

### NON-POTABLE IRRIGATION SYSTEM

#### PART 1 – GENERAL

##### 1.1 SCOPE

- A. This section addresses the installation of non-potable water distribution mains from four-inch (4”) to twenty-four inch (24”) diameter and service lines 1 ½-inch (1 ½”) or greater and includes the acceptable products, materials, and construction practices that may be used in installation.
- B.

##### 1.2 REFERENCES

- A. American National Standards Institute/American Water Works Association (ANSI/AWWA)
  - 1. C110/A21.10, *American National Standard for Ductile-Iron and Gray-Iron Fittings for Water*, latest.
  - 2. C116/A21.16, *Protective Fusion-Bonded Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings*, latest revision.
  - 3. C151/A21.51, *Ductile-Iron Pipe, Centrifugally Cast, for Water*, latest revision.
- B. American Water Works Association (AWWA)
  - 1. C105, *Polyethylene Encasement for Ductile-Iron Pipe Systems*, latest revision.
  - 2. C200, *Steel Water Pipe, 6 in. (150 mm) and Larger*, latest revision.
  - 3. C203, *Coal-Tar Protective Coatings and Linings for Steel Water Pipes*, latest revision.
  - 4. C205, *Cement–Mortar Protective Lining and Coating for Steel Water Pipe 4 in. (100 mm) and Larger—Shop Applied*, latest revision.
  - 5. C209, *Cold-Applied Tape Coatings for Steel Water Pipe, Special Sections, Connections, and Fittings*, latest revision.
  - 6. C210, *Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines*, latest revision.
  - 7. C213, *Fusion-Bonded Epoxy Coatings and Linings for Steel Water Pipe and Fittings*, latest revision.
  - 8. C214, *Tape Coatings for Steel Water Pipe*, latest revision.
  - 9. C215, *Extruded Polyolefin Coatings for Steel Pipe*, latest revision.
  - 10. C216, *Heat-Shrinkable Cross-Linked Polyolefin Coatings for Steel Water Pipe and Fittings*, latest revision.
  - 11. C222, *Polyurethane Coatings and Linings for Steel Water Pipe and Fittings*, latest revision.

12. *C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 60 in. (100 mm through 1,500 mm), latest revision.*

### **1.3 SUBMITTALS**

- A. Shop Fabricated Piping:
  1. Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, color, and other pertinent information.
  2. Layout drawing showing location of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
- B. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
- C. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
- D. Pipe Corrosion Protection: Product data.

### **1.4 DESIGN CRITERIA**

- A. Sizing
  1. Non-potable water distribution mains and appurtenances shall be a minimum of eight-inch (8") diameter. Installation of four-inch (4") or six-inch (6") pipe shall require approval from the City of Greeley Water and Sewer Department.
  2. Non-potable water distribution service lines and appurtenances shall be 1 ½-inch (1 ½") or greater diameter.
- B. Connections to the Existing Non-Potable Irrigation System
  1. When connecting to the existing non-potable irrigation system, ONLY City Water and Sewer Department personnel shall operate existing system valves. The Contractor shall provide at least forty-eight (48) hours notification prior to needing any valve operated, except in the case of emergencies.
  2. At locations where connections to existing mains are to be made, the Contractor shall locate the existing mains both vertically and horizontally and verify their exact size and material in advance of the time scheduled for making the connections.
    - a. Prior to connecting to existing mains, the Contractor shall have all labor, materials, and equipment ready to connect the fitting to the existing main, so as to keep the shutoff time to a minimum.
    - b. The Contractor shall notify the City of Greeley 48 hours in advance to examine the existing pipe or appurtenance and specify any necessary adjustments in line, grade, or connection requirements to accomplish the connection. Contractor to make corrections as directed by the City.
    - c. Use effective measures to prevent contamination to existing potable water lines.
  3. The City shall not be responsible for valve water tightness on existing facilities. If existing valves leak, the City Water and Sewer Department may assist in reducing the

influx of water, but the Contractor must use methods at his own disposal to dewater the trench and complete any required testing of the non-potable irrigation system.

4. All connections shall have valves installed to separate new construction from the existing system. New construction shall not be connected to the existing system until the new system has been tested, and accepted by the City.

C. Location and Looping of Non-Potable Irrigation Mains

1. All non-potable irrigation mains shall be located in dedicated street right-of-way or within a dedicated exclusive easement of appropriate width. City approval is required for all other proposed non-potable irrigation main locations.
2. A non-potable irrigation main serving one (1) lot shall extend all the way across the frontage for that lot.
3. Non-potable irrigation mains shall extend to the extremities of the property or the subdivision served. Extensions shall be in appropriate locations to provide adequate connections.
4. The City shall determine on a case by case basis if non-potable irrigation system looping is required for a development.

## PART 2 – PRODUCTS

### 2.1 PIPE MATERIAL

- A. Non-potable irrigation mains shall be AWWA C900 DR 18 (235 PSI) polyvinyl chloride (PVC) pressure pipe, purple color. PVC pipe markings shall include the designation “CAUTION NON-POTABLE WATER” OR “CAUTION RECLAIMED WATER” in addition to the standard factory labeling required by AWWA. Refer to *Section 02513, Polyvinyl Chloride (PVC) Pressure Pipe* for additional pipe material and installation requirements.
- B. Class 50 ANSI A21.51, AWWA C151 ductile iron pipe with exterior metallic zinc coating polywrapped in accordance with AWWA C105. Use minimum Class 53 thickness ductile iron pipe for flanged piping. Use mechanical joints conforming to ANSI A 21.10 (AWWA C110) or flanged fittings conforming to ANSI/AWWA C110 and ANSI B16.1 (125#). Refer to *Section 02512, Ductile Iron Pipe* for additional pipe material and installation requirements.
- C. AWWA C200 steel water pipe coated and lined in accordance with AWWA C203, AWWA C209, AWWA C214, AWWA C215, AWWA C216, AWWA C116, AWWA C213, AWWA C222, AWWA C205, and/or AWWA C210 is approved for above grade applications in pump stations or doglegs to pump stations or as approved by City

### 2.2 INTAKE PIPE AND INTAKE STRUCTURE

- A. Intake pipe (shall be 20” minimum or as shown on construction drawings whichever is larger) shall be AWWA C900 DR14 (200 PSI) polyvinyl chloride (PVC) pressure pipe, color white. Refer to *Section 02513, Polyvinyl Chloride (PVC) Pressure Pipe* for additional pipe material and installation requirements.
- B. Intake structure shall be self-flushing constructed of phosphorus coated 10 Mesh bronze screen manufactured by Lakos or approved equal. Intake structure control equipment located within pump station building to include: dielectric nipple, brass piping, brass ball valve, brass pressure regulator, brass wye filter with 20 mesh stainless steel screen, brass unions on each side of wye

filter for maintenance purposes, glycerin filled pressure gauges on each side of wye filter, and motorized ball valve controlled by pump station control panel.

### **2.3 MECHANICAL JOINT**

- A. Reference construction specification *Section 02510, Water Utility Distribution Piping.*

### **2.4 MECHANICAL JOINT RESTRAINTS**

- A. Reference construction specification *Section 02510, Water Utility Distribution Piping.*

### **2.5 VALVES**

- A. Reference construction specification *Section 02515, Water Utility Distribution Valves.*

### **2.6 AIR RELEASE, AIR/VACUUM, AND COMBINATION VALVES**

- A. Reference construction specification *Section 02515, Water Utility Distribution Valves.*

### **2.7 VALVE BOX**

- A. Reference construction specification *Section 02515, Water Utility Distribution Valves.*

### **2.8 CURB STOP**

- A. Reference construction specification *Section 02514, Water Service Lines, Meters, and Appurtenances.*

### **2.9 METER**

- A. Reference construction specification *Section 02514, Water Service Lines, Meters, and Appurtenances.*

### **2.10 METER PITS AND VAULTS**

- A. Reference construction specification *Section 02514, Water Service Lines, Meters, and Appurtenances.*

### **2.11 PRESSURE GAUGES**

- A. Reference construction specification *Section 01713, Water Distribution System Testing.*

### **2.12 TRACER WIRE AND TEST STATIONS**

- A. Tracer wire:
  - 1. Tracer wire shall be solid or stranded copper clad steel 12-gauge wire, with watertight insulation for direct burial.
  - 2. Tracer wire color code shall follow the APWA uniform color code for the utility being served. All non-potable tracer wire shall be denoted purple.
  - 3. Tracer wire manufacturers: Copperhead Industries or approved equal.

B. Connectors:

1. All mainline tracer wire shall be interconnected at mainline intersections, tees, and crosses with locking connectors with the appropriate number of branches. Three wires shall be joined with three-way locking connectors. Four wires shall be joined with two three-way locking connectors with a short jumper wire between them.
2. All connectors shall be dielectric silicone filled to seal out moisture and prevent corrosion, and shall be installed in a manner as to prevent any uninsulated wire exposure to soil.
3. Connectors shall be installed in a manner that does not involve cutting or splicing the mainline tracer wire in any way. Service laterals may have up to two wire splices per service excluding connection to the mainline tracer wire.
4. Acceptable connectors: Copperhead SnakeBite Locking Connectors or approved equivalent.

C. Test stations:

1. Service Test Stations at ROW: Test station shall consist of a coil of 2 FT linear tracer wire secured to the top of the curb stop box, and placed inside the upper half of a standard valve box as specified in 02514. Standard valve box cover shall be lockable, cast-iron, with "NON-POT / TEST" cast in the cover.
2. Service Test Stations at Irrigation Control Valves: Test station to be flush-to-grade type complete with both an insulated terminal block with two (2) terminals, and an external grounding rod on an on/off switch.
  - a. Service test station shall be the SnakePit Lite Duty Adjustable from Copperhead Industries or approved equivalent.
  - b. Test station section to be four-inch (4") inside diameter with an eighteen-inch (18") long flared plastic shaft to prevent removal.
  - c. Any test stations located in concrete or roadways shall be SnakePit Concrete/Driveway or SnakePit Roadway and shall be approved by City.
3. Non-potable Blow-off Test Stations: Test station to be flush-to-grade type complete with both an insulated terminal block with two (2) terminals, and an external grounding rod on an on/off switch.
  - a. Blow-off test station shall be the SnakePit Lite Duty Adjustable from Copperhead Industries or approved equivalent.
  - b. Test station section to be four-inch (4") inside diameter with an eighteen-inch (18") long flared plastic shaft to prevent removal.
  - c. Any test stations located in concrete or roadways shall be SnakePit Concrete/Driveway or SnakePit Roadway and shall be approved by City.

4. Grounding:
  - a. For grounding requirements, intervals, and installation, refer to the Utility Locating (“UL”) details in the Water & Sewer Standard Drawings, latest revision.
  - b. 1.5 lb drive-in magnesium ground rod with HDPE cap and 20 feet of 12-AWG wire.
  - c. Acceptable Manufacturers: Copperhead Industries or approved equivalent.

## **PART 3– EXECUTION**

### **3.1 THRUST RESTRAINT**

- A. Reference construction specification *Section 02510, Water Utility Distribution Piping*.

### **3.2 NON-POTABLE IRRIGATION MAIN AND SERVICE ENCASEMENTS**

- A. Refer to construction specification *Section 02445, Casing Pipe – Borings and Encasements* for typical non-potable irrigation main and service encasement requirements.

### **3.3 NON-POTABLE IRRIGATION MAIN BORINGS**

- A. Refer to construction specification *Section 02445, Casing Pipe – Borings and Encasements* for non-potable irrigation main boring requirements.

### **3.4 NON-POTABLE IRRIGATION SERVICES**

- A. General
  1. Non-potable irrigation service lines shall not be installed in trenches with other conduits/utilities. A service line shall be separated from other conduits a minimum ten (10) feet horizontally and eighteen-inches (18”) vertically.
  2. There shall be no physical connections between the non-potable irrigation system and the potable water system.
  3. Non-potable irrigation services not utilized shall be abandoned. Refer to appendix section A9 – Policies Impacting Design and Construction for abandonment procedures.
  4. The contractor shall mark the location of non-potable irrigation services with a stamped “IRR” four-inches (4”) high, three-inches (3”) wide into the face of the curb and gutter.

### **3.5 IRRIGATION SERVICES**

- A. Non-potable service lines shall be 1 ½” in diameter or greater.
- B. Non-potable irrigation services 2” in diameter shall be Municipex®, Uponor AquaPEX®, three-inches (3”) in diameter shall be AWWA C900-16 polyvinyl chloride (PVC).
- C. The non-potable irrigation service for a given lot must be tapped on the non-potable irrigation main within the confines of the extended property lines unless excepted by the City for the irrigation of multiple outlots. Refer to appendix section A7 – Compound Tap Exemption Policy for Irrigation of Multiple Outlots. Otherwise, irrigation systems from a single non-potable

irrigation service shall only be allowed for use on that single property. Refer to City of Greeley Charter and Code, Title 14: Public Services, Section 14.04.200 for compound tap restrictions.

- D. Pressure boosters are allowed if required and approved by the City. Booster pumps must be prefabricated units with variable speed controls. Provide submittal cut sheets for City approval prior to ordering booster pump.
- E. Non-potable irrigation services shall not be located under driveways, trees, or other permanent structure.
- F. Non-potable irrigation services shall be located a minimum five (5) feet inside the property being served.
- G. Non-potable irrigation service taps shall be separated by at least two (2) feet, measured along the non-potable irrigation main length, including when taps are on opposite sides of the non-potable irrigation main. Non-potable irrigation service taps shall also be a minimum two (2) feet from all joints, fittings, or valves.
- H. The corporation stop, curbstop, meter, that portion of the service line between the corporation stop and the meter, and five (5) feet past the meter shall all be the same diameter.
- I. Non-potable irrigation service curb stops shall be located  $\pm$  one (1) foot from the property line or easement boundary. Non-potable irrigation service vaults shall be located as close as possible beyond the curb stop. See City of Greeley Standard Drawings for additional service and meter installation requirements.
- J. Non-potable irrigation service vaults shall normally be located after the curbstop in a landscaped area. Meter vaults shall not be installed in any street, parking area, driveway, or sidewalk unless otherwise approved by the City. Meter vault shall be rated for HS-20 traffic loadings unless otherwise permitted by the City. Curbstops in paved areas shall be in a street valve box.
- K. There shall be no major landscaping (trees, boulders, or shrubs with mature growth greater than three (3) feet), buildings, or other permanent structures within ten (10) feet of the meter vault.

### **3.6 PIPE INSTALLATION**

- A. Depth of Bury for Non-Potable water distribution mains and service lines.
  - 1. The minimum depth of cover shall be four (4) feet and the maximum depth of cover shall be six (6) feet.
  - 2. When design or constructability constraints are present, deeper or shallower main installation may be permitted only with acceptance from the City. Additional design and installation considerations may be required by the City depending on the situation.
- B. Reference construction specification *Section 02510, Water Utility Distribution Piping* for additional pipe laying installation requirements.
- C. Valves
  - 1. Reference construction specification *Section 02515, Water Utility Distribution Valves*.
- D. Valve Boxes
  - 1. Reference construction specification *Section 02515, Water Utility Distribution Valves*.



- E. Air Release, Air/Vacuum, and Combination Air Valves
  - 1. Reference construction specification *Section 02515, Water Utility Distribution Valves*.
- F. Curb Stops
  - 1. Reference construction specification *Section 15140-2.13-C-1, Service Test Stations at ROW* for tracer wire test station requirements.
  - 2. Curb stop boxes shall be placed inside the upper half of standard valve box. The Contractor shall adjust the curb stop box to ½-inch (1/2") below valve box lid prior to final inspections.
  - 3. The Contractor shall adjust the valve box to ½-inch (1/2") above final grade prior to final inspections.
  - 4. Reference construction specification *Section 02514, Water Service Lines, Meters, and Appurtenances* for additional requirements.
- G. Meter Pits and Vaults
  - 1. Reference construction specification *Section 02514, Water Service Lines, Meters, and Appurtenances*.
- H. Non-Potable Irrigation Mains and Services in Relation to Other Utilities
  - 1. Non-potable irrigation mains and services shall have a minimum ten (10) feet horizontal and eighteen-inches (18") vertical separation from all utilities measured from outside diameter.
  - 2. Where non-potable irrigation lines cross above or below potable water lines with less than eighteen-inches (18") clearance, pipe encasement shall be designed and constructed so as to protect the potable water line.
  - 3. Non-potable irrigation main crossings under any open irrigation ditch shall have a minimum five (5) feet of cover and shall be encased or as required by the irrigation company, whichever greater.
  - 4. Dry utility crossings shall be encased in high density polyethylene pipe (HDPE), Standard Dimension Ratio (SDR) 11 from edge to edge of the easement or right-of-way, or ten (10) feet on either side of the non-potable irrigation main, whichever is greater. Right angle utility crossings are permitted above and below the non-potable irrigation main. Parallel installation of other utilities in exclusive non-potable irrigation easements is not permitted.
  - 5. Bored utility crossings shall have a minimum twenty-four inches (24") of vertical clearance from the outside diameter of the utility casing to the outside diameter of the non-potable irrigation line if the bored utility crosses above the non-potable irrigation line and a minimum thirty-six inches (36") of vertical clearance from the outside diameter of the utility casing to the outside diameter of the non-potable irrigation line if the bored utility crosses below the non-potable irrigation line.
  - 6. If there are horizontal or vertical clearance conflicts between the non-potable irrigation line and a utility, the City may require that the non-potable irrigation main be lowered, raised, or realigned in order to maintain the required clearances.

7. For a non-potable irrigation line crossing situation not specifically mentioned in this section, the crossing requirements provided in this specification shall be applied to that particular situation to the best extent possible.

I. Tracer Wire

1. Tape to top centerline of pipe every three (3') to four (4') feet with adhesive tape or plastic tie straps such that wire remains in place during embedding of pipe.
2. Tracing wire shall be brought to the surface on the inside of a test station at every service curb stop. Provide a two (2) foot loop of wire at each test station, and cover the tracer wire loop and curb stop with the upper half of a standard valve box set to final grade.
3. Tracer wire shall be installed per City of Greeley Standard Drawings.

J. Test Station

1. Test stations shall be installed per City of Greeley Standard Drawings.
2. Tracer wire and test station system shall be tested prior to City acceptance

**3.7 TRACER WIRE TESTING**

A. Tracer Wire Testing.

1. Reference construction specification *Section 02510, Water Utility Distribution Piping*.

**3.8 PIPELINE LEAK TESTING**

A. Reference construction specification *Section 01713, Water Distribution System Testing*.

**3.9 UNDERGROUND MARKING TAPE AND IDENTIFICATION**

A. Underground marking tape shall be installed above non-potable irrigation mains when purple colored pipe or appurtenances cannot be used for construction.

1. Buried appurtenances not available from the manufacturer in the purple color (ie. valves, fittings) shall be identified in the field by securing marking tape to the surface of the item.
2. Accessible appurtenances not available from the manufacturer in the purple color (ie. valve boxes, meter covers), shall be primed and painted with two (2) coats of an approved rust inhibitive paint.

B. At a minimum, underground marking tape for the non-potable system shall be colored purple, three-inches (3") wide, four (4) mils thick, non-detectable polyethylene. The marking tape shall be solid colored with black letters stating "CAUTION – BURIED NON-POTABLE WATER LINE BELOW" or "CAUTION – BURIED RECLAIMED WATER LINE BELOW".

C. Marking tape to be installed in accordance with City of Greeley Standard Drawings. Marking tape shall meet APWA Uniform Color Code specifications.

D. Approved signs and labels shall be posted bearing the warning "CAUTION – BURIED NON-POTABLE WATER LINE BELOW" or "CAUTION – BURIED RECLAIMED WATER LINE

BELOW". See the City of Greeley Standard Details an example of an approved sign. Coordinate signage requirements with the City of Greeley during design process.

### **3.10 NON-POTABLE IRRIGATION WATER STORAGE FACILITIES (PONDS)**

#### **A. General**

1. Signage must be provided on site indicating non-potable water is utilized for irrigation. Obtain signage approval by the City.

#### **B. Volume Design**

1. Pond side slopes shall be 4:1 safety bench for 12-feet horizontally and 3:1 slope thereafter to achieve maximum depth of pond.
2. Fencing must be installed around the pond as required for safety purposes or as directed by City. Fencing materials must match architectural components of development or HOA fencing requirements.

#### **C. Non-Potable Irrigation Pond Liner**

1. Reference construction specification *Section 02666, Pond and Reservoir Liners*.

#### **D. Shoreline Protection**

1. Refer to Construction Drawings for shoreline and erosion protection details.

### **3.11 NON-POTABLE IRRIGATION PUMPING SYSTEMS**

#### **A. General**

1. For systems requiring 200 gpm or more:
  - a. Non-potable irrigation pump station manufacturer shall be SynchroFlo - no exceptions Reference construction specification *Section 08200, Irrigation Pump Station*
2. For systems requiring less than 200 gpm:
  - a. Non-potable irrigation station manufacturer must be SynchroFlo or Quantum Pumps, as approved by City. Reference construction specification *Section 08200, Irrigation Pump Station*

### **3.12 AERATION SYSTEMS**

- #### **A.**
- Refer to construction specification *Section 11230, Aeration System* for additional non-potable pond aeration system requirements.