CONSTRUCTION SPECIFICATIONS
TABLE OF CONTENTS

SECTION	DESCRIPTION	PAGE NO.
01300	SUBMITTALS	119
01713	WATER DISTRIBUTION SYSTEM TESTING	129
01715	SEWER AND MANHOLE TESTING	133
01785	PROJECT RECORD DOCUMENTS	144
02240	DEWATERING	148
02275	RIPRAP	153
02315	EXCAVATION AND FILL	158
02445	CASING PIPE – BORINGS AND ENCASEMENTS	183
02510	WATER UTILITY DISTRIBUTION PIPING	190
02511	DISINFECTING OF WATER UTILITY DISTRIBUTION	208
02512	DUCTILE-IRON PIPE	215
02513	POLYVINYL CHLORIDE (PVC) PRESSURE PIPE	227
02514	WATER SERVICE LINES, METERS, AND APPURTENANCES	237
02515	WATER UTILITY DISTRIBUTION VALVES	250
02516	WATER UTILITY DISTRIBUTION FIRE HYDRANTS	258
02517	WATER PRESSURE REDUCING VALVES	264
02530	SANITARY UTILITY SEWERAGE PIPING	275
02533	POLYVINYL CHLORIDE (PVC) NON-PRESSURE PIPE	281
02534	SANITARY SEWER SERVICES LINES	288
02535	SANITARY UTILITY SEWERAGE MANHOLES, FRAMES, AND COVERS	291
02666	NON-POTABLE POND LINERS	306
02957 A	SANITARY SEWER MANHOLE REHABILITATION	323
02957 B	SANITARY SEWER MANHOLE COATING	327

02960	TEMPORARY SANITARY SEWER BYPASS PUMPING	335
03300	CAST-IN-PLACE CONCRETE	341
03400	PRECAST CONCRETE	358
11230	NON-POTABLE POND AERATION SYSTEM	364
11285	SLIDE GATES	374
15140	NON-POTABLE PUMP STATION	377

SECTION 01300

SUBMITTALS

PART 1 – GENERAL

1.1 SCOPE

A. This Section includes provisions for Contractor submittals. Additional provisions may be included in specific Specifications Sections.

B. This Section contains general information pertaining to the processing of submittals. Additional detailed submittal requirements are contained within the individual technical Specifications Sections.

C. Submittals shall be mailed or emailed as follows:

City of Greeley – Civil Inspections
1100 10th Street
Greeley, Colorado 80631

D. This Section specifies the general methods and requirements of submissions applicable to the following work-related submittals: Shop Drawings, Product Data, Manuals, Samples, Certificates of Compliance, Statements of Qualifications, Test Results, Survey Data, Calculation's and Construction or Submittal Schedules. Detailed submittal requirements will be specified in the technical Specifications sections.

E. All submittals shall be clearly identified by reference to Specification Section, Paragraph and Drawing No. or Detail as applicable. Submittals shall be clear and legible and of sufficient size for sufficient presentation of data. The "Submittal Transmittal Form" and the "Certification Statement" to be used with each submittal is included at the end of this Section.

F. Prepare, maintain, and submit submittal logs as specified herein.

1.2 SUBMI SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

A. Shop Drawings

1. Shop drawings include, but are not necessarily limited to, custom-prepared data such as fabrication and erection/installation (working) drawings, design calculations, lists, graphs, operating instructions, scheduled information, setting diagrams, actual shop work manufacturing instructions, custom templates, special wiring diagrams, coordination drawings, individual system or equipment inspection and test reports including performance curves and certifications, as applicable to the work.

2. All details on shop drawings submitted for approval shall show clearly the relation of the various parts of the work and control lines, and where correct

fabrication of the work depends upon field measurements such measurements shall be made and noted on the drawings before being submitted for approval.

B. Product Data

1. Product data as specified in individual Sections include, but are not necessarily limited to, standard prepared data for manufactured products (sometimes referred to as catalog data), such as the manufacturer's product specification and installation instructions, availability of colors and patterns, manufacturer's printed statements of compliance and applicability, roughing-in diagrams and templates, catalog cuts, product photographs, standard wiring diagrams, printed performance curves and operational- range diagrams, production or quality control inspection and test reports and certifications, mill reports, product operating and maintenance instructions and recommended spare-parts listing and printed product warranties, as applicable to the work.

C. Samples

1. Samples specified in individual Sections include, but are not necessarily limited to, physical examples of the work, such as sections of manufactured or fabricated work, small cuts or containers of materials, complete units of repetitively-used products, color/texture/pattern swatches and range sets, specimens for coordination of visual effect, graphic symbols and units of work to be used by the District for independent inspection and testing, as applicable to the work.

1.3 CONTRACTOR'S RESPONSIBILITIES

A. The CONTRACTOR shall prepare, approve, sign and submit to the City or Engineer of Record any and all Shop Drawings, Manufacturers' Project Data, Certificates, Wiring Diagrams, Operation and Maintenance Manuals and Samples required by the Contract Documents.

NOTE: All references in the Technical Sections under "Shop Drawings" or “Submittal” to the words "approval of" shall mean "reviewed by".

B. The CONTRACTOR, by preparing, reviewing, approving and submitting the Shop Drawings, Manufacturers' Product Data, Certifications, Wiring Diagrams, Operation and Maintenance Manuals and Samples, represents that the CONTRACTOR has determined and verified all materials, field measurements and filed construction criteria related thereto, and has checked and coordinated the information contained within such submittals with the requirements of the Work, the Project and the Contract Documents.

C. The CONTRACTOR shall inform the City or Engineer of Record, in writing, of any and all deviations and/or questions regarding the Contract Documents, and shall properly identify these areas of concern in the letter of transmittal of the Shop Drawings, Manufacturers' Product Data, Certification, Wiring Diagram and Samples for proper written disposition respectively by the Engineer of Record. The CONTRACTOR shall provide reproducible Shop Drawings.

D. All Shop Drawings, Manufacturers' Product Data, Wiring Diagrams, Certifications, Operation and Maintenance Manuals and Samples submitted, shall be accompanied by a preprinted standard transmittal form with submittal number, and shall be addressed to the City or Engineer of Record to be received and filed.

E. The Contractor is not relieved of the responsibility for any deviation from the requirements of the Contract Documents, by virtue of Contractor's approval and submittal of the Shop Drawings, Manufacturers' Product Data, Wiring Diagrams, Operation and Maintenance Manuals and Samples to the City or Engineer of Record. All deviations and/or interpretations of the Contract Documents must be approved in writing by the City or Engineer of Record.

F. The review of the Shop Drawings, Manufacturers' Product Data, Certifications, Wiring Diagrams, Operation and Maintenance Manuals; and Samples by the City or Engineer of Record does not relieve the Contractor of its responsibility from any requirements of the Contract Document, or any errors or omissions in such submittals, or for any failure to perform the requirements and intent of Contract Documents. The Contractor shall be responsible for a fully functional system as intended by the Contract Documents.

G. The Contractor shall review shop drawings, product data and samples, including those by subcontractors, prior to submission to determine and verify the following:

1. Catalog numbers and similar data.

2. Conformance with the Specifications.

H. Each shop drawing, sample and product data submitted by the Contractor shall have affixed to it the following Certification Statement including the Contractor's Company name and signed by the Contractor: "Certification Statement: By this submittal, I hereby represent that I have determined and verified all materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements." The cover sheet shall fully describe the packaged data and include a listing of all items within the package. Provide to the City or Engineer of Record a copy of each submittal transmittal sheet for shop drawings, product data and samples at the time of submittal of said drawings, product data and samples.

I. The Contractor shall utilize a 10-character submittal identification numbering system in the following manner:

1. The first two characters shall represent Shop/Working Drawing and other Product Data (SD), Sample (SL), Operating/Maintenance Manual (OM), Certificate of Compliance (CC), Statement of Qualification (SQ), or Test Results/Report (TR).

2. The next two digits shall be the numbers 01-99 to sequentially number each initial separate item or drawing submitted.

3. The next character shall be a letter, A-Z, indicating the submission, or resubmission of the same Drawing, i.e., A=1st submission, B=2nd submission, C=3rd submission, etc.

4. The next five digits shall be the applicable Specifications Section Number.

A typical submittal number would be as follows: SD-08-B-13122

SD	=	Shop Drawing
08	=	The eighth initial submittal
B	=	The second submission (first resubmission) of that particular shop drawing
13122	=	Specifications Section

J. Notify the City or Engineer of Record in writing, at the time of submittal, of any deviations in the submittals from the requirements of the Contract Documents.

K. The review and approval of shop drawings, samples or product data by the City or Engineer of Record shall not relieve the Contractor from his/her responsibility with regard to the fulfillment of the terms of the Contract. All risks of error and omission are assumed by the Contractor and the City and Engineer of Record will have no responsibility thereof.

L. No portion of the Work requiring a shop drawing, sample, or product data shall be started nor shall any materials be fabricated or installed prior to the approval or qualified approval of such item. Fabrication performed, materials purchased or on- site construction accomplished which does not conform to approved shop drawings and data shall be at the Contractor's risk. The City will not be liable for any expense or delay due to corrections or remedies required to accomplish conformity.

M. Project Work, materials, fabrication, and installation shall conform to approved shop drawings, applicable samples, and product data.

1.4 SUBMISSION REQUIREMENTS

A. Make submittals promptly in accordance with approved schedule, and in such sequence as to cause no delay in the Work or in the work of any other contractor.

B. Each submittal, appropriately coded, will be returned within thirty (30) Calendar Days following receipt of submittal by the City or Engineer of Record.

1. Submittal identification number

2. The date of submission and the dates of any previous submissions.

3. The Project title and number.

4. Contractor identification.

5. The names and telephone numbers of:

   a. Contractor

   b. Supplier

   c. Manufacturer

6. Field dimensions clearly identified as such.

7. Identification of deviations from Contract Documents.

8. Identification of revisions on resubmittals.

1.5 REVIEW OF SHOP DRAWINGS, PRODUCT DATA, WORKING DRAWINGS AND SAMPLES

A. The review of shop drawings, data, and samples will be for general conformance with the design concept and Contract Documents. They shall not be construed:

   1. as permitting any departure from the Contract requirements;

   2. as relieving the Contractor of responsibility for any errors, including details, dimensions, and materials;

   3. as approving departures from details furnished by the City, except as otherwise provided herein.

B. The Contractor remains responsible for details and accuracy, for coordinating the Work with all other associated work and trades, for selecting fabrication processes, for techniques of assembly, and for performing work in a safe manner.

C. If the shop drawings, data or samples as submitted describe variations and show a departure from the Contract requirements which City or Engineer of Record finds to be in the interest of the City and to be so minor as not to involve a change in Contract Price or time for performance, the City or Engineer of Record may return the reviewed drawings without noting an exception.

D. The City or Engineer of Record will reject incomplete submittals as not complying with the Contract requirements. Contractor shall provide space for 2.5” by 3.5” review stamp for each submittal.

E. After receipt of a complete submittal and within the time limits described below, the City or Engineer of Record will transmit the submittal back to the Contractor marked with one of the following review status:

   “Reviewed, No Exceptions Taken”

   “Make Corrections Noted, Do Not

Resubmit" "Revised and Resubmit"

"Rejected"

F. For items marked "Make Corrections Noted, Do Not Resubmit," the revisions will be marked on the submittal or will be described as comments in the response letter. The submittal will be considered approved without formal revision. The CONTRACTOR shall, within 7 calendar days, submit two (2) corrected record copies of the submittal to the City or Engineer of Record for record purposes.

G. If the submittal is returned to the Contractor marked "Revised and Resubmit," the submittal will be transmitted to the Contractor with a statement of the deficiencies. The Contractor shall promptly revise the submittal and resubmit to the City or Engineer of Record.

H. If the submittal is returned to the Contractor marked "Rejected," the Contractor shall revise said submittal and shall resubmit the revised submittal to the City or Engineer of Record.

I. Revisions indicated on submittals shall be considered as changes necessary to meet the requirements of the Contract Documents, Specifications, or Drawings. Submittal revisions shall not be taken as the basis of claims for extra work. The Contractor shall have no claim for damages or extension of time due to any delay resulting from making required revisions to the submittals. The review of submittals by City or Engineer of Record shall in no way relieve the Contractor of responsibility for errors or omissions contained therein nor will such review operate to waive or modify any provisions or requirements contained in the Contract Documents, Specifications, or Drawings.

J. After approval of submittals, the Contractor shall not deviate from the approved submittal without the prior written consent from the City or Engineer of Record. Commencement of production Work performed in advance of the receipt of approval of submittals shall be entirely at the Contractor's risk.

K. Resubmittals will be handled in the same manner as first submittals. On resubmittals the Contractor shall direct specific attention, in writing on the letter of transmittal and on resubmitted shop drawings by use of revision triangles or other similar methods, to revisions other than the corrections requested by the City or Engineer of Record, on previous submissions. Any such revisions which are not clearly identified shall be made at the risk of the Contractor. The Contractor shall make corrections to any work done because of this type revision that is not in accordance to the Contract Documents as may be required by the City or Engineer of Record.

L. Partial submittals may not be reviewed. The City or Engineer of Record will be the only judge as to the completeness of a submittal. Submittals not complete will be returned to the Contractor, and will be considered "Rejected" until resubmitted. The City or Engineer of Record may at his/her option, provide a list or mark the submittal directing the Contractor to the areas that are incomplete.

M. Repetitive Review

1. Shop drawings and other submittals will be reviewed no more than twice at the City or Engineer of Record expense. All subsequent reviews will be performed at times convenient to the City or Engineer of Record and at the Contractor's expense, based on the City or Engineer of Record then prevailing rates. The Contractor shall reimburse the City for all such fees invoiced to the City. Submittals are required until approved.

2. Any need for more than one resubmission, or any other delay in obtaining City or Engineer of Record review of submittals, will not entitle Contractor to extension of the time for completion.

N. If the Contractor considers any correction indicated on the shop drawings to constitute a change to the Contract Documents, the Contractor shall give written notice thereof to the City or Engineer of Record at least seven work days prior to release for manufacture.

O. When the shop drawings have been completed to the satisfaction of the City or Engineer of Record, the Contractor shall carry out the construction in accordance therewith and shall make no further changes therein except upon written instructions from the City or Engineer of Record.

1.6 DISTRIBUTION

A. Distribute reproductions of approved shop drawings and copies of approved product data and samples, where required, to the job site file and subcontractors as required or directed by the City.

1.7 SCHEDULES

A. Provide all schedules required by the requirements of these Specifications.

1.8 GENERAL PROCEDURES FOR SUBMITTALS

A. Coordination of Submittal Times: Prepare and transmit each submittal sufficiently in advance of performing the related work or other applicable activities, or within the time specified in the individual sections of the Specifications so that the installation will not be delayed by processing times including disapproval and resubmittal (if required), coordination with other submittals, testing, purchasing, fabrication, delivery and similar sequenced activities. No extension of the time for completion will be authorized because of the Contractor's failure to transmit submittals sufficiently in advance of the work.

1.9 QUALITY CONTROL SUBMITTALS

A. Certificates:

1. Manufacturer's Certificate of Compliance:

a. When specified in individual Specification sections or where products are specified to a recognized standard or code, submit prior to shipment of product or material to the Project site.

b. City or Engineer of Record may permit use of certain materials or assemblies prior to sampling and testing if accompanied by accepted certification of compliance.

c. Signed by product manufacturer certifying that materials, manufacture, and product specified conform to or exceed specified requirements and intent for which product will be used. Submit supporting reference data, affidavits, and certifications as appropriate.

d. May reflect recent or previous test results on material or product, but must be acceptable to City or Engineer of Record.

2. Certificates of Successful Testing or Inspection: Submit when testing or inspection is required by Laws and Regulations or governing agency or specified in the individual Specification sections.

B. Operation and Maintenance Manual: Submit Operation and Maintenance Manual in accordance with City requirements.

C. Statements of Qualification: Evidence of qualification, certification, or registration. As required in these Contract Documents to verify qualifications of Engineers, materials testing laboratories, specialty Subcontractors, trades, specialists, consultants, installers, and other professionals.

D. Written Test Reports of Each Test and Inspection: As a minimum, include the following:

1. Date of test and date issued, Project title and number, testing laboratory name, address, and telephone number, and name and signature of laboratory inspector.

2. Date and time of sampling or inspection and record of temperature and weather conditions.

3. Identification of product and Specification section, location of Sample, test or inspection in the Project, type of inspection or test with referenced standard or code, certified results of test.

4. Compliance with Contract Documents and identifying corrective action necessary to bring materials and equipment into compliance.

5. Provide an interpretation of test results, when requested by City or Engineer of Record.

1.10 SUBMITTAL LOG

A. The Contractor shall prepare and maintain an accurate submittal log for the duration of the project. The Contractor shall submit initial submittal log within 30 Calendar Days after Notice to Proceed. The Contractor shall submit an updated submittal log once a month and upon request of the City or Engineer of Record. The submittal log shall contain a listing of all submittals required by the Contract Documents and shall include the following.

1. Submittal identification number
2. Specification Section Reference
3. Description of submittal item
4. Projected submission date
5. Actual submission date
6. Date returned by the Engineer
7. Notation of the City or Engineer of Record response
8. Notation if re-submittal or record copy is required

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SUBMITTAL TRANSMITTAL/CERTIFICATE FORM

Project Name:

To: City of Greeley – Civil Inspections
1100 10th Street
Greeley, Colorado 80631
Attn:

From: _____
_____
_____
_____

Description:

_____

_____

Submittal #:_____-_____-_____- _____
Type Submittal # Submission Section

Date:_____Date of Previous Submission:_____Copies:_____

Supplier:_____Phone No:_____

Manufacturer:_____Phone No:_____

Remarks:

_____

_____

Relationship to Critical Features of Work:

_____

_____

Certification Statement: By this submittal, I hereby represent that I have determined and verified all materials, dimensions, catalog numbers and similar data, and I have checked and coordinated each item with other applicable approved shop drawings and all Contract requirements.

By: _____ _____
Signature Date

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.

3. Disinfection may occur after leak testing is completed and accepted or concurrently with the leak testing. 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 <u>not</u> 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:

$$L = \frac{SD\sqrt{P}}{148{,}000}$$

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. Flash Drives or USB portable hard drives

a. Submit Flash Drive or USB portable hard drives of completed, narrated, color digital videos identified by Project name, street name, right-of-way property name, and manhole numbers.

b. Flash Drives or USB portable hard drives become property of the City of Greeley Water and Sewer Department

2. Inspection Logs

a. Submit cleaning and television inspection logs of all new installed sewer lines, manholes, structures, and all connections to an existing sewer line.

b. Cleaning and television inspection logs shall be submitted prior to request for progress payment, pay applications, or prior to substantial completion. Failure to provide inspections log may result in delay of substantial completion or progress payments.

c. 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. Flash Drive or USB portable hard drive

1. Description: Digital video formatted files

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 5% of the base internal diameter.

3. Mandrel outside diameters in inches are as follows:

TABLE 3.3-B: Allowable Pipe Deflection – Mandrel Test

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

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:

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

   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-	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:

$$T = 0.085\left[\frac{D_1^{\,2}L_1 + D_2^{\,2}L_2 + \ldots + D_n^{\,2}L_n}{D_1L_1 + D_2L_2 + \ldots + D_nL_n}\right]\frac{K}{Q}$$

Where:

T = shortest time(s) allowed for the air pressure to drop 1.0 psig.
K = $0.000419(D_1L_1 + D_2L_2 + \ldots + D_nL_n)$ but not less than 1.0
Q = leak rate in cubic feet/minute/square feet of internal surface = 0.0015 CFM/SF
D_1, D_2, etc. = measured average inside diameter of pipe (in)
L_1, L_2, 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 3.7-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 TELEVISING 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 Project Record Documents, making legible and accurate entries on each sheet of Drawings and other documents where such entry is required to show change. Project Record Documents may be kept digitally but must be backed-up daily.

b. 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.

c. Field verify all as-built dimensions and materials.

3. Make entries within 48 hours after receipt of information that a change in the Work has occurred.

4. Prior to each request for progress payment, pay application, or when a field change is requested or made, the Engineer of Record, Project manager, Chief Construction, or City may request review and approval of current Redline Drawings. Failure to properly maintain, update, and submit Redline Drawings may result in a deferral of the whole or any part of Contractor's Application for Payment, either partial or final, and substantial completion may be delayed. The City reserves the right to review Redline Drawings throughout the project.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 MAINTENANCE OF DOCUMENTS AND SAMPLES

A. Do not use Project Record Documents for construction purposes.

B. Store documents in Contractor's field office apart from documents used for construction. Protect Project Record Documents from deterioration and store in a secure location. Updated Project Record Documents shall be scanned and saved as a PDF monthly.

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. Additionally, most recent PDFs must be provided upon City request.

3.2 RECORDING DURING CONSTRUCTION

A. Label each drawing "REDLINE 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 Redline 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 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 Redline 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 and materials 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 Redline Drawings information is obtained.

3.3 REDLINE DRAWINGS AND SUBMISSION

A. Contractor shall submit Redline Drawing information to the Engineer of Record and City on a monthly basis or prior to each request for progress payment, pay application, or when a field change is requested or made for review and approval.

1. The Engineer of Record and City shall review the submitted Redline Drawing information and any corrections, additions, or omissions identified shall be incorporated into the Redline 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. Redline 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 Redline Drawings to produce final As-Constructed Record Drawings. As-Constructed Record Drawings shall be submitted to the City for review and approval within 2 months of the Engineer of Record receiving the approved Redline 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 Redline 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 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. Must obtain all permits as required by State and Local regulations.

1. Colorado Department of Public Health and Environment (CDPHE) requires permits for dewatering operations.

2. Discharge of water from dewatering operations may need additional approvals based on water quality and location of discharge.

E. 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 as well as 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. Provide type and sizes of filters, if used.

5. Identify proposed alignment, support, and protection for discharge pipe. Identify location of discharge and provide details for that location. For pipes discharging into manholes, provide details of pipe entry at manhole.

6. Final recommendations for dewatering.

7. 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.

8. 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.

C. Well construction logs. Include:

1. Descriptions of actual materials encountered.

2. Construction details.

3. Well development procedures and results.

4. Deviations from original design.

D. Qualifications:

1. Dewatering contractor.

2. Dewatering design engineer.

3. Testing laboratory.

E. Permit for permanent groundwater monitoring wells.

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 may be included on the Drawings or Baseline Report.

B. If available, 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.

B. Regulatory requirements:

1. Obtain required water discharge permits.

2. Obtain permanent groundwater monitoring well permits.

PART 2 – PRODUCTS

2.1 DEWATERING SYSTEM

A. The dewatering system may be single- or multiple-stage wellpoints, deep wells, ejector wells, sumps, or approved alternatives 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. The responsibility for conducting the dewatering operation in a manner which will protect adjacent structures and facilities rests solely with Contractor.

D. 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.

E. 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.

G. Properly dispose of discharge water in accordance with Federal, State, and local requirements and permits. For discharge of water into holding tanks or infiltration ponds, include a means of overflow protection that is acceptable to the Engineer.

H. Control release of groundwater to its static level to prevent disturbance of natural foundation soils, or compacted backfills and fills and to prevent flotation or movement of structures, pipelines, or other facilities.

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, shallbe 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:

TABLE 2.1 – A: Gradation for Granular Bedding

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

B. Riprap

1. 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:

TABLE 2.1 – B: Classification and Gradation of Riprap

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

* *D50 = Median Particle size.*

C. Grout

1. Concrete for the grout shall be an approved batch meeting the following requirements:

   i. All concrete shall develop 4,000 psi compressive strength within 28 days.

   ii. The cement shall be Type V.

   iii. The stone aggregate shall have a maximum diameter of ½ inch.

   iv. The slump shall be within a range of 3 inches to 6 inches.

2. Use of a stiffer mix or other measures as approved by the City for steeper slopes or for vertical joints.

3. The water/cement ratio shall not exceed 0.48.

4. Add 1.5 pounds per cubic yard of synthetic fiber reinforcement per manufacturer's instructions.

5. The grout shall contain both an air entraining admixture and water reducing agent. The job site air content be 6.5% +/- 1.5% by volume. A water reducing agent shall be used.

6. The Contractor shall submit a mix design in writing to the City for approval prior to the placement of any grout.

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.

3.4 GROUTED RIPRAP

A. The subgrade shall be excavated, and any unstable material shall be removed. Approved material shall be placed and compacted in a maximum of 4-inch lifts to 95” of Maximum Standard Proctor Density (ASTM D698) to re-establish the subgrade.

B. The top of the riprap shall be as indicated on the Drawings.

C. The riprap shall be placed as described in Section 3.3. Placement shall be approved by the City prior to grouting.

D. Prior to placing the grout, any type of debris, fines, smaller rock, or silt shall be removed from around the riprap.

E. Dewatering shall be implemented to guarantee that the grout will not be placed in water and for a period of 24 hours the grout has been placed.

F. Keep riprap receiving grout wet at all times prior to receiving grout.

G. The concrete grout shall be placed by injection methods by pumping under low pressure, through a 2-inch maximum diameter hose to ensure complete penetration of the grout into the void area as detailed on the Drawings.

H. Grout will be placed up to 6 inches from the top of the riprap, or as directed by the Engineer. The operator shall be able to stop the flow and will place grout in the voids and not on the surface of the rocks.

I. Grout should be troweled out and finished to minimize visibility.

J. Clean and wash any spillage before the grout sets. The visual surfaces of the riprap will be free of grout. If washing does not clean off grout residue, the Contractor shall wash off any grout residue with muriatic acid and water using a brush to scrub off the residue.

K. A pencil vibrator shall be used to make sure all voids are filled between the riprap. The intent is to fill all voids from the subgrade level around the riprap to a depth as shown on the Drawings. The pencil vibrator may be used to smooth the appearance of the surface but the Contractor shall use a wood float to smooth and grade the grout around the boulders.

3.5 TOLERANCES

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

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^3 (600 kN-m/m^3))*, latest revision.

8. C1012/C1012M, *Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution*, latest revision.

9. D1556, *Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method*, latest revision.

10. D1557, *Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kn-m/m^3))*, latest revision.

11. D2487, *Standard Test Method for Classification of Soils for Engineering Purposes*, latest revision.

12. D4318, *Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils*, latest revision.

13. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density, latest revision

14. D4832, *Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders*, latest revision.

15. D6023, *Standard Test Method for Unit Weight, Yield, Cement Content, and Air Content (Gravimetric) of Controlled Low Strength Material (CLSM)*, latest revision.

16. D6024, *Standard Test Method for Ball Drop on Controlled Low Strength Material (CLSM) to Determine Suitability for Load Application*, latest revision.

17. D6938, *Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)*, latest revision.

D. Colorado Department of Transportation (CDOT)

1. (CDOT) Specifications for Road and Bridge Construction

E. (National Electrical Manufacturers Association (NEMA)

1. Z535.1, *Safety Color Code*, latest revision.

F. Occupational Safety and Health Administration (OSHA)

1. 29 CFR Part 1926, *Safety and Health Regulations for Construction*, latest revision.

G. City of Greeley Design Criteria and Construction Specifications Streets Volume I (SDC)

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 Standard proctor testing (ASTM D698) or Modified proctor testing (ASTM D1557) of proposed offsite source material as appropriate based on compaction requirements stated herein.

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. For trenched installations, 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. Depending on the required subsurface utility engineering (SUE) quality level, the Contractor shall be prepared to 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.

1.7 Soil and Bedrock Conditions

A. A geotechnical investigation may have been performed for the project in order to obtain relative data concerning the character of material in and upon which the project is to be built. If an investigation has been performed, the information will be available to the Contractor for information purposes only, and is not to be considered a part of the Contract Documents. The Contractor shall satisfy himself as to the kind and type of soil and/or rock to be encountered and any water conditions that might affect the construction of the project.

PART 2 – PRODUCTS AND EQUIPMENT

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. Refer to construction specification *Section 02240, Dewatering*, for dewatering products & requirements.

2.3 MARKING TAPE

A. Non-detectable:

1. Material: Solid colored non-detectable polyethylene.

2. Thickness: Minimum 4 mils.

3. Width: 3 inches.

4. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.

   a. Potable water lines: “CAUTION: BURIED WATER LINE BELOW”

   b. Non-potable water lines: “CAUTION – BURIED NON-POTABLE WATER LINE BELOW” or “CAUTION – BURIED RECLAIMED WATER LINE BELOW”

   c. Sanitary and Storm Sewers: “CAUTION: BURIED SEWER LINE BELOW”

5. Manufacturers and Products:

   a. Emedco

   b. Presco

   c. Approved equivalent.

B. 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 SUBGRADE MATERIAL BELOW STRUCTURES

A. At minimum, the top six-inches (6") of in-situ soil below structures shall be removed and replaced with an approved structural fill 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. Subgrade material below structures shall be crusher-run angular rock per ASTM 4253 and ASTM 4254, compacted 65-70% or 95% standard proctor dry density, and conforming to CDOT #357 (ASTM D448, AASHTO M43) in table below or approved equivalent.

TABLE 2.4-B: Subgrade Material Below Structures – CDOT #357

Size (inch)	Percent (%) Passing
2 ½"	100
2"	95-100
1"	35-70
½"	10-30
#4	0-5

C. Structures consist of but not limited to vaults, sewer manholes, equipment pads, etc.

2.5 STABILIZATION MATERIAL

A. In the case of poor soil conditions, subgrade stabilization may be required to adequately support structural foundations and utility pipelines. 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 shall be crushed concrete and natural aggregate with at least two fractured faces, conforming to CDOT Vehicle Tracking Pad (VTP) (ASTM D448, AASHTO M43)

TABLE 2.5-B: STABILIZATION MATERIAL – CDOT VTP

Size (inch)	Percent (%) Passing
3"	100
2"	0-25
3/4"	0-15

C. Geotextile fabric shall be used in conjunction with stabilization material unless approved otherwise by the City. 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.

1. Acceptable geotextile fabric manufacturers are:

a. TenCate – Mirafi 500X

b. Webtec, Inc. Geosythetics – TerraTex GS

c. Or approved equivalent.

2.6 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 CLSM mix design approved by the City is not to be exceeded. Do not add water after discharge of the CLSM from the mixer begins.

C. Place CLSM 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. 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 C6l8, 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 thesulfate 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.

2.7 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 or City approved equal

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

C. Bedding material for potable and non-potable water pipe shall be either ASTM C33 Sand or Squeegee Fine Sand.

TABLE 2.7-C.1: 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

TABLE 2.7-C.2: Bedding Material – Squeegee

Size (inch)	Percent (%) Passing
3/8"	100
#4	85-100
#8	30-70
#16	5-40
#30	0-15
#50	0-10
#100	0-5
#200	<1

D. Or approved equal.

E. Groundwater Barrier shall meet the following soil classification:

1. Soil Classifications

a. Minimum thirty-percent (30%) fines.

b. Minimum plasticity index of 10.

c. Material shall not be lumpy or hard but shall be finely divided, suitable, and free from stones.

2. Or CLSM 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 high density and rated for high compressibility of a minimum of 100 psi.

C. Insulation board shall be a minimum two-inches (2") 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.

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 of standard proctor compaction as determined in accordance with ASTM D698.

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. City shall approve proof-roll prior to backfill.

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 stabilization material. Stabilization material 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 over excavate 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 or benching shall meet current OSHA requirements or be 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. Refer to construction specification *Section 02240, Dewatering*, for dewatering requirements.

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 fil1 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 specificaiton, 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 of standard proctor compaction as determined in accordance with ASTM D1698

c. Place a minimum 6 inches of stabilization material below structures and slabs. Stabilization material shall be compacted and tested in accordance with ASTM D4254 to a minimum relative density of 65 percent.

d. Backfill with cohesive material 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.

2. 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. Atterberg Limits:

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.

3. 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 Over Excavated 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 Over excavation: Either trench stabilization material or granular pipe base material, as specified in Section 3.6 of this specification.

ii. Authorized Over excavation: 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 over excavation 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 over excavated areas is prohibited, unless in City's opinion, backfill will remain stable, and over excavated material is replaced as compacted earthfill.

F. Placing Fill Over Geosynthetics

1. General:

a. Place fill with sufficient care so as not to damage the geosynthetic.

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. Care shall be taken to not damage the pipe during compaction. Hand-held equipment shall be used to compact material immediately adjacent to the pipe.

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 ± two percent (2%) of optimum moisture content as determined by AASHTO T99. Alternatively, utility trenches can also be backfilled with CLSM to the bottom of the new pavement.

6. Trench backfill in utility easements within 20 feet of right-of-way shall be mechanically compacted to 95% maximum density or backfilled with CLSM 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. Marking tape to be installed in accordance with City of Greeley Standard Drawings. Marking tape shall meet APWA Uniform Color Code specifications. Continuously install marking tape along centerline of all buried piping, at eighteen-inches (18") above pipe. Coordinate with piping installation drawings.

3.9 TRACER WIRE AND TEST STATIONS

A. Refer to the proper construction specification and the standard drawings ("UL" section) for the utility specific tracer wire and test station requirements.

1. For water distribution and non-potable irrigation tracer wire, refer to construction specification *Section 02510, Water Utility Distribution Piping*.

2. For water distribution test stations at fire hydrants, refer to construction specification *Section 02516, Water Utility Distribution Fire Hydrants.*

3. For sanitary sewer service tracer wire and test stations, refer to construction specification *Section 02534, Sanitary Sewer Service Lines.*

3.10 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.

3.11 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 four (4) 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.

3.12 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. 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.

2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.

3. Fill entire trench section to pavement finish grade for a temporary driving surface in traveled areas, and screed off excess and finish with a float.

4. In other areas fill the trench section to top of trench backfill zone.

5. 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.

3.13 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% (ASTM D698)

   b. Moisture – ±2%

2. Bedding Material

   a. Compaction – 65% of relative density (ASTM D4254)

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.

3.14 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 recompacted 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 recompacted area.

2. Sanitary sewer line testing shall be performed between manholes on both sides of the recompacted area.

3. Sanitary sewer manhole testing shall be performed if recompaction 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, lastest revision.

3. F714, Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, lastest 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 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 shall size the casing pipe such that the inside clearance is at least one-inch (1") greater than the maximum outside diameter of the casing spacer runners.

C. The design and construct all Shafts in accordance with the Contract Documents and promote construction using Contractor's proposed tunneling means and methods.

D. Shafts shall be of sufficient size to install the Casing Pipes in accordance with the Contract Documents.

E. The disign shall determine the Shaft footprint size, methods of excavation, ground control, ground support type, and allowable excavation slopes needed to perform the work and provide safe access for tunnel construction subject to the limitations specified herein and elsewhere in the Contract Documents.

F. Ground support for Shafts and excavations shall stay within established easements.

a. Abide by the requirements of existing permits obtained by others, and obtain additional permits or approvals as needed.

G. Where excavations are undertaken near any structure or facility including but not limited to buildings, railroads, highways, streets, or utilities, the construction shall not alter, damage, impair, or interfere with the operation of the structure or facility.

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 2.2-B: Casing Pipe Specifications

Carrier Pipe Diameter (in)	Casing Pipe Diameter (in)	Borings and Encasements	Steel Casing Pipe	Encasements Only
		Casing Pipe Materials	Thickness (in)	Casing Pipe Materials
2” or less Water Services	4”	Welded Steel, Fusible C900 PVC	0.250	C900 PVC
4”	8”	Welded Steel, Fusible C900 PVC or HDPE	0.322	C151 DIP, C900 PVC, HDPE, Welded Steel
6”	12”	Welded Steel, Fusible C900 PVC or HDPE	0.375	C151 DIP, C900 PVC, HDPE, Welded Steel
8”	16”	Welded Steel, Fusible C900 PVC or HDPE	0.375	C151 DIP, C900 PVC, HDPE, Welded Steel
10”	20”	Welded Steel	0.375	Welded Steel
12”	24”	Welded Steel	0.375	Welded Steel
15”	30”	Welded Steel	0.500	Welded Steel
16”	30”	Welded Steel	0.500	Welded 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. - Plastic Casing Pipe thickness by design				

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 ½” 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 and non-potable water distribution mains from four-inch (4") to twenty-four inch (24") diameter and includes the acceptable products, materials, and construction practices that may be used in installation.

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. B170, *Standard Specification for Oxygen-Free Electrolytic Copper—Refinery Shapes*, latest revision.

3. B227, *Standard Specification for Hard-Drawn Copper-Clad Steel Wire*, latest revision.

4. B910, *Standard Specification for Annealed Copper-Clad Steel Wire*, latest revision.

5. B1010, *Standard Specification for Copper-Clad Steel Electrical Conductor for Tracer Wire Applications*, latest revision.

6. D1248, *Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable,* latest revision.

7. 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.

1.5 LOCATION AND LOOPING

1. All 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 main locations.

2. The centerline of mains shall not be placed closer than three (3) feet to the lip of street gutter without prior acceptance by the City.

3. A main serving one (1) lot shall extend all the way across the frontage for that lot.

4. Mains shall extend to the extremities of the property or the subdivision served. Extensions shall be in appropriate locations to provide adequate connections.

5. The City shall determine on a case by case basis if system looping is required for a development.

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 VALVES

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

2.3 FIRE HYDRANTS

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

2.4 BLOW-OFFS

Reference City of Greeley Standard Drawings.

2.5 SERVICE LINES, METERS, AND APPURTENANCES

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

2.6 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*.

2.7 TRACER WIRE AND TEST STATIONS

A. General

1. All system components, including tracer wire, connectors, ground rods and access points, must be compatible. The component parts of the Copperhead® Complete Utility Locating System™ have been designed and engineered for compatibility to ensure end-to-end conductivity for the purpose of detecting and protecting underground utility assets.

2. All tracer wire and tracer wire components shall be manufactured in the USA.

3. All tracer wire shall have HDPE (High Density Polyethylene) insulation for direct bury, color coded per APWA standard for the specific utility being marked.

B. Tracer wire and insulation

1. Tracer wire shall conform to the following ASTM standards as applicable:

a. B1010/B1010M – Standard Specification for Copper-Clad Steel Electrical Conductor for Tracer Wire Applications

b. B910/B910M – Standard Specification for Annealed Copper-Clad Steel Wire

c. B227 – Standard Specification for Hard-Drawn Copper-Clad Steel Wire

d. B170 – Standard Specification for Oxygen-Free Electrolytic Copper-Refinery Shapes

e. D1248 – Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable

2. Documentation verifying that tracer wire is 100% made in the USA.

3. If tracer wire manufacturer has not completed a 5-year corrosion test, a 5-year warranty must be provided.

4. Open Trench / Open Cut - Tracer wire shall be Copperhead® copper-clad steel 12-AWG High Strength, high carbon with minimum 450 lb. break load, minimum 30 mil HDPE insulation (1230*-HS-**).

5. Directional Drilling/Boring - Tracer wire shall be Copperhead copper-clad steel 12-AWG Extra High Strength with minimum 1,150 lb. break load, minimum 45 mil HDPE insulation (1245*-EHS-**).

6. Pipe Bursting - Tracer wire shall be Copperhead 7x7 stranded copper-clad steel SoloShot™ Xtreme Strength with 4,700 lb. break load, minimum 50 mil HDPE insulation (PBX-50*-**).

7. Acceptable Manufacturers:

a. Copperhead Industries, Inc.

b. Approved equivalent.

* denotes color

** spool size (500', 1000', 2500')

C. Connectors

1. All mainline tracer wires shall be interconnected at intersections, at mainline tees and mainline crosses. At tees, the three wires shall be joined using a single, three-way SnakeBite™ Locking Connector (LSC1230C). At crosses, the four wires shall be joined using two, three-way Copperhead SnakeBite™ Locking Connectors (LSC1230C) with a short jumper wire between them.

2. Direct bury wire connectors shall include three-way lockable Copperhead SnakeBite™ Locking Connectors (LSC1230C) and Copperhead Mainline-to-Service Connectors (3WB-01) specifically manufactured for use in underground tracer wire installation. Connectors shall be dielectric silicone filled to seal out moisture and corrosion and shall be installed in a manner as to prevent any uninsulated wire exposure.

3. Non-locking, friction fit or taped connectors are prohibited.

D. Grounding

1. Tracer wire must be properly grounded at all dead-ends/stubs.

2. Grounding of tracer wire shall be achieved by using a Copperhead 1.5-lb, drive-in, magnesium Ground Rod (ANO-12) with a minimum 20-feet, #12 red HDPE insulated copper-clad steel wire connected to the rod specifically manufactured for this purpose.

E. Termination/Access

1. All tracer wire termination points must provide a direct connection point to the tracer wire by a utility locate transmitter (above ground or at grade) specifically manufactured for lite duty, concrete/driveway, or roadway applications.

2. All at-grade access points shall be appropriately identified with "water" on the cap and be color coded per American Public Works (APWA) standards.

3. All two-terminal tracer wire access points must include a manually interruptible conductive/connective link between the terminal for the tracer wire connection and the terminal for the ground rod wire connection.

4. All two-terminal tracer wire access points must have external direct connection points to both the tracer wire and ground rod wire from top of lid.

5. All at-grade access points shall include an encapsulated magnet molded into the top portion of the tube, to allow for detection by a ferrous metal detector.

6. All at-grade access points shall be supplied with anti-corrosion wax/gel to protect wires.

7. Service laterals on public property – Tracer wire shall terminate at an approved at-grade access point located at the edge of the road right-of-way, and out of the roadway. Approved at-grade access points shall be a two (2) foot linear cathode-wire loop within the specified grounding interval or a grounded two-terminal externally switchable lid, where there is a direct connection point for a locate transmitter and an external switch to turn "ground" on and off from the top of the lid. Acceptable access points with two-terminal, externally switchable lids include Copperhead's SnakePit® Lite Duty (LD14*2T-SW), Lite Duty Adjustable (LD14*2T-ADJ-SW), Lite Duty XL (LDXL36*2T-SW), or Concrete/Driveway (CD14*2TP-SW).

8. Service laterals on *private* property – Tracer wire shall terminate at an approved Copperhead® single-terminal access point (when grounding isn't required) affixed to or near the building exterior directly above where the utility enters the building, or at a two-terminal access point (when grounding is required) located within two linear feet of the building being served by the utility.

   a. Single-terminal access points may include:

      i. Above-grade, Cobra™ Access Point (T1-*)

      ii. Above-grade, SnakeSkin™ Access Point (SNSK-*-01)

iii. At-grade, SnakePit® Lite Duty (LD14*TP), Lite Duty Adjustable (LD14*TP-ADJ), Lite Duty XL (LDXL36*TP), or Concrete/Driveway (CD14*TP) Access Point

iv. Equivalent single-terminal access point from an approved manufacturer.

b. Two-terminal access points may include:

i. Above-grade, Cobra™ Access Point (T2-*)

ii. At-grade Two-terminal Switchable SnakePit® Lite Duty (LD14*2T-SW), Lite Duty Adjustable (LD14*2T-ADJ-SW), Lite Duty XL (LDXL36*2T-SW), or Concrete/Driveway (CD14*2T-SW) Access Point

iii. Equivalent two-terminal access point from an approved manufacturer.

9. Hydrants – Tracer wire shall terminate at an approved above-grade

a. Copperhead Cobra™ Access Point properly affixed to the hydrant-grade flange (T2-*-FLPKG). Affixing with tape or plastic ties shall not be acceptable. Tracer wire may also terminate at an approved at-grade Copperhead SnakePit® Lite Duty (LD14*2T-SW), Lite Duty Adjustable (LD14*2T-ADJ-SW), Lite Duty XL (LDXL36*2T-SW), or Concrete/Driveway (CD14*2TP-SW) Access Point.

10. Long-runs, more than 1,000 linear feet, without service laterals, hydrants, or any other access points – Tracer wire access must be provided utilizing an approved at-grade Copperhead SnakePit® Access Point or approved equal. All dead-ends shall be grounded utilizing a 1.5-lb., drive-in, magnesium Copperhead Ground Rod (ANO-12).

* denotes color

F. Prohibited Products

1. The following products shall NOT be allowed or acceptable:

a. Non-American-made products

b. Uninsulated tracer wire

c. Stainless steel tracer wire

d. Tracer wire insulations other than HDPE

e. Tracer wire not domestically manufactured

f. Brass or copper ground rods

g. Brass fittings with tracer wire connection lugs

h. Wire connections utilizing taping or spray-on waterproofing

2.8 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 2.8-D: Couplings

Straight Couplings		
Romac	Style XR501	4” through 12”
Romac	Style ALPHA	4” through 16”
Romac	Style 400	16” and larger
Smith-Blair	Style 441	all sizes
Insulating Couplings		
Romac	Style IC501	4” through 12”
Romac	Style IC400	16” and larger
Smith-Blair	Style 416	all sizes
Reducing Couplings		
Dresser	Style 62	all sizes
Romac	Style RC501	4” through 24”
Romac	Style RC400	16” through 60”
Smith-Blair	Style 415	all sizes
Transition Coupling		
Dresser	Style 162	all sizes
Flange Coupling Adapters and Restrained Couplings		
Smith-Blair	Style 913	all sizes
Smith-Blair	Style 923	all sizes

Romac	Restrained Flanged Coupling Adapter (RFCA)	all sizes

Or approved equivalent.

2.9 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, latest revision.

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 and non-potable water distribution 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.

B. Main connections to the existing potable water distribution system shall be made by wet tap or cut in tee. All wet taps and all cut-in tees on mains smaller than 16” diameter shall be made by the Contractor under the direct supervision of the City. It is the Contractor’s responsibility to provide all approved tapping materials (tapping sleeves, tapping valves, insulator kit, etc.). Taps for new 8” and 12” main connections to existing 16” or larger mains shall be performed by the City unless otherwise directed.

C. Connections to the existing transmission mains or distribution mains larger than sixteen-inch (16”) shall be limited and must be approved by City.

D. For wet taps on existing transmission mains or sixteen-inch (16”) and larger distribution mains, manufacturer’s shop drawings and specifications for the proposed tapping sleeve

shall be submitted to the City for review and acceptance prior to installation of the tapping sleeve by the Contractor. Tapping of connections 4" or larger in diameter shall be completed by the City.

E. Taps on existing transmission mains or sixteen-inch (16") and larger distribution mains shall require the installation of an insulator kit between the tapping sleeve and tapping valve.

F. Connection to cast iron mains constructed prior to 1950 may require replacement or non-standard fittings which must be reviewed and approved by City of Greeley Water & Sewer department.

G. Construction documents shall include a note for all wet taps: "Contractor to reference specifications for approved tapping materials and prior to installation shall contact Distribution for direct supervision of installation by the City."

H. 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.

I. 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.

J. 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 depth of cover for potable water and non-potable water mains shall be five (5) feet and four (4) feet respectively, .

13. When 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.

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

15. Tracing wire shall be installed with PVC pipe and ductile iron pipe (DIP) according to the Standard Drawings, latest revision.

16. Install underground marking tape in accordance with City of Greeley Standard Drawings. Tape installation shall be continuous along the pipe

B. Underground Marking Tape and Identification Signs

1. Reference construction specification *Section 02315, Excavation and Fill for Marking Tape Requirements*.

2. Approved signs shall be posted bearing warning of buried pipelines.

a. Potable water lines: "CAUTION – BURIED WATER LINE BELOW"

b. Non-potable water lines: "CAUTION – BURIED NON-POTABLE WATER LINE BELOW" or "CAUTION – BURIED RECLAIMED WATER LINE BELOW".

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

C. 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. Potable and non-potable irrigation main crossings under any open irrigation ditch shall have a minimum five (5) feet of cover and shall be encased.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

3.6 TRACER WIRE & TEST STATION INSTALLATION

A. Non-Potable Water System

1. Refer to Water & Sewer Standard Drawings for installation and grounding requirements specific to Non-Potable.

B. General

1. Tracer wire locating system must meet requirements of Senate Bill 18-167 or any update.

2. Tracer wire installation shall be performed in such a manner that allows proper access for connection of line tracing equipment, proper locating of wire without loss or deterioration of low frequency (512 Hz) signal, and without distortion of signal caused by more than one wire being installed in close proximity to one another.

3. Tracer wire systems must be installed as a single continuous wire, except where using approved connectors. No looping or coiling of wire is allowed.

4. Any damage occurring during installation of the tracer wire must be immediately repaired by removing the damaged wire and installing a new section of wire with approved connectors. Taping and/or spray coating shall not be allowed.

5. Mainline tracer wire shall not be connected to existing conductive pipes. Treat as a mainline dead-end ground using an approved waterproof connector to a Ground Rod driven into virgin soil beneath and in line with the utility.

6. 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.

7. Tracer wire shall be installed and grounded per City of Greeley Standard Drawings, latest revision.

8. All service lateral tracer wire shall be a single wire, connected to the mainline tracer wire using a three-way mainline-to-service connector, installed without cutting/splicing the mainline tracer wire.

9. In occurrences where an existing tracer wire is encountered on an existing utility that is being extended or tied into, the new tracer wire and existing tracer wire shall be connected using approved connectors.

10. Tracer wire on all service laterals/stubs must terminate at an approved tracer wire access point located directly above the utility, at the edge of the road right-of-way, but out of the roadway.

11. One foot of excess/slack wire is required in all tracer wire access points after meeting final elevation.

12. Tracer wire must be properly grounded as specified.

13. At all mainline dead-ends, tracer wire shall go to ground using an approved connection to a 1.5-lb., drive-in, magnesium ground rod.

14. When grounding the tracer wire at dead-ends/stubs, the Ground Rod shall be driven into virgin soil directly beneath and in line with the utility.

15. Ground rod wire shall be connected to the ground rod terminal on the two-terminal SnakePit® Access Point Lid or to the bottom terminal on the two-terminal Cobra™ Access Point.

16. Where the Ground Rod wire will be connected to a tracer wire access point, one foot of excess/slack wire is required after meeting final elevation.

17. Test Station

    a. Tracing wire shall be brought to the surface in a two (2) foot cathode loop at every service curb stop. Place upper half of standard valve box over curb stop and cathode loop per City of Greeley Standard Drawings.

    b. Fire hydrant test station access boxes shall be installed according to manufacturer specifications.

C. Water System

1. A mainline tracer wire must be installed, with all service lateral tracer wires properly connected to the mainline tracer wire, to promote tracing/locating capabilities from a single connection point.

2. Lay mainline tracer wire continuously, by-passing around the outside of valves and fittings on the north or east side.

3. A single tracer wire only shall be installed on all water service laterals and must terminate at an approved tracer wire access point, color coded blue and located directly above the service lateral at the edge of road right-of-way.

4. Tracer wire access points will be installed at all fire hydrants.

5. All conductive and non-conductive service lines shall include tracer wire.

D. Prohibited Installation Methods

1. The following methods shall NOT be allowed or acceptable:

a. Looped wire or continuous wire installations that have more than one wire laid side-by-side or in close proximity to one another

b. Tracer wire wrapped around the corresponding utility

c. Wire terminations within the roadway in valve boxes, cleanouts, manholes, etc.

d. Connecting tracer wire to existing conductive utilities

E. Testing

1. All new tracer wire installations shall be located using typical low frequency (512 Hz) line tracing equipment, witnessed by the contractor, engineer and facility owner as applicable, prior to acceptance of ownership.

2. This verification shall be performed upon completion of rough grading and again prior to final acceptance of the project.

3. Continuity testing in lieu of actual line tracing shall not be accepted.

3.7 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 Pip*e.

3.8 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.

D. Non-potable 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. Reference construction specification *Section 02315, Excavation and Fill for Marking Tape Requirements*.

3.9 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.

3.10 DISSIMILAR METALS AND INSULATOR KITS

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

3.11 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.*

3.12 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. If pre-approved by the City, leakage test and disinfection can be completed at the same time.

B. The Contractor shall disinfect all pipe and fittings which will be installed between the new main and the existing mains, which will not be subjected to the standard 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 41º 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 and disinfection procedures. Under no circumstances shall the main be put in service prior to bacteriological testing.

B. The Contractor shall schedule with the Testing Agency for sample collection and bacteriological testing. The Contractor shall notify City of Greeley a minimum of 48 hours prior to the testing so the City can be onsite to observe.

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 reflushed 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, F*langed 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, S*tandard 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 A2l.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.

B. If corrosion level is Medium-High or High, all DIP shall be zinc coated in accordance with ASTM A153/153M.

C. Pipe joints shall be “push-on single gasket” type conforming to applicable requirements of AWWA C111.

D. DIP shall have normal laying lengths of either eighteen (18) feet or twenty (20) feet. Random pipe lengths are not acceptable.

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 lining 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, slip joint DIP shall conform, at a minimum, to the following pressure classes:

TABLE 2.2-H: Pressure Class and Wall Thickness – Slip Joint DIP

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
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. 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. If corrosion level is Medium-High or High, all DIP shall be zinc coated in accordance with ASTM A153/153M.

C. Pipe joint shall be "mechanical single gasket" type conforming to applicable requirements of AWWA C111.

D. DIP shall have normal laying lengths of either eighteen (18) feet or twenty (20) feet.

E. All mechanical joint glands shall be sized and drilled in accordance with AWWA C111.

F. 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%

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

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

I. As shown in AWWA C151, mechanical joint DIP shall conform, at a minimum, to the following pressure classes:

TABLE 2.3-I: Pressure Class and Wall Thickness – Mechanical Joint Pipe

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
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.		

A. Bolts and nuts for all fitting, mechanical joints, and appurtenances

1. All other applications shall be corrosion resistant, high strength, low-alloy steel (blue bolts) in accordance with ASTM A242 and ANSI/AWWA C111/A21.11 (latest version). Bolts shall meet or exceed ASTM A588, Grade A and nut shall meet or exceed ASTM A563 Grade, C3. Coating shall be Xylan 1424 top coat colored coded blue and zinc plating base coat. Acceptable bolts and nuts are:

2. Romac Industries, Inc

3. Or approved equivalent.

2.4 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

3. Romac Industries, Inc.

2.5 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.

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 2.5-G: Pressure Class and Wall Thickness – Flanged Joint DIP

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
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. Bolts and nuts for all fitting and appurtenances

1. All buried applications shall be corrosion resistant, high strength, low-alloy steel (blue bolts) in accordance with ASTM A242 and ANSI/AWWA C111/A21.11 (latest version). Bolts shall meet or exceed ASTM A588, Grade A and nut shall meet or exceed ASTM A563 Grade, C3. Coating shall be Xylan 1424 top coat colored coded blue and zinc plating base coat. Acceptable bolts and nuts are:

2. In all other applications shall be manufactured to the dimensional specification of ASME B18.2.1 and B18.2.2 and conform to ASTM F593 and F594 Type 316 stainless steel with minimum tensile strength of 75,000 PSI in accordance with ANSI/AWWA C111/A21.11 (latest version).

   a. Romac Industries, Inc

   b. Or approved equivalent.

2.6 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.

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 2.6-G: Pressure Class and Wall Thickness – Restrained Joint DIP

Diameter (inch)	Pressure Class (psi)	Nominal Wall Thickness (inch)
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.

2.7 MECHANICAL JOINT RESTRAINTS

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

2.8 TRACER WIRE AND TEST STATIONS

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

2.9 MECHANICAL COUPLINGS

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

2.10 FITTINGS

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

2.11 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.

2.12 POLYETHYLENE ENCASEMENT

A. All buried ductile-iron pipe and fittings shall be encased in V-Bio 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

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 and non-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 indicting 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 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 PVC pipe of the specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C900 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 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 C900-16.

3. Pipe shall be blue in color for potable water mains and purple for non-potable water mains.

a. Purple 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.

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 73.4ºF (23ºC) 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.

2.3 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 for potable water mains and purple for non-potable water mains.

a. Purple 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..

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 quality for a rating of 4000 psi for water at 73.4ºF (23ºC) 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.

2.4 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 for potable water mains and purple for non-potable water mains.

a. Purple 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.

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 73.4ºF (23ºC) 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 descripted in these specifications.

2.5 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

2.6 TRACER WIRE AND TEST STATIONS

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

2.7 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 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 manufacture shall be used in the fusion process. Fusion machines must incorporate the following elements:

    a. Heat Plate – Heat plates shall be 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 suppliers' 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 suppliers 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 syste3ms 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 3.5-D: Maximum PVC Pipe Joint Deflection (or per manufacturer's limits whichever is more restrictive)

Pipe Diameter (in)	Maximum Joint Deflection (°)
8"	1°
12"	1°
16"	1°
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 meter box.

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.

2. C904, Cross-Linked Polyethylene (PEX) Pressure Tubing, 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.*

3. B88, Standard Specification for Seamless Copper Water Tube, latest revision.

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. 1-inch (1") inclusive through 2-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 1-inch (1") inclusive through 2-inch (2") tapping saddles are:

TABLE 2.1-A: 1" – 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. 4-inch (4”) and larger taps on new construction shall use tees.

C. 4-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 4-inch (4”) and larger tapping saddles are:

TABLE 2.1-C: 4” and Larger Tapping Saddles

Manufacturer	Model
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 2-inch (2”) and smaller.

C. Tap sizes shall match line sizes, i.e., 1-inch (1”) corporation tap with a 1-inch (1”) line.

D. Acceptable manufacturers and models of corporation stops are:

TABLE 2.2-D: Corporation Stops

Manufacturer	Model
Mueller	H-15013
Ford	F1000

No substitutions allowed.

2.3 SERVICE LINES

A. 2-inch (2") and smaller service lines shall be cross-linked polyethylene (PEX) pressure tubing that conforms to AWWA C904 or Type K Copper conforming to AWWA C800. From water main to the curb stop shall be cross-linked PEX (service line shall be one size larger than the tap side or matching ID) or Type K copper. From curb stop to meter-setter shall be Type K copper. From meter-setter to 3 feet (3') past the meter pit, Type K copper shall be installed with a copper setter. No PEX shall be allowed in the meter pit. Ensure service lines are the same types of materials noted or they may require an appropriate insulator to be installed at the junctions of any dissimilar metals.

B. Acceptable manufacturers for service lines include:

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.

3. Copper Water Tube

   a. Type K standard Copper tube produced in accordance with, ASTM B88, NSF 61 approved, and UNS C12200.

   b. Copper tubing shall be made in the United States.

C. 4-inch (4") and larger service lines shall be C900 PVC pipe or ductile iron pipe and conform to construction specification *Section 02513 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE or Section 02512, Ductile-Iron Pipe*. 3-inch (3") service lines shall use a 4-inch (4") tap/tee and reduce to 3-inches (3") immediately after the tap/tee.

D. Fire service lines shall be a minimum of 4-inch (4") diameter and shall be restrained C900 PVC pipe or ductile iron pipe and conform to construction specification *Section 02513 POLYVINYL CHLORIDE (PVC) PRESSURE PIPE or 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 1-inch by ¾-inch (1" x ¾") inclusive to 2-inches (2") shall conform to AWWA C800.

1. All curb stops shall have compression connections at both ends.

2. Curb stops shall be plug type, full opening, Minneapolis pattern.

3. Acceptable manufacturers and models of 1-inch (1") curb stops are:

TABLE 2.5-A.3: 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 2-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 3-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. Curb stop boxes at tracer wire test stations shall be in street valve box and conform to construction specification *Section 02515, Water Utility Distribution Valves*.

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

TABLE 2.6-C: 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.

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

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

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

Or approved equivalent.

E. Curb stop boxes for 3-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, sizes ¾-inch (3/4") through 8-inch (8") shall be Badger E-Series and 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 1-inch (1") meter setters shall have a meter stop inlet valve with a lockwing. 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: 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 2-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-C: 1 ½” and 2” Meter Setters

Meter Size	Setter Manufacturer	Setter Model	Total Lay Length (in)
1 ½” Meter	Ford Meter	VBB76-12B-44-66-NL	13 3/8”
1 ½” Meter	Mueller	H-1423N	13 1/4”
2" Meter	Ford Meter	VBB77-12B-44-77-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 1-inch (1”) meters:

1. Meter pits shall be 20-inches (20”) in diameter and shall be constructed of rigid High-Density Polyethylene (HDPE).

2. Meter pit covers shall be constructed of rigid HDPE with cap type top lid with a 3-inch (3”) deep plastic inner frost lid, or fiberglass lid with a 3-inch (3”) deep plastic inner frost lid. All lids shall be traffic rated.

   a. The minimum allowable opening for meter pit covers shall be 11-inches (11”) diameter.

   b. All meter pit covers shall have a 27/32-inch worm-lock with a Standard Waterworks pentagon head.

   c. Meter pit covers shall be capable of withstanding minus 40 °F to 190 °F and shall be resistant to ultraviolet light degradation.

   d. Meter pit covers shall have a pre-installed, recessed, 2-inch (2”) hole for the meter endpoint radio transmitter (RT Unit). Fiberglass lids do not need a hole.

3. Reference City of Greeley Standard Drawings.

B. 1 ½ -inch (1 ½”) and 2-inch (2”) meters:

1. Meter vaults shall be 48-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 rings may be an aluminum or Fiberglass manhole ring, and cover with a 24-inch (24") diameter opening unless approved otherwise, in writing, by the City Water and Sewer Department. Aluminum lids shall have a 2-inch (2") recessed hole for endpoint. Fiberglass lids do not need a hole. Frost lid not required. All potable meter vault covers shall have the word "WATER" cast in the lid.

4. Reference City of Greeley Standard Drawings.

C. 3-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 aluminum ring and lid, or fiberglass ring and lid. 3-inch (3") through 8-inch (8") meter vault lids shall be 24-inch (24") diameter. 10-inch (10") and larger meter vault lids shall be 36-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. Aluminum lid shall have a 2-inch (2") recessed hole in lid for endpoint. Fiberglass lid does not need hole. Frost lid not required.

5. Include gravel sump

6. Reference City of Greeley Standard Drawings for vault size and layout.

2.10 TRACER WIRE AND TEST STATIONS

A. Reference construction specification *Section 02510, Water Utility Distribution Piping* for tracer wire products, manufacturers, and requirements.

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 feet (5') 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, 4-inches (4”) high, 3-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. Connections to the existing potable water distribution system shall be made by wet tap or cut in tee. All wet taps and all cut-in tees on mains smaller than 16” diameter shall be made by the Contractor under the direct supervision of the City. It is the Contractor’s responsibility to provide all approved tapping materials (tapping sleeves, tapping valves, insulator kit, etc.).

E. Taps for new 8” and 12” main connections to existing 16” or larger mains shall be performed by the City unless otherwise directed.

F. Connections to the existing transmission mains or distribution mains larger than sixteen-inch (16”) shall be limited and must be approved by City.

G. For wet taps on existing transmission mains or sixteen-inch (16”) and larger distribution mains, manufacturer’s shop drawings and specifications for the proposed tapping sleeve shall be submitted to the City for review and acceptance prior to installation of the tapping sleeve by the Contractor.

H. Taps on existing transmission mains or sixteen-inch (16”) and larger distribution mains shall require the installation of an insulator kit between the tapping sleeve and tapping valve.

I. Connection to cast iron mains constructed prior to 1950 may require replacement or non-standard fittings which must be reviewed and approved by City of Greeley Water & Sewer department.

J. Construction documents shall include a note for all wet taps: "Contractor to reference specifications for approved tapping materials and prior to installation shall contact Distribution for direct supervision of installation by the City."

K. Service taps on mains will be made only under the direct supervision of the City. The Contractor shall give seventy-two (72) hours advance notice to the City before any taps are made.

L. 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.

M. Tapping equipment shall be of good quality, used for the purpose intended, and used in accordance with the manufacturer's instructions.

N. Taps shall not be made within two feet (2') of any joint, fitting, or valve.

O. Taps shall be separated by at least two feet (2'), measured along the pipe length, even when taps are made on opposite sides of the pipe.

P. 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 feet (10') of each other, measured along the pipe length shall be staggered by fifteen degrees (15º).

3.4 SERVICE LINES

A. All water service lines, and fire sprinkler lines shall be a minimum five feet (5') and a maximum six feet (6') 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 2-inches (2") and smaller.

b. Service lines shall be uniform in size from the corporation stop to five feet (5') 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 6-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 4-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 2-inch by 4-inch (2" x 4") wooden post, pressure treated and exterior grade, shall be placed at the end of the future service line.

1. All wooden posts shall extend from the end of the service to a point two feet (2') 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 18-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. The Contractor shall adjust the curb stop box to ½-inch (1/2") above final grade prior to final inspections.

C. Curb stop boxes shall not be placed in driveways or sidewalks.

D. Curb stop boxes shall be plumb.

E. Curb stop boxes at tracer wire test stations shall be installed inside a standard valve box and installed in accordance with the City of Greeley Standard Drawings, latest revision.

F. 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 feet (3') in mature height, etc.) or structure (retaining wall, etc.) within ten feet (10') of the meter pit or vault. All shrubs less than three feet (3') in mature height shall be located no closer than five feet (5') 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. To complete maintenance or repairs of the meter pit, meter, or service, the driveway must be a minimum of two feet (2') from the edge of the pit to the concrete.

F. All tees, connections, and couplings shall be a minimum of 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 3-inches (3") or larger shall be flanged pipe only.

G. The meter pit or vault shall be adjusted to ½-inch (1/2") above final grade if the surrounding grade is changed.

H. Reference Greeley Standard Drawings, latest revision, for additional meter pit/vault installation requirements.

3.8 TRACER WIRE AND TEST STATIONS

A. Reference construction specification *Section 02510, Water Utility Distribution Piping,* and City of Greeley Standard Drawings, latest revision of each, for tracer wire and test station installation along water service lines.

3.9 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 hours (48) 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.

G. All exposed valves that are not equipped with motorized or pneumatic actuators shall be equipped with a handwheel.

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. Valves shall be facility tested in compliance with ANSI/AWWA C509.

5. Proof-of-design test certification shall be submitted in compliance with ANSI/AWWA C509.

6. Acceptable manufacturers of resilient seat gate valves are:

a. Mueller

b. Kennedy

c. American AVK Company

d. Clow

2.3 VALVE BOXES

A. Valve boxes for potable water applications 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.

3. Model 6850 series with drop lid

4. The word “WATER” shall be cast into the box lid for potable water and “WATER/TEST” into box lids for potable water valves with test stations.

5. Acceptable manufacturers of valve boxes are:

a. Castings, Inc

b. Tyler

c. Or approved equivalent.

B. Valve boxes for non-potable irrigation water applications shall be cast-iron or ductile iron, triangular top and cover, 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.

3. The word "IRRIGATION" shall be cast into the box lid for non-potable irrigation water and "IRR/TEST" into box lids for non-potable irrigation water valves with test stations.

4. Acceptable manufacturers and models of valve boxes are:

a. Castings, Inc, Model 4TCI with 6850 series bottoms

b. 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 REDUCING VALVES

A. The function of the Pressure Reducing 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, electronic actuated pressure sustaining pilot control 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. PRV shall include an intergraded flow meter and fully functional with City SCADA system to monitor and control the PRV valve.,

6. 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.

7. Allow sufficient room around the PRV for assembly and to make adjustments and for servicing.

8. The standard PRV size to match pipe size unless otherwise approved by the City.

D. Refer to PRV Standard Drawing for acceptable manufacturers of pressure reducing valve manufacturers and various appurtenances.

E. Acceptable manufacturers of pressure reducing valves are:

1. Cla-Val

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.

C. Proof-of-design test certification shall be submitted to owner in compliance with ANSI/AWWA C509.

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. Operating nut shall be accessible between 4 FT and 6 FT below finished grade. Extensions may be required for any operating nut that is deeper than 6 FT.

4. 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 Reducing 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. Fire hydrants shall be of the following, approved manufacturer:

1. Kennedy Valve, Guardian K-81D

2. American AVK, 2780 Nostalgic

3. City approved equal

B. Specifications for fire hydrants 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. No more than one (1) six-inch (6”) or one (1) twelve-inch (12”) hydrant extension section may be used.

B. The extension manufacturer shall be the same as the fire hydrant manufacturer.

1. Kennedy Hydrant, K-8150

2. American AVK Hydrant, 2780 Nostalgic

C. 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.

D. 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 CONNNECTION

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.

2.6 TRACER WIRE AND TEST STATIONS

A. Test Station:

1. Test station section to be four-inch (4”) inside diameter with an eighteen-inch (18”) long flared plastic shaft to prevent removal from an approved manufacturer.

2. Test station lid shall be a lockable two-terminal lid and include a ground switch.

3. Cover shall be lockable, cast iron, with “WATER / TEST” cast in the cover

4. Approved Test Station:

   a. Copperhead Industries Snakepit® Access Point

   b. Approved equal.

B. Grounding Rod: 1.5-lb magnesium anode grounding rod from Copperhead Industries, or approved equal.

C. Tracer Wire and Connectors: Reference construction specification *Section 02510, Water Utility Distribution Piping* for product information and installation.

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,* and Trench Cross Section Standard Drawing.

B. Reference construction specifications *Section 02512, Ductile-Iron Pipe,* and *Section 02513, Potable Polyvinyl Chloride (PVC) Pressure 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.

H. Tracer wire and test station box shall be installed per City of Greeley Standard Drawings, latest revision.

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 that 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 if 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 02517

WATER PRESSURE REDUCING VALVES

PART 1 – GENERAL

1.1 SCOPE

A. This specification covers the design, manufacture, and testing of 1 in. through 16 in. Pressure Reducing Valves (PRV). The Pressure Reducing Valve shall maintain a constant downstream pressure regardless of changing flow rate and/or inlet pressure.

1. Standard products - use the same manufacturer for multiple units of same type.

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 1/2 in. through 48 in., latest revision.

2. C512, Air Release, Air/Vacuum, and Combination Air Valves for Waterworks Service, latest revision.

3. 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

4. Pilot Control and Trim 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. The Pressure Reducing Valve shall automatically throttle to reduce a higher incoming pressure and maintain an accurate and constant lower downstream pressure without causing shock of water hammer on the system regardless of changing flow rate and/or inlet pressure. If downstream pressure increases above the pilot spring setting, the valve shall close.

B. The primary PRV is sized to match pipe size unless otherwise approved by the City.

C. The PRV shall be hydraulically operated with a free-floating guided piston having a seat diameter equal to the size of the valve.

D. All PRV's shall be rated for a minimum working pressure of 150 psi and a hydrostatic test pressure equal to 150% of the actual rated working pressure of the valve.

E. Allowable PRV size combinations of primary and secondary valves are as follows or as determined by City.

High Flow PRV Size	Low Flow PRV Size
8"	2" or 4"
12"	6"
16"	8"

2.2 MATERIALS

A. Material Specification for the Pressure Reducing Control Valves Main Valve as follows:

Component	Material
Body & Cover	Ductile Iron-ASTM A536
Main Valve Trim	Stainless Steel
Seat	Stainless Steel
Stem, Nut and Spring	Stainless Steel
Seal Disc	Buna-N® Rubber
Diaphragm	Nylon Reinforced Buna-N® Rubber
Internal Trim Parts	Stainless Steel
End Detail	Flanged (2" – 16")

Pressure Rating	Class 150 lb. (250psi Max.)
Temperature Range	Water to 180°F
Any other wetted metallic parts	Stainless Steel
Coating	Fusion Bonded Epoxy Coating (Interior and Exterior); ANSI / NSF 61 Approved / AWWA coating specifications C116-03.
Additional Components	Valve Position Indicator, Limit Switch, E-Flowmeter, Pressure Gauges, Restriction Fitting, Isolation Valve, Opening & Closing Flow Controls, Check Valves Isolation Valve (Stainless steel for all components)

2.3 MANUFACTURE

A. Main Valve:

1. The main valve shall be hydraulically operated, single diaphragm actuated, globe pattern. The valve shall consist of three major components; the body with seat installed, the cover with bearing installed and the diaphragm assembly. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from line pressure. Packing glands, stuffing boxes and/or rolling diaphragm technology will not be permitted and there shall be no pistons operating the main valve or pilot controls. No fabrication or welding shall be used in the manufacturing process. Y-pattern valves shall not be permitted. Main valve shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

B. End Connections:

1. End Connections for control valve shall be flanged per ASME/ANSI B16.42, Class 150 (2" thru 16").

C. Main Valve Body:

1. No separate chamber(s) below the diaphragm shall be allowed between the main valve cover and body. No fabrication or welding shall be used in the manufacturing process.

2. The valve shall contain a resilient, synthetic rubber disc with a rectangular cross-section contained on three- and one-half sides by a disc retainer and forming a tight seal against a single removable seat insert. No O-ring type discs (circular, square, or quad type) shall be permitted as the seating surface. The disc guide shall be of the contoured type to permit smooth transition of flow and shall hold the discs firmly in place. The disc retainer shall be of a sturdy one-piece design capable of withstanding opening and closing shocks. It must have straight edge sides and a radius at the top edge to prevent excessive diaphragm wear as the

diaphragm flexes across this surface. No hours-glass shaped disc retainers shall be permitted, and no V-type or slotted-type disc guides shall be used.

3. The diaphragm assembly containing a non-magnetic stainless-steel stem; of sufficient diameter to withstand high hydraulic pressures and shall be fully guided at both ends by a bearing in the main valve cover and an integral bearing in the valve seat. The valve seat shall be a solid, one-piece design and shall have a minimum five-degree taper on the seating surface for a positive, drip-tight shut off. No center guides shall be permitted. The stem shall be drilled and tapped in the cover end to receive and affix such accessories as may be deemed necessary. The diaphragm assembly shall be the only moving part and shall form a sealed chamber in the upper portion of the valve, separating the operating pressure from the line pressure. No bolts or cap screws shall be permitted for use in the construction of the diaphragm assembly.

4. The flexible, non-wicking, FDA approved diaphragm shall consist of nylon fabric bonded with synthetic rubber compatible with the operating fluid. The diaphragm's center hole for the main valve stem must be sealed by the vulcanized process or a rubber grommet sealing the center stem hole from the operating pressure. The diaphragm must withstand a Mullins Burst Test of a minimum of 600 X per layer of nylon fabric and shall be cycled tested 100,000 times to insure longevity. The diaphragm shall not be used as the seating surface. The diaphragm shall be fully supported in the valve body and cover by machined surfaces which support no less than one-half of the total surface area of the diaphragm in either the fully opened or fully closed position. Bellofram type rolling diaphragms shall not be permitted.

5. The main valve seat and stem bearing in the valve cover shall be removable. The cover bearing and seat in the 6" and smaller size valve shall be threaded into the cover and body. The valve seat in the 8" and larger size valves shall be retained by flat head machine screws for ease of maintenance. The lower bearing of the valve stem shall be contained concentrically within the seat and shall be exposed to the flow on all sides to avoid deposits. To ensure proper alignment of the valve stem, the valve body and cover shall be machined with a locating lip. No "pinned" covers to the valve body shall be permitted. Cover bearing, disc guide and seat shall be made of the same material. All necessary repairs and/or modifications other than replacement of the main valve body shall be possible without removing the valve from the pipeline. The valve shall be designed such that both the cover assembly and internal diaphragm assembly can be disassembled and lifted vertically straight up from the top of a narrow opening/vault. Y-pattern valves shall not be permitted. The seat shall be of the solid one-piece design. Two-piece seats or seat inserts shall not be permitted. Packing glands and/or stuffing boxes shall not be permitted.

D. Pilot Control System:

1. The pressure reducing pilot control shall be a direct-acting, adjustable, spring-loaded, normally open, diaphragm valve designed to permit flow when controlled pressure is less than the spring setting. The pilot control is held open by the force of the compression on the spring above the diaphragm and it closes when the delivery pressure acting on the underside of the diaphragm exceeds the spring

setting. The pilot control system shall include a strainer and a fixed orifice closing speed. No variable orifices shall be permitted. The pilot system shall include an opening speed control on all valves sizes 3" and smaller as standard equipment. The pilot control shall have a second downstream sensing port which can be utilized to install a pressure gauge. A full range of spring settings shall be available in ranges of 0 to 150 psi. Pilot to be manufactured by control valve manufacture. Pilot shall comply with NSF/ANSI 61 and certified lead free to NSF/ANSI 372 as a safe drinking water system component.

E. Material Specification for Pilot Control

Component	Material
Body & Cover	Stainless Steel
Pilot Trim	Stainless Steel 303
Rubber	Buna-N®
Connections	FNPT
Pressure Rating	150 psi Max.
Temperature Range	Water to 180°F Max.
Control Tubing	Flexible Braided Stainless Steel
Control Fittings	Stainless Steel

F. Factory Assembly:

1. Each control valve shall be factory assembled.

2. The Quality Management System of the factory shall be certified in accordance with ISO 9001: 2008.

3. For all control valves, the factory assembly shall include the complete main valve, pilot valve(s), and all associated accessories and control equipment.

4. During factory assembly the control valve manufacture shall make all necessary adjustments and correct any defects.

G. Nameplates:

1. Each Control Valve and associated pilot(s) shall be provided with an identifying nameplate.

2. Nameplates, depending on type and size of control valve, shall be mounted in the most practical position possible, typically on the inlet side of the valve body.

3. Nameplates shall be brass and a minimum of 3/32" thick, ¾" high and 2-3/4" long.

4. Pertinent control valve data shall be etched or stamped into the nameplate. Data shall include control valve Catalog number, function, size, material, pressure rating, end-connection details, type of pilot controls used and control adjustment range.

H. Factory Testing:

1. Each control valve shall be factory tested.

2. The Quality Management System of the factory shall be certified in accordance with ISO 9001: 2008

3. Tests shall conform to approved test procedures.

4. Shell Test: Control valves and pilot valves in the partially open position with both ends closed off with blind flanges (valves) and pipe plugs (pilots) shall be subject to an air pressure test. The applied pressure shall be 200 psi minimum. The pressure shall be applied for a minimum of 15 minutes. No visible leakage is permitted through the pressure boundary walls of the valve or pilot body or valve cover or the body-cover joint.

5. Seat Test: Control valves and pilot valves shall be subjected to an air pressure seat test and held for a minimum of 15 minutes.

2.4 PRODUCT DATA

A. The following information shall be provided:

1. Control Valve manufacturer's technical product data.

2. Control Valve manufacturer's Installation, Operation and Maintenance manual (IOM).

3. Control Valve manufacturers certified Shell and Seat test results.

B. Provide specific information on all optional features specified above and confirm that these items are provided.

C. The valve manufacturer shall be able to supply a complete line of equipment from 1" through 16" sizes and a complete selection of complementary accessories and equipment.

2.5 CONSTRUCTION

A. Flanges and covers shall conform to ASTM A126, Class B.

B. All PRVs shall be furnished with flanged ends sized and drilled in accordance with ANSI/ASME B16.1, Class 125 specifications.

1. 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.

C. The PRV shall be purchased from the manufacturer as an assembly and shall include a main valve, electronic actuated pressure sustaining pilot control system which controls operation of the main valve, and other operational components.

1. The pilot valve shall be a single seated, diaphragm operated, spring loaded type.

2. 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.

D. PRV shall include an intergraded flow meter and fully functional with City SCADA system to monitor and control the PRV control valve.

E. Allow sufficient room around the PRV for assembly, and to make adjustments and for servicing.

F. Refer to PRV Standard Drawing for acceptable manufacturers of pressure reducing valve manufacturers and various appurtenances.

G. Acceptable manufacturers of pressure reducing valves are:

1. Cla-Val

2. Or approved equivalent.

2.6 SCADA & Electrical

A. Submittals

1. The Contractor shall deliver four (4) copies of all submittals to the City a minimum two (2) weeks prior to ordering materials.

2. Electrical and SCADA Equipment

a. Materials List: Control system components, and electrical equipment. Quantities of materials need not be included.

b. Manufacturer's Data: Submit manufacturers' catalog cut sheets, startup manuals, and operating instructions for equipment shown on the materials list. Submit complete instructions for installation, operation, and recommended maintenance of the system.

c. Shop Drawings: Submit shop drawings of the proposed PRV system. Show products required for proper installation, their relative locations, and critical dimensions. Submit technical data sheets, electrical/wiring schematics showing all devices, connections and wire numbers, sequence of operation, and UL listing authorization form.

d. Operation and Maintenance (O&M) Manual: Include operating procedures, adjustments, and preventative maintenance procedures. Include a guide for troubleshooting operational problems with the PRV and complete documentation for programming (i.e. recommended settings, adjustments). Deliver the O&M Manual to the City prior to PRV start-up. Provide an unlocked, unencrypted electronic backup copy of all programming and equipment settings for all programmable equipment on a USB drive that can be used to reprogram a replacement component in the event of a memory loss or failure.

e. Electrical Studies: Include complete Arc Flash Study including load flows, short circuit calculations and coordination study of all overcurrent protective devices down to each disconnecting means of each branch circuit. Studies to be completed using SKM per the IEEE 1584-2018. Entire SKM Project File is to be provided to the City of Greeley, including all subfolders, reports, tables, and settings files to allow for future updates of study. SKM Project File to be unlocked and unencrypted delivered via USB flash drive. Study to be based upon actual installed cable length and conduit types in addition to actual equipment and protective devices installed.

f. Provide a USB flash drive to the I&C department with a copy of the electrical and controls drawings. Provide a copy of the PLC program. Provide a bill of material spreadsheet with a list of all electrical and controls parts.

B. Warranty

1. Electrical and SCADA:

2. A two (2) year warranty shall be provided for the system including performance, materials, and installation.

3. The date of substantial completion shall be specifically determined, in writing, for the PRV electrical and SCADA.

C. SCADA

1. Alarming

a. Power failure

b. Intrusion alarm

c. Flood Alarm. Provide flood alarm sensor to detect a flooding in the vault.

d. Upstream vs Downstream pressure difference

e. Low pressure

f. High pressure

g. Flow GPM alarm

2. Historian

a. Flow Rate (GPM)

b. Upstream Pressure

c. Downstream Pressure

d. Pressure Reducing Control, model CRD feedback

e. Pressure Reducing Control, model CRD commanded position

3. Contractor to build and test SCADA screens before starting up the PRV. Provide one workshop to review design of new SCADA screens.

4. Contractor to setup and test SCADA alarming and program SCADA phone to call out.

D. Contractor to verify with COG I&C department that we have a line of sight from existing radio tower to new radio.

E. Controls Narrative

1. Provide SCADA PSI setpoint.

2. Provide new SCADA screen with the following:

a. Alarming, historian, pressures, flow rates, and alarm call out.

F. Electrical

1. PRV should have an arc flash study and labeled per the NEC and NFPA 70E. Labels shall be designed to meet the NFPA 70E.

2. PRV shall meet the NEC standard for electrical equipment workspace clearances.

3. Power Monitor

a. The main power supply in the PRV shall be equipped with a power monitor. It shall detect low voltage and phase loss. A voltage adjustment, status light, and a plug-in base shall be provided.

4. Surge Protection Device

a. The main power supply in the PRV shall be equipped with a UL 1449 surge protected device (SPD). The SPD shall be mounted external to the main cabinet. The SPD shall have a current rating of not less than 10,000 amps, an SCCR rating 200,000 amps, and shall include a green OK status light. The SPD shall be connected to the power distribution block immediately downstream of the main circuit breaker, so it can be isolated for replacement. The SPD shall include an event counter and an audible alarm in the event of SPD failure.

5. Pressure Transducer

a. Standardize with GE UNIK5000UK 0-150 PSI Part # PTX5032-TA-A2-CA-HO-PF. No equivalent allowed.

6. Programmable Logic Controller (PLC)

a. The City shall be provided with an unlocked PLC program.

b. Approved PLC Manufacturers are:

i. Allen Bradley

c. Testing of SCADA and Electrical

i. Notify the City (2) weeks in advance of testing.

ii. Test, verify, and demonstrate to the City the proper operation of all control and safety shut off devices.

iii. Verify flow and pressure sensors are working correctly.

iv. Verify that all alarming and call outs are working correctly.

v. Verify that all electrical equipment is working.

2.7 SCADA RECORD (AS-BUILT) DRAWINGS

A. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded including photos of work as performed.

B. Record conduit and wiring network alterations. Record work which is installed differently than shown on the construction drawings. Record accurate reference dimensions, measured from at least two permanent reference points.

C. Prior to Final Review, obtain from the Engineer a reproducible copy or CAD files of the drawings. Using pen or CAD, duplicate information contained on the project drawings maintained on site. Label each sheet "Record Drawing". Completion of the Record Drawings will be a prerequisite for substantial completion.

D. Provide copy of all Record Drawings for Electrical and Instrumentation Controls wiring diagrams and programming information within a SCH 40 PVC conduit, large enough to hold documents, painted “SAFETY ORANGE” capped on both ends and labeled with 2” tall blocked black letters “RECORDS DRAWING” securely mounted to the wall inside the building, located in easily accessible and visible location adjacent to electrical equipment. Include CAD AND PDF versions of the drawings on a flash drive attached to a lanyard attached to the top cap of the container. Both ends shall have screwed on caps, not plugs, for easy removal and to shed water.

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.

C. Proof-of-design test certification shall be submitted to owner in compliance with ANSI/AWWA C509.

3.2 INSTALLATION

A. PRVs shall be installed as shown on the Construction Drawings, per the manufacturer's recommendations, and in accordance with City of Greeley Standard Drawings.

B. Final location of vault antenna mast and control panel shall be determined by Water & Sewer Department.

3.3 FIELD TESTING

A. A direct factory representative shall be made available by the equipment supplier for start-up service, inspection, and necessary adjustments.

3.4 WARRANTY

A. The Control Valve manufacturer shall warrant the valve to be free of defects in material and workmanship for a period of two-years from date of shipment provided the valve is installed and used in accordance with all applicable instructions. Electrical components shall have a two-year warranty.

3.5 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 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 indicting 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 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.

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 than 2-inches.

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 items 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.

3.4 CONNECTIONS TO EXISTING SYSTEM

A. Main 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 and secured to the manhole to prevent any material or the plug 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 any difference from the design to the City and engineer to verify suitability of 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

1. 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 73.4ºF (23ºC) 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.

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 73.4ºF (23ºC) 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 descripted 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 manufacture shall be used in the fusion process. Fusion machines must incorporate the following elements:

   a. Heat Plate – Heat plates shall be 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 suppliers 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 suppliers 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 syste3ms 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 02534

SANITARY SEWER SERVICE LINES

PART 1 – GENERAL

1.1 SCOPE

A. This section addresses the furnishing and installation of sanitary sewer service lines, clean-outs, and other appurtenances.

B. Reference construction specification *Section 02530, Sanitary Utility Sewerage Piping*.

PART 2 – PRODUCTS

2.1 PIPE

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

B. Piping shall be a minimum of 4” diameter. Pre-approval from the City required for 3” diameter.

2.2 SANITARY SERVICE SADDLE

A. City to supply service saddle for connection to existing sewer mains.

B. Contractor to supply service saddle for connection to new sewer mains.

C. Acceptable manufacturer is:

1. Geneco Sealtite

2.3 FLEXIBLE COUPLINGS

A. Flexible coupling may be used when bell and spigot pipe joints cannot be made.

B. Acceptable flexible coupling manufacturers are:

1. Fernco – Strong Back

2. Or approved equivalent.

2.4 TRACER WIRE AND TEST STATIONS

A. Reference construction specification *Section 02510, Water Utility Distribution Piping* for tracer wire products, manufacturers, and requirements.

PART 3 – EXECUTION

3.1 GENERAL

A. Only those Contractors licensed and bonded with the City of Greeley will be permitted to install sanitary sewer service connections.

B. Sanitary sewer service connections shall be installed at locations designated on the City accepted Construction Drawings.

C. The Contractor shall mark the location of the sanitary sewer service with a stamped "S", 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 the City gives prior approval, only City personnel shall make service taps on existing mains that have final acceptance by the City. Tapping of existing sewer line and manholes to be scheduled with City at least 72 hours prior to construction at (970) 350-9322.

1. For connection to existing manholes, contractors shall install connection and be accepted by City personnel. Any connection to existing manholes shall require the installation of a flow channel per City of Greeley Standard Drawings.

B. The Contractor shall not make any taps without permission from the City.

C. Wyes and bends shall not be permitted for service connections unless previously approved in writing by the City.

D. Taps shall not be made within five (5) feet of a manhole.

E. The spring line of the service connection shall be a minimum one-inch (1") above the spring line of the sanitary sewer collection main and no closer than three (3) feet to the bell or spigot of the pipe.

F. Reference City of Greeley Standard Drawings.

3.4 SERVICE LINES

A. All sanitary sewer services shall be extended at a constant grade from the tap on the collection main to the building.

B. Sanitary sewer service lines shall be uniform in size from the tap to the building.

C. Sanitary sewer service trenches shall be subject to compaction specifications. Reference construction specification, *Section 02315, Excavation and Fill*.

D. The end of all sanitary sewer services will be plugged with an airtight cap or plug.

E. The end of all sanitary sewer services shall be marked with a 2-inch by 4-inch (2” x 4”) exterior grade, pressure treated, lumber wood post.

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 green.

2. Adequate steel that can be located by a ferrous metal detector should be placed at the end of the service. The steel shall be installed 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 sanitary sewer system has been accepted by the City. After the system has been accepted by the City, the Owner or Developer shall be responsible for maintaining the marker posts until the service line is completed to a structure.

F. Tracer Wire

1. Reference construction specification *Section 02510, Water Utility Distribution Piping* for tracer wire product and installation specifications as applicable.

2. Tracer wire shall be installed per Water & Sewer Standard Drawings.

G. Test Station

1. Test stations shall be installed per Water & Sewer Standard Drawings, latest revision.

2. Test stations to be installed by builder at service cleanout near structure.

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, Monolithihc Surfacings, 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 MICROBIAL INDUCED CORRSION PROTECTION FOR NEW MANHOLES

A. POLYMER CONCRETE

1. 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:

i. Armorock LLC

ii. Or approved equivalent.

2. 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.

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

ii. Polymer manholes will be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06

iii. Unit soil weight of 120 pcf located above portions of manhole, including base slab projections

iv. Internal liquid pressure based on unit weight of 63 pcf

v. Dead load of manhole sections fully supported by polymer concrete manhole base

3. Polymer Manhole Design

i. 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:

ii. 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

iii. Reinforcement – Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design

iv. 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

v. 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

vi. 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

vii. Marking and Identification - Each manhole shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location and Production Date

viii. 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

ix. Minimum clearance between wall penetrations and joints shall be per manufacturer's design

x. 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

xi. 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

B. ANTIMICROBIAL CYSTALLINE WATERPROOFING ADMIXTURE

1. Acceptable manufactures:

a. Xypex Bio-San C500

b. Or approved equal

2. System Performance Requirements

a. Testing Requirements: Antimicrobial crystalline waterproofing system shall have been tested in accordance with the following standards and conditions and as per the manufacturer's dosage range, and the testing results shall meet or exceed the performance requirements as specified herein.

b. Independent Laboratory: Testing shall have been performed by an accredited independent laboratory meeting the requirements of ASTM E329 or other applicable international standard for certification of testing laboratories.

c. Indicator: The Admixture shall include an indicator that visually identifies concrete that includes Xypex Bio-San C500.

d. Antimicrobial Effect: Independent testing shall be performed according to ISO 22196 (Mod.) "Measurement of Antibacterial Activity on Plastics and other Non-Porous Surfaces". Treated and non-treated control concrete samples shall be tested, and a definite anti-microbial effect shall be evidenced by a significant reduction in formation of Thiobacillus Novellus / Starkeya Novella bacteria on the treated samples versus the non-treated samples.

e. Concrete Corrosion Rate: Treated and non-treated control concrete samples shall be tested in a live wastewater environment with high concentrations of H2S. Treated samples shall show at least 9 times less mass loss after 10 years as compared to control samples.

f. Long-term Antimicrobial Action and Efficacy: The antimicrobial admixture must show long-term antimicrobial action and efficacy as demonstrated by minimal bacterial concentration on the treated concrete after 10 years exposure to an elevated H2S live wastewater environment.

g. Crystalline Formation: Crystallizing capability of waterproofing system shall be evidenced by independent SEM (Scanning Electron Microscope) photographs showing crystalline formations within the concrete matrix.

h. Permeability 1: Independent testing shall be performed according to a U.S. Army Corps of Engineers CRD-C48 (Mod.) "Permeability of Concrete". Concrete samples shall be pressure tested to 150 psi (350-foot head of water) or 1.05 MPa (106 m head of water). After 5 days the untreated samples shall leak, and the treated samples shall exhibit no measurable leakage.

i. Permeability 2: Independent testing shall be performed according to EN 12390-8. Treated samples shall be exposed to water with a pressure of 0.5 MPa for 72 hours. Treated samples must exhibit a reduction in permeability coefficient of at least 80% when compared to control concrete. Control samples must have a depth of penetration of at least 50 mm.

j. Sulfuric Acid Resistance: Independent testing shall be performed to determine "Sulfuric Acid Resistance of Concrete Specimens". Treated concrete samples dosed at 3% shall be tested against untreated control samples. All samples shall be immersed in 7% sulfuric acid and weighed daily until a control sample reaches a mass loss of 50%. On final weighing the percentage mass loss of the treated samples shall be significantly lower than the control samples.

k. Sulfate Resistance: Independent testing shall be performed to determine "Sulfate Resistance of Concrete Specimens" treated with integral crystalline admixture. Treated and untreated samples shall be immersed in a concentrated sulfate solution for at least 4 months. On final weighing the percentage mass loss of the treated samples shall be significantly lower than the control samples.

l. Compressive Strength: Concrete samples containing the antimicrobial crystalline waterproofing additive shall be tested against an untreated control sample of the same mix. At 28 days, the treated samples shall exhibit equal or increased compressive strength over the control sample.

3. Xypex Bio-San C500 must be added to concrete mix at batch plant.

4. The antimicrobial crystalline powder shall be added to the concrete mix at 1% by weight of the cementitious material content

C. HDPE LINED MANHOLE SYSTEM

1. HDPE Lined Manhole System

a. Provide HDPE Lined Manhole System components which include monolithic base, risers, conical tops or flat lids and grade rings designed and manufactured in accordance with ASTM C478.

b. Monolithic concrete base section shall be lined with prefabricated one-piece homogeneous fiber reinforced polymer (FRP) compound with a minimum thickness of 0.197-in (5mm).

c. The sanitary sewer baseliner shall include:

i. Full flow channels with side walls to the crown of the pipe(s).

ii. A non-skid pattern on inner bench surfaces.

iii. Pipe connections with specified invert elevations and slopes for incoming pipes.

iv. The standard vertical side wall (skirt) height above the bench shall be 2-in minimum.

v. Other skirt heights, as agreed upon between the purchaser and the manufacturer.

d. Riser sections to be lined with HDPE Liner sheets with a minimum thickness of 0.065-in (1.65mm).

e. Manhole flat lids and cones to be lined with FRP.

f. Manhole joints shall be assembled with a bell and spigot with SDV seal gaskets per ASTM C443. Joint sealing surfaces shall be free of dents, gouges, and other surface irregularities. The joints and complete assembly shall pass vacuum test per ASTM C1244.

g. The minimum clear distance between two wall penetrations shall be 6 inches. Minimum clear distance between penetrations and joint seams shall be 3 inches.

2. Basis of Design

a. Concrete sewer manholes shall be manufactured from self-consolidating concrete (SCC) with a minimum compressive strength of 4,000 PSI conforming to material and performance standards of ASTM C-478.

b. Cement for the manholes shall conform to ASTM C-150, Type II-V. All sand and aggregate shall be nonreactive in an acid environment.

c. Manhole system to support AASHTO HL-93 or HS-20 loads.

3. Joints

a. Elastomeric gasket material shall be produced from EPDM 5055 rubber and

b. manufactured by D+S SDV Seal.

c. B. Installed joints shall be capable of holding constant internal pressure of 30 PSI.

4. HDPE Lining

a. The interior of the manhole risers shall be lined with a High-Density Polyethylene (HDPE) concrete protective liner (CPL) with a minimum thickness of 1.65 mm. The CPL shall have a minimum of (94 qty) anchors per square foot extruded as one homogeneous piece.

b. All edges of the HDPE CPL shall be covered with a EPDM liner clip manufactured by D+S Sealants.

c. HDPE CPL shall be capable of resisting groundwater pressure up to 30 PSI.

5. FRP Lining

a. The interior of the manhole base section and flow channels shall be coated prior to casting with a FRP factory spray coating a minimum of 0.197-in (5 mm) thickness.

b. FRP coating shall have spray bonded embeds on the back side of the base liner section.

c. When monolithically cast into the base shell the structure the FRP liner shall be capable of resisting groundwater pressure up to 30 PSI.

d. At the discretion of the manufacturer the FRP coating may be used in all or part of the liner fabrication for the cone.

6. Acceptable manufactures:

a. Geneva Pipe and Precast

b. Or approved equal

2.4 CAST-IN-PLACE MANHOLES

A. All fine and coarse 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*.

2.5 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 a maximum of 8-inch (8").

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.

2.6 GROUT – CONCRETE MANHOLE

A. Grout shall be pre-mixed or job-mixed non-shrink and non-metallic.

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.

2.7 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

2.8 RING AND COVER

A. All rings shall be maximum eight-inch (8") in height and have an internal diameter of twenty-four inches (24").

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. Acceptable rings and covers are:

a. Castings, Inc. – MH-250-24 CI

b. Or approved equivalent.

C. For manholes in traffic areas, covers shall be HS-20 load capable and meet the same criteria listed above. For non-pedestrian traffic areas, covers shall be non-perforated checker pattern with maximum 3/16 inch (3/16") raised pattern. For pedestrian traffic areas, manhole covers shall also have a non-skid pattern, complying with American with Disabilities Act (ADA) requirements.

1. Acceptable ADA covers are:

a. Castings, Inc. – MH-310-24CI

b. Or approved equivalent.

D. Manhole covers located within designated 100-year floodplains and areas subject to water inundation shall meet the criteria listed above for standard iron ring and covers as well as the following:

1. Cover shall be the non-perforated, solid, bolt down,gasket type cover.

i. Gasket shall be 1/8"x3/4" Rubber

ii. Or approved equivalent.

2. Covers shall be bolt down.

3. Ring and covers shall be HS-20 load capable gray iron conforming to ASTM A48 Class 30, with black coat finish.

4. The word "SEWER" shall be cast in the cover.

5. Acceptable manufacturers are:

a. Castings, Inc.

b. Or approved equivalent.

2.9 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.

2.10 STEPS

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

2.11 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 40ºF and 110ºF.

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.

2.12 MODULAR SEALING UNITS

A. Link-Seal®

B. Or approved equivalent.

2.13 DROP MANHOLE BOWL

A. Reliner®

B. Or approved equivalent.

2.14 INTERIOR MANHOLE COATING

A. See construction specifications *Section 02957 A, Sewer Manhole Rehabilitation* and *Section 02957 B, Sewer Manhole Coating* for additional information.

2.15 MANHOLE PIPE PENETRATION SEALS

A. For pipe penetrations in a cast-in-place manhole base, an approved expanding hydrophilic waterstop/swellstop seal on pipe barrel shall be used. Approved swellstop manufacturers are:

1. Sika – Strip Applied Waterstops (Swellstop)

2. Aquafin – Waterstop-strip

3. Or approved equivalent.

B. For pipe penetrations in a pre-cast manhole base, an approved rubber boot connector seal on pipe barrel shall be used. Approved rubber boot connector manufacturers are:

1. A-LOK – Boot Connectors

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 performed 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 02666

NON-POTABLE POND LINERS

PART 1 – GENERAL

1.1 SCOPE

A. This specification covers pond liners using High Density Polyethylene (HDPE), Linear Low Density Polyethylene (LLDPE), Ethylene Propylene Diene Monomer (EPDM), and Polypropylene (FPP) flexible polypropylene liner, Nonwoven Geotextile, seams, gaskets, metal battens, bolts, embed channels, clamps, and sealant. – f

1.2 REFERENCES

A. ASTM International (ASTM)

1. C33/C33M, *Standard Specification for Concrete Aggregates*, latest revision.

2. D5199, *Standard Test Method for Measuring the Nominal Thickness of Geosynthetics*, latest revision.

B. American Water Works Association (AWWA)

1. C652, *Disinfection of Water-Storage Facilities*, latest revision.

1.3 ABBREVIATIONS

A. HDPE – High Density Polyethylene Geomembrane

B. LLDPE – Linear Low Density Polyethylene Geomembrane

C. LLDPE-R – Reinforced Linear Low-Density Polyethylene Geomembrane,

D. EPDM – Ethylene Propylene Diene Terpolymer Geomembrane

E. FPP – Flexible Polypropylene Geomembrane

F. FPP-R – Reinforced Flexible Polypropylene Geomembrane

1.4 SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, and accessories for geomembrane liners.

B. Shop Drawings: Include panel layout, seams, penetrations, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples: For each exposed product and for each color specified. Include one 12-inch (300-mm) seam length for factory-bonded sheets and one 12-inch (300-mm) seam length for field-bonded sheets.

D. Qualification Data: For Installer.

E. Product Certificates: For each type of geomembrane liner.

F. Product Test Reports: For each geomembrane sheet, for tests performed by a qualified testing agency.

G. Source quality-control reports.

H. Field quality-control reports.

I. Sample Warranty: For manufacturer's special warranty.

J. Maintenance Data: For geomembrane liner to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

B. All flexible membrane installations shall be certified by the installer or manufacturer as meeting the material and installation requirements of the plans and specifications.

1.6 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace geomembrane liner that fail(s) in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Leaks in geomembrane liner.

b. Defects in seams.

c. Cracks and holes in floating cover.

2. Warranty Period: twenty-five (25) years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain geomembrane liner, accessories, and required seaming materials, solvents, and adhesives from single source.

2.2 PERFORMANCE REQUIREMENTS

A. Provide geomembrane liners that prevent the passage of water.

B. Anchor liners to pre-vent uplift due to wind or slippage down the side slope.

C. Subsurface conditions such as soil type and groundwater levels will dictate the direction and scope of the design of the drainage and venting system beneath the geomembrane liner. An inadequate drainage and venting system may result in floating of the geomembrane liner. Hydrostatic pressures from fluctuating groundwater levels or leakage through the liner may cause the liner to float. Gas production and buildup beneath the liner due to the presence of organic material in the soil or leachate leakage through the liner may cause “whales” or bubbling of the liner.

D. If the groundwater level may be near the invert elevation of the pond, groundwater monitoring should be conducted during the site investigation to verify the expected water table location. In some situations, it may be necessary to install groundwater monitoring wells for a year or more to determine the ground water levels and gather enough information to properly determine the required flow capacity of the drainage system. If high water tables could adversely affect the proper functioning of the structure, interceptor or relief-type drainage systems shallbe included to control uplift pressures. Leakage through the liner due to liner damage should also be considered.

2.3 LINER MATERIALS

A. Flexible membrane liner materials shall have a nominal thickness as specified in the following table:

Minimum Geomembrane Thickness Criteria	
Type	**Minimum Thickness**
HDPE	40
LLDPE	40
LLDPE-R	36
EPDM	45
FPP	40
FPP-R	36

B. Liner Properties

1. The liner shall be uniform in color, thickness, and surface texture. The liner shall be resistant to fungal or bacterial attack and free of cuts, abrasions, holes, blisters, contaminants, and other imperfections.

2. HDPE and LLDPE—The HDPE or LLDPE liner shall be manufactured from virgin polymer material and shall meet the property values specified in Tables 521A–1 through 521A–4 as applicable.

3. EPDM—The EPDM liner shall be formulated from virgin compounding materials and shall meet the property values specified in Tables 521A–5 and 521A–6 as applicable. Regrind, reworked, or trim materials shall be from the same manufacturer and the same formulation as the liner. Recycled materials shall not be allowed.

4. FPP—The FPP liner shall be manufactured from virgin polymer material and shall meet the property values specified in Tables 521A–7 and 521A–8 as applicable. A reinforced FPP liner shall consist of one ply of reinforcing polyester (scrim) between two sheets of FPP. The polyester scrim shall be of an open weave that permits strike-through of the FPP.

TABLE 2.3-B.1 Requirements for smooth HDPE Liner

Property	Test Methods	Requirements[1]		
		Nominal Thickness (mils)		
		30	40	60
Density, g/cc	ASTM D 1505	0.940	0.940	0.940
Tensile Properties	ASTM D 6693			
Yield Stress, lb/in	(type IV at 2 in/min)	63	84	126
Break Stress, lb/in		114	152	228
Yield Elongation, %		12	12	12
Break Elongation, %		700	700	700
Tear Resistance, lb	ASTM D 1004	21	28	42
Puncture Resistance, lb	ASTM D 4833	54	72	108
Carbon Black Content, %	ASTM D 1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM 6392			
Shear Strength, lb/in		60	80	120
Peel Strength[2], lb/in		39/FTB	52/FTB	78/FTB

1. All values, unless specified otherwise, are minimum average roll values as reported for the test method.
2. Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

TABLE 2.3-B.2: Requirements for Textured HDPE Liner

Property	Test Methods	Requirements[1]		
		Nominal Thickness (mils)		
		30	40	60
Density, g/cc	ASTM D 1505	0.940	0.940	0.940
Tensile Properties	ASTM D 6693			
Yield Stress, lb/in	(type IV at 2 in/min)	63	84	126
Break Stress, lb/in		45	60	90
Yield Elongation, %		12	12	12
Break Elongation, %		100	100	100
Tear Resistance, lb	ASTM D 1004	21	28	42
Puncture Resistance, lb	ASTM D 4833	45	60	90
Carbon Black Content, %	ASTM D 1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D 6392			
Shear Strength, lb/in		60	80	120
Peel Strength[2], lb/in		39/FTB	52/FTB	78/FTB

1. All values, unless specified otherwise, are minimum average roll values as reported for the specified test method.
2. Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

TABLE 2.3-B.3: Requirements for Smooth LLDPE Liner

Property	Test Methods	Requirements[1]		
		Nominal Thickness (mils)		
		30	40	60
Density, g/cc	ASTM D 1505	0.915	0.915	0.915
Tensile Properties	ASTM D 6693			
Break Stress, lb/in	(type IV at 2 in/min)	114	150	228
Break Elongation, %		800	800	90
Tear Resistance, lb	ASTM D 1004	16	22	33
Puncture Resistance, lb	ASTM D 4833	42	56	84
Carbon Black Content, %	ASTM D 1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D 6392			
Shear Strength, lb/in		44	58	90
Peel Strength[2], lb/in		37/FTB	50/FTB	75/FTB

1. All values, unless specified otherwise, are minimum average roll values as reported for test method.
2. Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

TABLE 2.3-B.4: Requirements for Textured LLDPE Liner

Property	Test Methods	Requirements[1]		
		Nominal Thickness (mils)		
		30	40	60
Density, g/cc	ASTM D 1505	0.915	0.915	0.915
Tensile Properties	ASTM D 6693			
Break Stress, lb/in	(type IV at 2 in/min)	60	80	120
Break Elongation, %		350	350	350
Tear Resistance, lb	ASTM D 1004	17	22	33
Puncture Resistance, lb	ASTM D 4833	33	44	66
Carbon Black Content, %	ASTM D 1603	2-3	2-3	2-3
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2	Cat 1-2
Seam Properties	ASTM D 4437			
Shear Strength, lb/in	(1 in wide at 2 in/min)	40	53	79
Peel Strength[2], lb/in		33/FTB	44/FTB	66/FTB

1. All values, unless specified otherwise, are minimum average roll values as reported for test method.
2. Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

TABLE 2.3-B.5: Requirements for Non-Reinforced EPDM Liner

Property	Test Methods	Requirements[1]	
		Nominal Thickness (mils)	
		45	60
Specific Gravity	ASTM D 792	1.1	1.1
Tensile Properties	ASTM D 882		
Break Stress, lb/in	(type IV at 20 in/min)	50	50
Break Elongation, %		400	400
Tear Resistance, lb	ASTM D 1004	9	11
Puncture Resistance, lb	ASTM D 4833	35	60
Low Temperature Brittleness, °F	ASTM D 1790	< -45	< -45
Seam Properties	ASTM D 413/4437		
Shear Strength[2], lb/in	(NSF modified 20 in/min strain rate)	35	35
Peel Strength[3], lb/in		14	14

1. All values, unless specified otherwise, are minimum average roll values as reported for the test method.
2. At 200 percent strain.
3. Cohesive bond mode.

TABLE 2.3-B.6: Requirements for Reinforced EPDM Liner

Property	Test Methods	Requirements[1]
		Nominal Thickness (mils)
		45
Specific Gravity	ASTM D 792	1.1
Tensile Properties	ASTM D 751 Method A	125
Tear Resistance, lb	ASTM D 5884 Method B	130
Puncture Resistance, lb	FTMS 101C Method 2031	45
Ply Adhesion, lb/in	ASTM D 413 Machine Method	7
Low Temperature Brittleness, °F	ASTM D 1790	< -45
Seam Properties		
Shear Strength[2], lb/in	ASTM D 751	35
Peel Strength[3], lb/in	ASTM D 413	14

1. All values, unless specified otherwise, are minimum average roll values as reported for the test method.
2. At 200 percent strain.
3. Cohesive bond mode.

TABLE 2.3-B.7: Requirements for Unreinforced FPP Liner

Property	Test Methods	Requirements[1]		
		Nominal Thickness (mils)		
		30	40	60
Specific Gravity	ASTM D 792	0.90	0.90	0.90
Tensile Properties	ASTM D 638			
Break Stress, lb/in	(type IV at 20 in/min)	60	72	130
Break Elongation, %		600	600	600
Tear Resistance, lb	ASTM D 1004	9	11	16
Puncture Resistance, lb	ASTM D 4833	28	35	65
Carbon Black Content, %	ASTM D 1603	2-4	2-4	2-4
Carbon Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2	Cat 1-2
Low Temperature Brittleness, °C	ASTM D 1790	< -40	< -40	< -40
Seam Properties	ASTM D 6392, D 6214, D 4437[3]			
Shear Strength, lb/in		35	45	55
Peel Strength[2], lb/in		20/FTB	30/FTB	40/FTB

1. All values, unless specified otherwise, are minimum average roll values as reported for test method.
2. ASTM D 6392 shall b used for thermally welded seams, D 6214 for chemically welded seams, and D 4437 for all other types.
3. Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

TABLE 2.3-B.8: Requirements for Reinforced FPP Liner

Property	Test Methods	Requirements[1]	
		Nominal Thickness (mils)	
		36	45
Specific Gravity	ASTM D 792	0.90	0.90
Tensile Properties	ASTM D 751 Method A	225	225
Tear Resistance, lb	ASTM D 5884 Method B	55	75
Puncture Resistance, lb	FTMS 101C Method 2031	200	250
Ply Adhesion, lb/in	ASTM D 413 Machine Method	20	20
Carbon Black Content, %	ASTM D 1603	2-4	2-4
Carbone Black Dispersion	ASTM D 5596	Cat 1-2	Cat 1-2
Low Temperature Brittleness, °F	ASTM D 2136	< -40	< -40
Seam Properties			
Shear Strength, lb/in	ASTM D 751	160	200
Peel Strength[2], lb/in	ASTM D 413	20/FTB	20/FTB

1. All values, unless specified otherwise, are minimum average roll values as reported for the test method.
2. Film tear bond: A failure of one of the bonded sheets by tearing prior to complete separation in the bonded area.

TABLE 2.3-B.9: Requirements for Non-Woven Geotextiles

Property	Test Methods	Material[1]
Mass per Unit Area, oz/sy[2]	ASTM D 5261	10
Grab Tensile Strength, lb	ASTM D 4632	230
Grab Tensile Elongation, %	ASTM D 4632	>50
Trapezoidal Tear Strength, lb	ASTM D 4533	95
Puncture (pin) Strength, lb	ASTM D 4833	120
Puncture (pyramid) Strength, lb[4]	ASTM D 5494	300
Puncture (CBR) Strength, lb[4]	ASTM D 6241	700
Puncture (CBR) Elongation, in[4]	ASTM D 6241	1.5
UV Resistance 500 hr Exposure[2]	ASTM D 7238	70
Apparent Opening Size (AOS)	ASTM D 4751	As specified[3], max #100
Permittivity, 1/seconds	ASTM D 4491	0.70 min.

1. All values are minimum average roll value except UV resistance which is a minimum value.
2. Evaluation to be on 2.0 inch strip tensile specimens after 200 lt. hours exposure.
3. U.S. Standard sieve analysis.
4. Alternative puncture test methods to be considered in place of Pin Puncture, ASTM D 4833.

2.4 MISCELLANEOUS MATERIALS

A. Gaskets: Gasket material shall be neoprene, closed-cell medium, 0.25 inch thick, with adhesive on one side, or other gasket material as approved by the liner manufacturer.

B. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

C. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

D. Battens Strips:

1. Long-length strips of material indicated, size as indicated on Drawings. Fabricate battens with sharp projections removed and edges eased and then predrilled or punched for anchors. Provide stainless steel anchors and bolts, or other type of attachment, of type and spacing recommended in writing by geomembrane liner manufacturer for attaching geomembrane liner system to substrate and as indicated.

2. Batten strips are normally used to secure geomembrane liner materials to concrete substrates. Verify compatibility of manufacturer's recommended sealant, usually silicone or butyl rubber, with containment conditions and materials.

3. Batten Material: Stainless Steel

4. Minimum Dimensions: 0.25-inch-thick by 2-inch-wide.

E. Sand: ASTM C33/C33M; fine aggregate, natural or manufactured sand.

F. Cover Soil: Cover soil may be used on other liners but is not required unless essential for the proper performance, protection and durability of the installation. Cover soils shall not contain sharp, angular stones or any objects that could damage the liner. Maximum allowable particle size of soil cover material shall be 3/8-in for geomembrane liners unless the liner is protected by a 10-oz/sq yd or heavier non-woven geotextile cushion material. Cover materials shall be stable against slippage down the slope under all operational and exposure conditions, such as rapid drawdown or saturation by precipitation or snowmelt.

2.5 FABRICATION

A. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for soil compaction and grading; for subgrade free from angular rocks, rubble, roots, vegetation, debris, voids, protrusions, and ground water; and for other conditions affecting performance of geomembrane liner.

B. Examine anchor trench excavation or concrete perimeter, where geomembrane liner will be secured, for substrate conditions indicated above and for correct location and configuration.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Subgrade preparation shall conform to manufacturer recommendation and applicable state regulations. Subgrade materials shall not contain sharp, angular stones or any objects that could damage the liner or adversely affect its function unless a cushion layer is used.

B. Cushion. A cushion layer shall be placed be-neath the liner if the subgrade particles contain sharp angular stones that could damage the liner or particles greater than 3/8-inch for geo-membrane liners. The cushion may be a 10-oz/sq yd or heavier non-woven geotextile or a layer at least 6 inches thick of soil meeting the particle size and shape requirements of the subgrade. Geotextile cushion material shall meet the requirements of GRI Test Method GT12(a). Follow the manufacturer’s recommendations for any additional protective measures.

C. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.

D. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.

E. Remove curing compounds and coatings from concrete surfaces to be sealed to geomembrane liner.

3.3 INSTALLATION

A. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge

over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

B. Field Seams: Comply with geomembrane liner manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches (50 to 102 mm), unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

1. Adhesive Bonding: Apply bonding cement to both contact surfaces in seam area and press together immediately, or use other seaming methods as instructed by geomembrane liner manufacturer. Roll to press surfaces together, to distribute adhesive to leading edges of panels, and to remove wrinkles and fishmouths. Remove excess adhesive.

C. Installation in Anchor Trench: Install geomembrane liner in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.

D. Attachment to Concrete: Use manufacturer's standard system to suit Project conditions. Support adhesive and geomembrane on minimum 8-inch- (200-mm-) wide concrete substrate unless otherwise indicated.

1. Install batten strips over geomembrane liner as indicated on Drawings.

E. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

F. Cover soil shall be placed within 24 hours after placement of the liner to minimize the potential for damage from various sources, including precipitation, wind, and ultra-violet exposure.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Contractor to engage a qualified testing agency to perform tests and inspections.

B. Nondestructive Testing: Follow the testing requirements as indicated by the manufacturer to maintain warranty coverage. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.

C. Destructive Testing: Follow the testing requirements as indicated by the manufacturer to maintain warranty coverage. Record locations of sample locations and failed seams.

Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches, and test sample locations.

D. Prepare test and inspection reports.

3.5 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

SECTION 02957 A

SANITARY SEWER MANHOLE REHABILITATION

PART 1 – GENERAL

1.1 SCOPE

A. This Section covers work necessary for construction of miscellaneous existing manhole rehabilitation work associated with, and in preparation for, construction specification *Section 02957 B, Sanitary 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 pump shall be used to maintain flow while working on existing sanitary structures. See *Section 02960, Temporary Sanitary Sewer Bypass Pumping.*

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. Care shall be taken to avoid flushing anything removed from entering the sewer system.

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 manufacturer recommendations or 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 manufacturer recommendations or 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 bypass pumping plan shall be obtained from the City, see *Section 02960, Temporary Sanitary Sewer Bypass Pumping.*

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

SANITARY SEWER MANHOLE COATING

PART 1 – GENERAL

1.1 SCOPE

A. Manhole coating with cementitious liner including preparation, build back and corrosion protection. Manhole coating shall follow any miscellaneous existing manhole rehabilitation work associated with *Section 02957 A, Sanitary Sewer Manhole Rehabilitation*.

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 Surfacings 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 pumping 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 a 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./ft3 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 Manufacture.

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.

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 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. 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.

8. All quantities of mix ingredients in batch.

9. Amounts of admixtures added to mix.

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 non-potentially 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.

a. Document all water added on site during or prior to placement.

4. Indicate all components included in the concrete mix and any admixtures.

L. Curing

1. Manufacturers' data for the following products:

    a. Evaporation retardant.

    b. Curing and sealing compound.

    c. 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 placemen, 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-pm (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 SO4

c. 600 ppm alkalis as (Na,O + 0.658 KSO).

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.

2. Total air content: 5% to 8%

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 ($CaCl_2$).

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. Antimicrobial Crystalline Waterproofing Admixture

1. Xypex Bio-San C500

2. Xypex Bio-San C500 must be added to concrete mix at batch plant.

3. The antimicrobial crystalline powder shall be added to the concrete mix at 1% by weight of the cementitious material content

H. 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.

a. Form ties shall be submitted for approval by the city prior to use.

2. For water holding structures, form tie shall have integrated water stops.

3. 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).

1. Exception: Concrete utilized for thrust blocks shall develop a minimum field compressive strength of 2500 psi after 28 days. Contractor may utilize standard concrete plant mix design for exterior use and air entrainment.

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.

2.8 CURING AND SEALING 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^2/72 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 90º F.

3.3 PROTECTION

A. Cold Weather Concrete

1. Concrete shall not be placed unless the air temperature adjacent to the concrete placement is 30º 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 40º F or when temperatures are predicted to be below 40º F within three (3) days of concrete placement, comply with ACI 306.1.

3. Water shall not be heated to a temperature greater than 150º 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 90º F unless otherwise accepted by the City.

2. When daily high temperature is 90º 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 50º F and 90º 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 placing 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. Batch ticket shall indicate amount of mixing water withheld, and maximum amount that may be permitted to be added at Project site. Any water added must be document and amount provided to City. Any additional water above noted maximum amount shall be rejected and removed from the Project site.

C. Convey concrete to the point of final deposit by methods which will prevent the separation or loss of concrete components.

D. Height of concrete freefall shall be limited to four (4) feet.

E. 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.

F. Notify City at least 1 full working day in advance before starting to place concrete.

G. 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.

H. 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 50º 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/C3 IM and ASTM C39/C39M) and shrinkage specimens (ASTM C157/C l57M) 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/ Cl57M, 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 an 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 or polyurethane material that is specific to the type of repairs and meets manufacturer requirements. Patch areas of damp spots previously recorded and repeat water leakage test in its entirety until the structure successfully passes the test.

    a. Contractor has one attempt at fixing the leaking of the structure. Any subsequent repairs shall be performed by a City approved structural leak repair expert.

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. Admixtures

1. Product data on all admixtures that are proposed to meet design requirements.

C. 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. Design calculations to prevent floatation when groundwater is present.

D. 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.

E. Certificate of Compliance

1. Certify admixtures and concrete do not contain calcium chloride.

F. Test Reports

1. For precast manufacturer's concrete test cylinders.

2. Inspection of installed panels.

G. 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:

a. Master Builders Co.

b. Euclid Chemical Co.

E. Antimicrobial Crystalline Admixture

1. Xypex Bio-San C500

2. Xypex Bio-San C500 must be added to concrete mix at batch plant.

3. The antimicrobial crystalline powder shall be added to the concrete mix at least 1% by weight of the cementitious material content.

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 C3l.

B. Test and record concrete strengths.

PART 3 – EXECUTION

3.1 SEALER APPLICATION

A. Coverage is entirely dependent on the porosity of the substrate. Extremely non-porous substrates may only require 1 coat. To ensure proper penetration depth, a field mock up is recommended.

B. The penetrating sealer shall be applied liberally and allowed to soak into the substrate. This shall be accomplished by the use of brushes, rollers, low pressure gun or airless spray equipment.

C. Prepare the quantity of hydrophobic impregnation required for a given area based on the targeted consumption rate.

D. On vertical surface, apply the product from top down in successive passes until the targeted consumption for the first coat is achieved.

E. Successive passes are done when the concrete surface still has a matt appearance from the product, but no longer wet (e.g. when placing the bare hand on the surface and removing it, no wetness on the hand is observed). The concrete surface is assumed to be saturated with the Silane application when it remains “wet” in appearance for at least 5 seconds.

F. The following coat can then be applied when the concrete is completely dry.

G. On horizontal surface, saturate the substrate by continuous spray (airless or low-pressure gun) or flooding technique and allow to have “wet” look for at least 5 seconds

3.2 ANTIMICROBIAL CRYSTALLINE ADMIXTURE

A. Manufacturer to be ISO 9001 registered, and to have no less than 10 years experience in manufacturing crystalline waterproofing additives. Manufacturer must be capable of providing field service representation during construction phase. Manufacturers who cannot provide ongoing field support or who cannot provide the performance test data specified herein will not be considered for the project.

B. Ready-mix supplier and/or installer of antimicrobial crystalline waterproofing additive shall be approved by the manufacturer or manufacturer's representative in writing.

C. Prior to installation of antimicrobial waterproofing system, conduct meeting with Architect/Engineer, owner's representative, concrete supplier, concrete placer and

antimicrobial waterproofing manufacturer's representative to verify and review the following:

1. Project requirements for antimicrobial protection and waterproofing as set out in Contract Documents.

2. Manufacturer's product data including mixing and installation instructions.

D. The manufacturer's representative shall provide technical consultation on antimicrobial protection and waterproofing applications and shall provide on-site support as needed.

3.3 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.

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.

3.4 INSTALLATION

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

3.5 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.

3.6 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.

3.7 FIELD QUALITY CONTROL

A. Inspection:

1. Inspect panels with City for cracks or damage. Record location and condition of damaged panels.

2. Any structure that requires liquid tightness shall be leak tested prior to acceptance. Refer to Liquid Tightness Test in *Section 03300, Cast-In-Place Concrete.*

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 11230

NON-POTABLE POND AERATION SYSTEM

PART 1 – GENERAL

1.1 SCOPE

A. It is the intent of this specification to describe the construction of an automatic pond aeration system for a raw water irrigation ponds. All components of the aeration system including compressors, electrical controls, valves, prefabricated pipe manifolds, flow meters, gauges, pond aeration tubing and modules, and all other items necessary for the proper assembly and operation of the system must be provided by a single supplier as a "knocked down" aeration system. The intent is to provide sole source responsibility for the materials, installation, and warranty of the system.

B. Furnish all labor, materials, supplies, equipment, tools, and transportation, and perform all operations in connection with and reasonably incidental to the complete installation of the aeration system, and guarantee/warranty as shown on the drawings, the installation details, and as specified herein. Items of work specifically included are:

1. Procurement of all applicable licenses, permits, and fees as required by local codes and utilities.

2. Connection of electrical power supply to the aeration system.

3. Installation of compressors, electrical controls, piping, valves, aeration feeder / distribution tubing, aeration modules, and appurtenances necessary for the complete operation of the aeration system.

4. Coordinating installation of aeration mechanical system with the installation of the pump system concrete mounting pad, conduit penetrations, building walls, doors, vents, and other equipment in the building.

5. Testing and start-up, and adjustment of aeration system.

6. Start-up, testing, adjustment of aeration system, training, and demonstration of performance to the City’s Representative.

7. Maintenance period.

1.2 DISCREPANCIES:

A. It is the intent of these plans and specifications that the aeration system be complete and workable. It is the Contractor's responsibility to make sure that the equipment furnished is compatible and adheres to all regulations. Any discrepancies should be noted immediately and should be reported to the City’s Representative for clarification.

1.3 SUBMITTALS:

A. Deliver all submittals under provisions of Section 01300.

B. Materials List: Include pipe, valves, flow meters, fittings, compressors, control system components, and electrical equipment. Quantities of materials need not be included.

C. Manufacturers' Data: Submit manufacturers' catalog cuts, specifications, and operating and maintenance instructions for all equipment supplied.

D. Maintenance Manual: Submit in all manufacturer's data listed above and recommended operating procedures, adjustments, system trouble shooting, and preventive maintenance procedures.

E. Shop Drawings: Submit shop drawings of compressor system, electrical controls, and flow meter control unit installation. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to the installation drawings.

1.4 RULES AND REGULATIONS:

A. Work and materials shall be in accordance with the latest edition of the National Electric Code and applicable laws and regulations of the governing authorities. When a discrepancy exists between the national and local codes, the local codes shall prevail.

B. When the contract documents call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, provide the quality and size required by the contract documents.

C. All electrical control panels with controls shall be built in accordance to N.E.C.,

D. U.L. and E.T.L. standards. The electrical components and enclosure shall be labeled as a complete U.L. listed assembly with manufacturer’s U.L. label applied to the door. All equipment and wiring shall be mounted within the enclosure and labeled for proper identification.

1.5 SYSTEM PERFORMANCE

A. Refer to Section 5 Non-Potable Irrigation System Design Criteria.

1.6 TESTING:

A. Notify the City's Representative three days (72 hours) in advance of testing.

B. On completion of assembly, the aeration system piping shall be hydrostatically tested at a pressure not less than 50 PSI.

C. Control and safety shut off devices shall be tested and verified operational.

D. Flow and discharge pressure shall be verified with specified values.

E. All costs, including travel expenses and site visits by the City’s Representative, for any re-testing that may be required due to non-compliance with the Construction Documents shall be the sole responsibility of the Contractor.

1.7 REVIEWS:

A. The purpose of on-site reviews by the City's Representative is to observe the Contractor's interpretation of the construction documents and to address questions with regards to the installation.

1. Scheduled reviews such as those for testing should be scheduled with the City's Representative as required by these specifications.

2. Impromptu reviews may occur at any time during the project.

3. Final review will occur at the completion of the aeration system installation and As-Built Drawings.

1.8 GUARANTEE/WARRANTY AND REPLACEMENT:

A. The purpose of this guarantee/warranty is to insure that the City receives aeration system materials of prime quality, installed and maintained in a thorough and careful manner.

1. The manufacturer shall warrant the aeration system to be free of defects and product malfunctions for a period of two years from date of start up or 30 (thirty) months after shipment, whichever occurs first.

2. Failures caused by lightning strikes, power surges, vandalism, flooding, or operator abuse are excluded from warranty coverage.

3. Repair damage to the premises caused by a defective item. Make repairs within seven days of notification from the City's Representative.

4. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.

PART 2 – MATERIALS

2.1 QUALITY:

A. Materials used in the system shall be new and without flaws or defects of any type, and shall be the best of their class and kind.

2.2 SUBSTITUTIONS:

A. Make complete submittals of all manufacturer's data showing compliance with the Contract Documents.

B. In making a request for a substitution, the Contractor represents that they:

1. Has investigated the proposed substitution and found that it is the same or better quality, level, capacity, function, or appearance than the specified product, and can demonstrate that to the City's Representative.

2. Will coordinate the installation and make all modifications to the work that may be required for complete installation and operation of the system.

C. The City will determine acceptability of the proposed substitution and will notify Contractor of acceptance or rejection.

D. Pipe sizes referenced in the construction documents are minimum sizes, and may be increased at the option of the Contractor upon approval by the City's Representative.

2.3 GENERAL REQUIREMENTS:

A. The complete aeration mechanical system and related equipment shall be designed to function in an outdoor environment exposed to all of the elements. Furnish protective enclosures and covers as required for proper operation of the system.

B. The prefabricated aeration system shall have a capacity as shown in the drawings.

C. The aeration system includes one oil-less compressor, one air-cooled aftercooler, one corona discharge unit, flow meters, gauges, fittings, valves, and piping as required and as shown on the drawings and details.

D. Completely assemble and operate all components of the aeration system prior to shipment to insure proper fit, assembly and operation on the job site.

E. Construction shall include a fabricated steel skid assembly to support all components during shipping and to serve as the installed mounting base.

F. Connection of the aeration system to 240 or 480 three-phase, 460 volt, 60 hertz power supply to service control panel for compressor and air cooler.

G. All system components shall be supplied and be the responsibility of one manufacturer, even though some components were manufactured by others.

H. The aeration system and related equipment shall meet all the general and technical specifications; shall be designed, fabricated and installed in a workmanlike manner; and shall be delivered within schedules negotiated between Contractor and manufacturer.

I. Furnish shop drawing for approval prior to installation.

J. Provide a factory-trained technician to supervise the installation of the aeration system.

In addition to the time required for installation supervision, the technician shall provide a minimum of 1 day of training for the City's staff in the operation, maintenance, and programming of the aeration system. Notify the City's Representative one week in advance of training to schedule with City.

K. Acceptable Manufacturers:

1. Aqua Sierra, Inc.

   Contact: Bill Logan, Aqua Sierra, Inc., 8350 South Mariposa Drive, Morrison, Colorado, 80465, (303) 697-5486, FAX (303) 697-5069.

2. Keeton Fisheries, Inc.

Contact: Jim Keeton, Keeton Fisheries, Inc., 300 Lincoln Court, Fort Collins, Colorado, 80524, (303) 493-4831, FAX (303) 493-4921.

3. City Approved Equivalent.

2.4 COMPRESSOR SYSTEM:

A. Furnish "oil-less" air compressor designed for continuous duty operation as main aeration compressor.

1. Manufactured by Powerex or approved equivalent, having the capacity and operating discharge pressure as shown in the drawings.

2. Constructed with motor mounted 840 RPM, 460 volt, 3-phase, 60 HZ, electric motor, and all electrical controls.

3. Equipped with air inlet filter and silencer.

4. Furnish ventilation and sound suppression enclosure and components to reduce sound level by 7 dBa.

5. The control system shall include NEMA motor starter with overload protection, 120V transformer, HOA switch, pressure switch, pressure gauge and runtime hour meter, and 24-hour field programmable time clock.

6. Furnish automatic drain valve, safety relief valve, pressure gauge, and necessary brass valves and copper piping.

2.5 AIR COOLED AFTERCOOLER:

A. Furnish air-cooled aftercooler with 1/12 HP fan, and copper tube, aluminum fin heat exchanger designed for continuous duty operation.

1. Speedaire Model 5Z757 rated for 20 CFM at 100 PSI or approved equivalent.

2.6 CONDENSATE SEPARATOR:

A. Furnish condensate separator with automatic drain valve.

1. Wilkerson Model WSA-04-FM0 or approved equivalent.

2.7 PIPING:

A. Compressor Piping: Furnish Type L rigid copper pipe, brass fittings, and components necessary for the complete installation of the aeration mechanical system. Submit shop drawing for approval prior to construction. Show pressure gauges, flow meter, filters, valves, etc.

B. Air Distribution Tubing: Furnish 100 PSI 1/2-inch high density flexible PVC connecting pond aeration modules to discharge pipe from compressor assembly.

1. Use non-leaded, self-weighted high density flexible PVC air feeder tubing from compressor assembly discharge to aeration modules.

C. Pond Aeration Modules: Furnish stainless steel disk aeration modules for installation on the bottom of the ponds.

1. Furnish Model as shown in the drawings as manufactured by Air Diffusion Systems, Lake Bluff, Illinois, 60044, (847) 615-0044.

2. City approved equivalent.

D. Piping Hardware: Furnish stainless steel clamps, fittings, nylon ties (cable ties), supports, and gaskets as required for all piping and tubing connections.

2.8 VALVES:

A. Check Valves: Furnish bronze check valves downstream of each compressor.

B. Isolation Valves: Furnish bronze ball valves for isolation of compressors.

C. Regulating Control Valves: Furnish 1/2-inch bronze ball valves where indicated on aeration flow diagram detail.

2.9 GAUGES:

A. Furnish 2.5-inch diameter liquid filled or vibration/pulsation dampened pressure gauges. Install ball valves to provide total isolation of pressure gauges.

2.10 FLOW METERS:

A. Furnish flow meters, located on each lateral pipe, for each pond aeration module. Label each flow meter with the associated module and location of the module in the pond. Provide a diagram of the modules showing location and label to match the flow meters.

2.11 ELECTRICAL:

A. Enclosures:

1. Mount the aeration system electrical controls in a self-contained NEMA 3S enclosure with drip lip, fabricated from not less than 14 gauge steel. Furnish door gasket seals constructed from neoprene sponge, sufficient to protect interior components from weather and dust.

2. Furnish operating handle for main station power disconnect located on the front of the panel. Provide dust and weatherproof enclosures for all external operating devices.

3. Mount all internal components of the enclosures on removable back panels. Do not mount components on the panel enclosure with screws that protrude from enclosure.

B. Compressor Motor Starters, Disconnect, and Electrical Switch Gear:

1. Furnish compressor motor starters contained within a single NEMA 3S enclosure with a single access door and main disconnect. Each starter shall be protected on

each power leg by a time delay fuse of the appropriate amperage. Motor starter coils shall be 120 volt operated.

2. Use ambient-compensating type overload relays installed on each power leg set to trip at 105% of motor full-load current rating.

C. Electrical Control Panel:

1. The electrical control panel shall be NEMA 3S enclosure equipped with a gasketed enclosure door. Isolate the incoming power by means of a circuit breaker or fused disconnect.

2. The operation of the compressors shall be controlled by an industrial grade, field programmable, and timer.

3. All starting circuits, stations safety shutdown circuits and any optional equipment control circuits shall have an operating voltage not exceeding 120 volts. All time delay control relays shall be plug-in type for easy replacement.

4. Switches: The control panel shall be equipped with a flow switch to disconnect the electrical power in the event of the main compressor failure. An indicating lamp on the control panel will alert the maintenance person as to the failure.

D. Aeration System Wiring:

1. All wiring from control panel to compressors shall be in liquid-tight conduit with copper conductors rated not less than 600 volts AC and of proper size to carry the full load amperage of the motors without exceeding 70% capacity of the conductor. A grounding cable shall be included in the liquid-tight conduit. Splices between the motor starters and the motor connection boxes are not allowed.

2. Furnish multi-conductor shielded cable suitable for Class ll low voltage controls for wiring to flow sensors.

E. Lightning Arrestor:

1. The main power supply feeding the aeration system station shall be equipped with a 3 phase secondary lighting arrestor having a breakdown current rating of not less than 60,000 amps at 14,000 volts discharge. Power supplies, 300 volts and less, shall use 300 volt rated arrestor with an 800 volt spark-over voltage. Power supplies 301-600 volts shall use 600 volt rated arrestor with a 1,000 volt spark-over voltage.

F. Standards:

1. All wiring shall conform to the National Electrical Code Standards.

2. Flexible conduit sections shall be less than 5 feet in length to meet code. All conduit to devices shall be attached securely to avoid trip hazards.

3. A wiring schematic shall be provided by the manufacturer for approval prior to manufacture. The schematic shall show all devices, connections and wire numbers. Furnish a laminated copy of the schematic attached to the interior door of the panel.

4. All controls and electrical equipment shall be thoroughly inspected and tested before shipment.

2.12 PAINTING:

A. Painting of the entire unit shall consist of a multi-step coating system which includes metal preparation, rust inhibitive prime coat, and a two-part catalyzed acrylic finish having a total dry film thickness of not less that 4 mils. Paint aeration system components with the manufacturer's standard color. Paint all electrical enclosures and accessory panels with a minimum thickness of 3 mils and baked at 160-180 F.

PART 3 – EXECUTION

3.1 INSPECTIONS AND REVIEWS:

A. Site Inspections:

1. Verify site conditions and note irregularities affecting work of this section. Report irregularities to the City's Representative prior to beginning work.

2. Beginning work of this section implies acceptance of existing conditions.

3.2 AERATION SYSTEM INSTALLATION:

A. Shipping, off-loading and the technical start up shall be furnished by the aeration system manufacturer. Location and mounting details shall be furnished to the Contractor by the aeration system manufacturer.

B. Coordinate the installation of the aeration system with the installation of the irrigation pumping system and the construction of the concrete floor slab referenced in other sections of the specifications.

C. Install the system as recommended by the manufacturer and as shown in the drawings. Make all connections and adjustments necessary for the proper operation of the aeration system.

D. Install compressors, filters, coolers, flow meters, valves, pressure gauges, and pipe including copper manifolds, sleeves, air distribution pipe, pond aeration tubing, and pond aeration modules.

1. Install pond aeration tube as shown on plans

a. Tie all self-weighted feeder / distribution tubing together at the bottom of the pond with a maximum distance of 20-ft between ties.

b. Install ties no closer than 30-ft to the pond aeration module to allow for surfacing and removal of the module.

2. Make connection between air distribution feeder pipe and pond aeration modules where shown on plans and as recommended by the manufacturer.

3. Install sleeving where indicated on the drawing. Coordinate the installation of the pond edge sleeves with the installation of the trench wall and the pond liner and seal all penetrations as recommended by the manufacturer.

E. Technical start up procedures by the aeration system manufacturer shall include the following:

1. Provide detailed start-up procedure to City's Representative for review, one week prior to start-up.

2. System start up and pressurization of aeration piping system.

3. Pressure, flow, and balance adjustments.

3.3 INSTALLATION OF ELECTRICAL COMPONENTS:

A. Install electrical control panels and disconnect on wall of mechanical enclosure as recommended by manufacturer and as shown on drawings.

B. Install all conduit and wiring as recommended by the manufacturer and as necessary for the proper operation of the system.

3.4 PAINTING:

A. Paint all bare metal surfaces to match paint as applied by pump system manufacturer. Touch up all dings and scratches as required.

3.5 OPERATION AND MAINTENANCE MANUALS:

A. Furnish System Operation and Maintenance manuals to City's Representative prior to project completions. Furnish four copies of single, bound manual.

3.6 OTHER ITEMS:

A. Tools and Spare Parts:

1. Prior to Substantial Completion of the Work, supply to the City operating keys, servicing tools, test equipment, and any other items indicated on the drawings.

2. Prior to Substantial Completion, supply to the City one complete set of gaskets for the compressor, and one filter (replacement) cartridge for each filter assembly.

3. Furnish other spare parts indicated on the drawings.

B. Other Materials: Install other materials or equipment shown on the drawings or installation details to be part of the aeration system, even though such items may not have been referenced in these specifications.

3.7 PROJECT AS-BUILT DRAWINGS:

A. Submit As-Built Drawings in accordance with Specification Section 01785.

B. Record pipe system alterations. Record work that is installed differently than shown on the construction drawings.

3.8 MAINTENANCE:

A. Upon completion of the Work (installation of aeration system and irrigation pond filled with water), maintain system for a duration of 30 calendar days. Make periodic examinations and adjustments to aeration system components as necessary.

B. Following completion of the Contractor's maintenance period, the City will be responsible for maintaining the system in working order during the remainder of the guarantee/warranty period, and for performing necessary routine maintenance.

3.9 CLEANUP:

A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish.

B. Contractor shall clean all surfaces and touch up scratches with factory paint to match original.

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. Use of slide gates within the non-potable pump station shall require specific design and specification for each application.

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. Wedqe – 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, Al64

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.

SECTION 15140

NON-POTABLE PUMP STATION

PART 1 – GENERAL

1.1 SCOPE

A. This section addresses the installation and manufacture of non-potable irrigation pumping stations including factory assembled pump system and buildings. The pump station shall automatically deliver water to the turf irrigation system. It shall include vertical turbine pumps; submersible pressure maintenance pump; variable frequency drives; controls, alarms, sensors, displays, valves, and other devices as specified below; and all interconnecting piping and wiring. All equipment shall be fabricated, mounted on a structural steel base.

B. Furnish all labor, materials, supplies, equipment, tools, and transportation and perform all operations in connection with and reasonably incidental to the complete installation of a non-potable irrigation pumping station and guarantee/warranties.

1.2 REFERENCES

A. ASTM A523, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, latest revision.

B. ASTM A234, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*, latest revision.

C. ANSI/AWWA C200, *Steel Water Pipe – 6 in. (150mm) and Larger*, latest revision.

D. ANSI/AWWA C206, *Field Welding of Steel Water Pipe*, latest revision.

E. ANSI/AWWA C207, *Steel Pipe Flanges For Waterworks Service – Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm)*, latest revision.

F. ANSI/AWWA C208, *Dimensions for Fabricated Steel Water Pipe Fittings*, latest revision.

G. ANSI/AWWA C213, *Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines*, latest revision.

H. ANSI/AWWA C218, *Coating the Exterior of Aboveground Steel Water Pipelines and Fittings*, latest revision.

I. NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilation Systems*, latest revision.

1.3 DEFINITIONS

A. ETL ETL Testing Laboratories, Inc.

B. Hz Hertz

C. IBC International Building Code

D. lbs Pounds

E. LCD Liquid Crystal Display

F. PLC Programmable Logic Controller

G. NEC National Electric Code

H. NEMA National Electrical Manufacturers Association

I. NFPA National Fire Protection Association

J. PM Pressure Maintenance Pump

K. PTFE Teflon

L. RPM Revolutions Per Minute

M. SCADA Supervisory Control and Data Acquisition

N. UL Underwriters Laboratories Inc.

O. VFD Variable Frequency Drive

P. HMI Human Machine Interface

1.4 QUALITY ASSURANCE

A. The pump equipment shall be furnished by a single supplier, who shall be solely responsible for the design and fabrication of the equipment. The supplier shall be regularly engaged in the design and fabrication of such equipment.

B. List of references for similar pump station installations.

1.5 PROVISIONS FOR LOSS PREVENTION

A. The complete pump station shall be UL and ETL Listed. The pump station control panel(s) shall be UL listed and labeled. UL listing and labeling of individual electrical components only shall not be acceptable.

1.6 SUBMITTALS

A. The Contractor shall deliver four (4) copies of all submittals to the City a minimum two (2) weeks prior to ordering materials.

B. Pump Equipment

1. Materials List: Include piping, valves, fittings, pumps and motors, control system components, and electrical equipment. Quantities of materials need not be included.

2. Manufacturer's Data: Submit manufacturers' catalog cut sheets, pump performance curves, specifications, startup manuals, and operating instructions for equipment shown on the materials list. Submit complete instructions for installation, operation, and recommended maintenance of the pump system.

3. Shop Drawings: Submit shop drawings of the proposed pump system. Show products required for proper installation, their relative locations, and critical dimensions. Submit technical data sheets, electrical/wiring schematics showing all devices, connections and wire numbers, sequence of operation, and UL listing authorization form.

4. Operation and Maintenance (O&M) Manual: Include operating procedures, adjustments, and preventative maintenance procedures. Include a guide for troubleshooting operational problems with the pump system and complete documentation for programming (i.e. recommended settings, adjustments). Deliver the O&M Manual to the City prior to pump system start-up. Provide an unlocked, unencrypted electronic backup copy of all programming and equipment settings for all programmable equipment on a USB drive that can be used to reprogram a replacement component in the event of a memory loss or failure.

5. Electrical Studies: Include complete Arc Flash Study including load flows, short circuit calculations and coordination study of all overcurrent protective devices down to each disconnecting means of each branch circuit. Studies to be completed using SKM per the IEEE 1584-2018. Entire SKM Project File is to be provided to the City of Greeley, including all subfolders, reports, tables, and settings files to allow for future updates of study. SKM Project File to be unlocked and unencrypted delivered via USB flash drive. Study to be based upon actual installed cable length and conduit types in addition to actual equipment and protective devices installed.

6. Provide a USB flash drive to the I&C department with a copy of the electrical and controls drawings. Provide a copy of the PLC program, HMI program, spreadsheet, and program file of the VFD parameters. Provide a bill of material spreadsheet with a list of all electrical and controls parts.

C. Pump House:

1. Materials List: Include pipe, fittings, mechanical, and electrical components. Quantities of materials need not be included.

2. Manufacturers' Data: Submit manufacturers' catalog cuts, specifications, and operating instructions for all equipment supplied.

3. Shop Drawings: Submit shop drawings of building and other drawings called for in the installation details or specifications. Show products required for proper installation, their relative locations, and critical dimensions. Note modifications to the installation detail.

1.7 WARRANTY

A. Pumping System:

1. A two (2) year warranty shall be provided for the non-potable irrigation pump station system including performance, materials, and installation.

2. The date of substantial completion shall be specifically determined, in writing, for the non-potable pumping system.

B. Building:

1. For a period of two year from commencement of the formal maintenance period, guarantee/warranty materials, equipment, and workmanship against defects. Fill and repair depressions. Restore landscape or other components damaged by the building installation. Repair damage to the premises caused by a defective item. Make repairs within seven days of notification from the Owner's Representative.

2. Contract documents govern replacements identically as with new work. Make replacements at no additional cost to the contract price.

3. Guarantee/warranty applies to originally installed materials and equipment and replacements made during the guarantee/warranty period.

1.8 PERMITTING

A. Obtain permits for the precast building, electrical within and outside of building, and all other necessary permits required for this Work.

1.9 DISCREPANCIES

A. It is the intent of the plans and specification that all equipment installed in the pump building be complete and operational. It is the Contractor's responsibility to make sure that the equipment furnished is compatible and adheres to all regulations. Any discrepancies should be noted immediately and should be reported to the Owner’s Representative for clarification.

1.10 RULES AND REGULATIONS

A. Work and materials shall be in accordance with the latest edition of the International Building Code, the International Electric Code, the International Plumbing Code, and applicable laws and regulations of the governing authorities.

B. When the contract documents call for materials or construction of a better quality or larger size than required by the above-mentioned rules and regulations, provide the quality and size required by the contract documents.

C. If quantities are provided either in specifications or drawings, these quantities are provided for information only. It is the Contractor's responsibility to determine the actual quantities of all material, equipment, and supplies required by the project and to complete an independent estimate of quantities and wastage.

1.11 CONTROL FEATURES

A. A pressure start time delay, a stop time delay, and a minimum run timer with automatic and manual time out; shall be provided for each pump. Flow ON and OFF sequencing set points and a 100 percent speed start time delay shall be provided for each main pump.

B. "Double successive" automatic alternation shall be provided for the main pumps to prevent short cycling while limiting equal wear. Time delayed automatic "sequence shifting" shall be provided to ensure that all operating pumps will sequence properly when one or more of them have been disabled due to a motor overload or a manual shutdown.

C. An auto-pressurizing mode with adjustable settings that gradually restores system pressure with the VFD main pump shall be provided to protect the irrigation piping at station startup and after extended station shutdowns.

D. An energy saving mode with adjustable settings shall be provided to reduce the system pressure at low flow rates when friction losses in the system are lower.

1.12 OPERATION

A. During non-irrigation times, the pressure maintenance (PM) pump will cycle ON and OFF as required to maintain irrigation system pressure. The cycling pressures shall be user selected and set substantially below normal set point pressure, if desired.

B. If the PM pump cannot maintain the desired pressure, then the programmable logic controller (PLC) will start the first main pump and will gradually ramp the pressure up to desired irrigation pressure to meet small demands.

C. If the first main pump cannot maintain the desired pressure, the PLC will start the second main pump and will gradually ramp the pressure up to the desired irrigation pressure, and so on and so forth until all pumps are operating to maintain the desired pressure.

D. Pump speeds will be modulated to hold a constant discharge pressure regardless of flow. As the flow rate increases and the main VFD pump can no longer maintain pressure while at maximum speed, the next sequential pump will be started and the VFD drive pump will accordingly reduce its speed and modulate.

E. An algorithm shall be included for accurately reducing the VFD pump speed as the next sequential pump is started so that no pressure surges are generated during the transition (even with across the line starting). Algorithm shall apply to all transitions between pumping states.

F. As the flow continues to increase, pumps will sequentially be started until all pumps are operating. As the flow begins to decrease, pumps will be sequentially turned off until only a single VFD driven pump is operating. When a no flow condition occurs, the last pump in operation shall be turned off.

PART 2 – PRODUCTS

2.1 GENERAL

A. Materials used in the system shall be new and without flaws or defects of any type and

shall be the best of their class and kind.

B. Pumping stations shall have a capacity and discharge pressure as shown on the Construction Drawings.

C. Prefabricated pump skids shall be completely piped, wired, hydraulically and electrically tested before shipment to the construction site. The pump station and related equipment shall meet all the general and technical specifications and shall be designed, fabricated, and installed in a workmanlike manner.

D. All components of the pumping system shall be designed to function within an indoor environment. Furnish protective enclosures, covers, and HVAC system as required for proper operation and maintenance of the system.

E. Construction shall include skid assembly to support all components during shipping and to serve as the installed skid base. Skid base shall be of sufficient size and strength to resist twisting and bending from shipping, installation, and hydraulic forces and support the full weight of the pumps and motors.

F. A trained representative or technician from the pump manufacturer shall supervise the installation of the pump skid. The pump manufacturer's representative shall also provide a minimum two (2) days for the startup and training to City personnel in the operation, maintenance, and programming of the new pumping system.

G. All pump skid components including but not limited to pumps, self-cleaning filters, steel piping, valves, fittings, and pump controls and magnetic flow meter shall be supplied by one (1) manufacturer, even though others manufactured some components. Refer to 2.2, 2.5, and 2.8 for items to be supplied by pump skid manufacturer.

2.2 PREMANUFACTURED PUMP SKID

A. Vertical Turbine Pumps:

1. Furnish variable frequency drive (VFD) vertical turbine pumps, electric motor driven, complete with the required length of threaded column assembly. Surfaces in contact with water shall be epoxy coated or stainless steel.

2. Pump discharge head shall be surface mounted and have 125 class, 200 psig rated, discharge flange of the same size as the pump check valves. Discharge head shall be cast iron.

    a. A check valve assembly consisting of two 3/4-inch swing type, 125 class, 200 psig rated, brass or bronze, check valves shall be mounted vertically on each main pump discharge head. The check valves shall be placed in series, in opposite directions, and modified to quickly release air from a main pump when it starts, and to slowly allow air to return when it stops. Each check valve assembly shall remain closed when its pump is running.

3. The pump discharge head shall include a stuffing box and be provided with a drain for the stuffing box wastewater to drain to the wet well.

4. Suction strainers shall be of the basket type and have total inlet areas of at least four times those of the suction bells.

5. Pump efficiency shall be minimum 80% at the specified operating point. The performance curve of each pump selected shall be continuously rising as it approaches shutoff.

6. Bowl assemblies including the suction, intermediate, and discharge bowls shall be furnished with epoxy coating or stainless steel flanged connections. Furnish bronze, dynamically balanced, impellers that are vertically adjustable by a hex nut located at the top of the pump motor.

7. Line shafts shall be supported by bearings no further than 10 feet apart.

8. Column pipe sections shall be no longer than 10 feet and joined together using threaded couplings.

9. Furnish each pump with a flanged, cast iron discharge head complete with a cast iron adjustable packing gland, gland plate, grease seal, packing bushing, packing and water slinger.

10. Provide a continuous bypass flush line from the stuffing box of each pump to the wet well.

11. All bowl bearings shall be constructed of bronze, all column bearings shall be fluted rubber. Each pump shaft, column line shaft, and pump motor shaft shall be turned, ground and polished 416 stainless steel, sized to transmit full nameplate HP of the motor. Minimum acceptable shaft size is one-inch (1").

12. All shaft couplings shall be threaded and machined from 300 series stainless steel. Furnish two (2) piece head shaft assembly. All shaft couplings shall have left hand threads that tighten during pump operation.

13. Each motor shaft shall be removable and couple to the pump head shaft between the bottom of the motor and the packing gland with sufficient clearance to allow removal of the packing gland assembly without motor removal.

14. Materials List

Component	Material
Pump Bowls	Cast Iron with Enamel Lining
Suction and Discharge Cases	Cast Iron with Enamel Lining
Pump Discharge Head	Cast Iron
Impeller	Bronze
Suction and Discharge Case Bearing	Bronze
Intermediate Bowl Bearing	Bronze
Column Bearing Retainer	Bronze
Packing Follower	Bronze
Packing Bushing	Bronze
Motor Shaft Hex Nut	Bronze

Column Bearings	Fluted Rubber
Pump Shaft and Motor Shaft	Polished 416 Stainless Steel
Line Shaft	416 Stainless Steel
Line Shaft Couplings and Motor Shaft Couplings	300 stainless steel
Column Piping and Couplings	Steel
Packing Material	Graphite Impregnated
Water Slingers	Rubber
Pump Suction Strainers	Zinc Plated or Stainless Steel

B. Vertical Holllowshaft Pump Motors

1. Vertical hollowshaft pump motors shall be premium efficiency squirrel cage induction type motors with WP-1 enclosures and Class F insulation, manufactured in the United States, rated for continuous inverter duty and designated NEMA MG 1, Part 31.

2. A thrust bearing sized to carry the weight of all rotating parts plus the hydraulic thrust of the pump at shutoff shall be incorporated into each motor.

3. Motors shall be rated for continuous inverter duty, VFD rated, and shall be sized to drive the pump at any point on its operation curve without exceeding motor HP nameplate rating. All motor shall have a 1.25 service factor rating.

4. All motor bearings shall be rated for at least five years of continuous operation.

5. Pump shaft connections shall be made through a bolted coupling at the top of each motor.

6. Motors shall be equipped with non-reverse ratchets and space heaters.

7. All vertical turbine pump motors shall be 1800 RPM nominal.

8. All motors shall be coated with the motor manufacturer's original paint only.

9. Furnish motor thrust bearings of ample capacity to accommodate the weight of all rotating parts plus the hydraulic thrust of the pump at shutoff conditions. Furnish motor bearings rated for a minimum service life not less than five (5) years continuous operation at the design rating point.

10. Furnish motors manufactured in the United States.

11. Acceptable motor manufacturers are:

    a. Nidec/US Electrical Motors

    b. Or approved equivalent

12. Miscellaneous:

a. Install vibration sensors on each motor.

b. All motors shall have shaft grounding systems. Grounding systems shall be installed per manufacturer recommendations.

C. Pressure Maintenance Pump (PM Pump)

1. Furnish a PM pump, with a multistage, submersible type, well pump.

2. Pump shall be equipped with a motor shroud for proper cooling of submersible motor and stainless steel suction screen.

3. The pump discharge connection and all riser pipe couplings shall be threaded steel.

4. The submersible pump, riser pipe, riser pipe support plate, and discharge connection shall be removable as a single unit by unbolting the riser pipe support plate from the skid base.

5. Materials

Component	Material
Pump Suction Interconnector	416 Stainless Steel
Inlet Screen	416 Stainless Steel
Pump Shaft	416 Stainless Steel
Check Valve Housing	416 Stainless Steel
Check Valve	416 Stainless Steel
Diffuser Chamber	416 Stainless Steel
Top Bearing	416 Stainless Steel
Split Cone	416 Stainless Steel
Impellers	416 Stainless Steel
Couplings	416 Stainless Steel
Straps	416 Stainless Steel
Cable Guard	416 Stainless Steel
Priming Inducer	416 Stainless Steel
Check Valve Seat	NBR Rubber and Stainless Steel
Intermediate Bearings	NBR Rubber, Bronze or Stainless Steel
Riser piping and couplings	Galvanized Steel

6. The motor leads shall be strapped to the riser pipe on three foot maximum centers with a 12” service loop.

7. Manufacturer: The pump and motor shall be as manufactured by Grundfos or approved equivalent.

D. Skid Base

1. The skid base shall be constructed from structural steel channel, cross members,

a 3/4 inch solid steel pump mounting plate, and 3/16 inch steel “diamond” plate. Angle iron shall be used only to support open areas of the deck. The skid base shall completely cover the wet well. A wet well access hatch or flap shall be provided.

E. Piping

1. All piping 3-inches and larger shall be Schedule 40, black steel, ASTM A120 or A53 Grade B, electric resistance welded pipe.

2. All welded flanges shall be forged steel with slip-on or welding neck type. All welding fittings shall be seamless, conforming to ASTM A234, with pressure rating not less than 150 psi.

3. All fabricated piping shall conform to AWWA standards.

4. All piping smaller than 3 inches shall be schedule 40, galvanized steel, ASTM A120 Grade B, continuous welded pipe.

5. All threaded pipe fittings shall be galvanized, malleable iron, 150 class, ASTM A126 Grade B.

6. All pressurized tubing material shall be Impolene polymer.

F. Valves

1. Pressure Relief Valves

a. Furnish a hydraulically operated, pilot controlled, diaphragm-type pressure relief valve and bypass piping to the wet well installed on the discharge piping. Size the pressure relief valve to bypass sufficient water to avoid operating pumps at or near shut off head conditions. The valve size shall be based on at least 50 percent of the total station capacity:

i. 2.5 inch - 670 GPM,

ii. 3 inch - 1000 GPM, and

iii. 4 inch - 1800 GPM

2. The relief valve discharge shall be piped to the wet well through a diffuser tube assembly. The assembly shall be the same size as the relief valve and shall extend into the wet well to a depth of 3 feet below the normal water level. Relief valves discharging directly into the wet well, without diffusing it below the water line, is not acceptable. The portion of the assembly above the skid decking shall be constructed with steel pipe, a steel support plate, and 150 class steel flanges at the relief valve and the diffuser tube.

3. The diffuser tube shall be made of schedule 40 PVC pipe, fittings, and end cap. The tube shall have 3/4 to 1-inch diameter holes drilled around the bottom one to two foot section of the tube. The total area of the holes shall be at least 4 times

the area of the diffuser tube diameter.

4. Pilot controls shall include an adjustable 20 to 200 psig rated, pilot valve with a bronze body, a stainless steel stationary seat, and a buna-n resilient seat. An adjustable needle valve closing speed control shall be provided. The inlet connection to the pilot system shall be on the discharge piping with an isolation ball valve and a wye-strainer strainer. The inlet connection to the pilot system shall not be permitted on the body the pressure relief valve itself. An air release cock shall be provided at the cover tip connection of the relief valve.

5. A brass hose bib shall be provided at the inlet side tapping of the pressure relief valve.

6. Pressure Relief Valve shall be a model CRL-60 as manufactured by Cla-Val or approved equivalent.

G. Check Valves

1. Provide check valves on each pump mounted directly to its pump head's discharge flange and one on the discharge end of the Automatic Self-Cleaning Filter.

2. Check valves shall be of the spring loaded, center guided, silent wafer type.

3. Valve bodies shall be cast iron. Valve internals shall be bronze and stainless steel with buna-n seats. The valves shall have a compound sealing action: metal to metal, and metal to buna-n rubber.

4. The valves shall be 400 psig W.P.

5. Velocities shall be limited to 10 fps, and pressure drops shall be limited to 2.5 psig.

6. Check Valve shall be as manufactured by Val-Matic.

H. Pump Discharge Isolation Valves

1. Each pump shall have a discharge isolation valve. Valves shall be of the lug body, butterfly type rated at no less than 200 psig working pressure.

2. Valves 6-inches and under shall have a 10 position, locking, lever handle. Valves 8-inches and over shall have a hand wheel / gear operator with position indicator.

3. Each valve body shall be ductile or cast iron with an aluminum bronze disc, a 416 stainless steel shaft, bronze shaft bushings, and an EPDM rubber seat.

I. Pressure Relief Valve Inlet Isolation Valves

1. Provide an isolation valve on the inlet of the Pressure Relief Valve. The isolation valve shall be the same as the Pump Discharge Isolation Valves.

J. Station Discharge Isolation Valve

1. Provide an isolation valve at the end of the meter run pipe. The isolation valve shall be the same as the Pump Discharge Isolation Valves

K. Air/Vacuum Valves

1. A 1-inch air-release valve shall be located on the discharge manifold. The valve shall be capable of releasing air while the pumps are running at any flow rate or delivery pressure. The valve shall open under a vacuum to allow air to enter when the station is drained. Its exhaust port shall be tubed back to the wet well. The valve shall have a cast iron body, stainless steel trim and float ball, a Viton seat, and a minimum pressure rating of 200 psig.

L. Ball Valves

1. Provide ball valves to isolate the following items:

   a. Air Release Valve

   b. Each pilot assembly connection of the System Relief Valve

   c. Pressure transducer sensing line connection

   d. Drain connections

   e. Pressure gauges

2. Each isolation valve shall be a full port ball valve, rated for 200-psig minimum, with a brass body, a chrome plated brass ball, and a Teflon seat.

M. Drain Valves

1. Drain valves are to be provided at any possible low point in the system and are to consist of ¼" brass angle valves unless otherwise noted.

2. Provide a drain valve in the pump discharge manifold between the pump check valve and control valve.

3. Provide a ¾" brass hose bib in the discharge piping to function as a wash down connection and a drain.

N. Gauges

1. All gauges shall be isolated from electrical switch gears and control panels.

2. Provide a pressure gauge near the inlet of the pressure relief valve. The gauge shall be 2-1/2-inch, glycerin filled, and have an accuracy of ANSI Class B or better.

O. Drain Tubes

1. Drain lines shall be provided from packing drain area of each pump discharge head, from the packing gland bypass connection of each pump, from the air-

in/air-out check valve assembly on each pump, from the exhaust port of the air/vacuum valve, all drain valves. All of these drain connections shall discharge into the wet well.

P. Automatic Self-Cleaning Filter

1. Provide an appropriately sized automatic backwash filter, with a self-cleaning mechanism, driven by an electric motor.

2. The filter shall have a 300 micron stainless steel mesh screen.

3. An additional pressure gauge shall be provided so that up & downstream filter pressures can be read.

4. The filter shall be operated by the pump system control panel. A filter selector switch, filter flush totals, 4 flushing modes, and 6 diagnostic alarms shall be provided with the PLC and HMI programming.

5. Manufacturer:

   a. Amiad SAF Series

   b. No equivalent allowed.

Q. Painting

1. The entire station, with the exception of the control panel, motors, and the underside of the skid base, shall be machine cleaned and painted with a multipart coating system having a total dry-film thickness of not less than 8 mils. One coat of white, polyamide, epoxy primer shall be applied to a dry film thickness of not less than 4 mils. Two coats of Mayan Green, gloss, aliphatic, acrylic, polyurethane, finish shall be applied to a dry-film thickness of not less than 4 mils. A 1-quart can of the finish paint shall be shipped with the station for job site touch up.

2. The underside of the skid shall be coated with a black, polyamide, epoxy lining, not less than 10 mils thick. The control panel and the motors shall retain their manufacturer's original coatings.

R. Electrical and Controls

1. Refer to Section 2.5.

S. Acceptable Pump Skid Manufacturers are:

1. SyncroFlo, 6700 Best Friend Road, Norcross, GA 30071, www.syncroflo.com

   a. Local Representative: Cascade Industries, 970-402-3252
   email: cascadeindustrieslimited@gmail.com

   b. Or approved equivalent.

2.3 PIPE SUPPORT STANDS

A. Furnish manufactured steel pipe support stand as shown on the Construction Drawings or City of Greeley Standard Drawings.

B. Support must be capable of supporting 500 lbs dead load and be adjustable within the range shown on the pump piping detail.

C. Approved pipe stands are:

1. Material Resources – Standon S89, Flanged Adjustable Pipe Support

2. Material Resources – Standon S92, Adjustable Pipe Saddle Support

3. Or approved equivalent.

2.4 DISCHARGE "Z" PIPING

A. A welded steel pipe with two 45 degree steel bends (Z-Pipe) shall be provided for installation between the pump station discharge valve located inside the pump station building and the buried irrigation main line. The Z-pipe shall have a welded steel flange for connection to the discharge valve, an underground welded steel thrust plate, and a plain end for connecting to the buried irrigation main piping. The Z-Pipe outside diameter shall be compatible with AWWA C-900 and C-905.

B. A 2-inch threaded steel outlet shall be welded to the top of the Z-pipe located at the top of the pipe outside the pump building for a winterizing connection. A 2-inch steel threaded plug shall be provided.

C. Steel: AWWA C200 steel pipe for both direct bury and exposed applications. Submit proposed interior and exterior coatings for City review and approval.

2.5 PUMP SKID ELECTRICAL AND CONTROLS

A. General

1. All electrical control panels with controls and wiring shall be built in accordance with NEC, UL, and ETL standards. The electrical components and enclosure shall be labeled as a complete UL listed assembly with manufacturer's UL label applied to the door.

2. All equipment and wiring shall be mounted within the enclosure and labeled for proper identification.

3. The power supply to the pump station shall be three (3) phase, 480 volt.

4. All wiring from control panels to motors shall be in liquid-tight conduit with MTW or THWN, stranded copper conductors rated not less than 600 volts AC. All wiring shall follow NEC code and local code. All wiring from the control panel to the motors shall be sized according to NEC requirements based on motor full load current. A grounding cable shall be included in the liquid-tight conduit. There shall be no splices between the motor starters and the motor connection

boxes, except for the submersible pump motor.

5. Wiring to flow sensors and pressure transducer shall be multi-conductor shielded cable suitable for Class 2 low voltage controls. Must use Black and red wiring in cable for all class 2 low voltage controls.

6. All control wiring carrying more than 24 volts, shall be 16-gauge minimum with wire numbers at all termination points. The wiring to all devices outside the control panel shall be contained in metal lined, liquid-tight conduit.

7. All secondary control components shall be powered with 120 VAC or 24 VDC. All control relays shall be plug in type for easy replacement. No 120 VAC powered components shall be allowed on the door of the control panel, just 24 VDC components are permitted on the door.

8. Primary and secondary circuit breakers shall be provided for the control power transformer. A circuit breaker shall also be provided for the motor space heater circuits.

9. Provide full alarms and safety features needed to protect equipment and piping.

B. Enclosures

1. The pumping station electrical controls shall be mounted in a self-contained UL Type 4 or 12 (NEMA-4 or 12) enclosure.

   a. The enclosure shall be mounted on the pump skid or placed on a concrete maintenance pad.

2. Door gasket seals shall be neoprene sponge, sufficient to protect interior components from weather and dust. The electrical panel doors shall be constructed from 12-gauge steel with integral locking screws and latches.

3. All internal components of the enclosures shall be mounted on removable back panels.

4. All internal wiring within, and interconnecting between, the panels shall be complete and no field wiring within the panels shall be permitted. Wiring troughs and cable raceways shall be self-contained within the enclosures and no external cable trays or wiring troughs are permitted.

5. No pressure gauges, pressure switches, water activated devices, or water lines of any sort shall be installed in any electrical control panel.

6. All adjustments and maintenance shall be capable from the front of the control enclosure. A complete wiring circuit and legend with all terminals, components, and wiring identification shall be provided. Main disconnect shall be interlocked with door.

7. All electrical starter and control panels in the pump system shall be assembled from components that are UL listed.

8. A closed type cooling system shall be included to cool the enclosure and reject heat from the VFD. Open type cooling systems allowing outside ambient air to enter the panel are not acceptable.

9. Adjustable, ambient temperature compensated, bimetallic, inverse time, UL class 10 thermal overload relays or motor circuit protectors shall be provided for each motor.

10. Provide complete instrumentation and controls to automatically start, stop, and modulate pump speeds for efficient and reliable pump flow rates, at a constant discharge pressure.

C. Power Monitor

1. The main power supply in the pump station shall be equipped with a 3-phase power monitor. It shall detect low voltage, phase loss, reversal, shift, or improper sequence. A voltage adjustment, status light, and a plug-in base shall be provided.

D. Surge Protection Device

1. The main power supply in the pump station shall be equipped with a 3 phase, 480 volt rated, UL 1449 surge protected device (SPD). The SPD shall be mounted external to the main cabinet. The SPD shall have a current rating of not less than 10,000 amps, an SCCR rating 200,000 amps, and shall include a green OK status light. The SPD shall be connected to the power distribution block immediately downstream of the main circuit breaker, so it can be isolated for replacement. The SPD shall include an event counter and an audible alarm in the event of SPD failure.

E. Variable Frequency Drive

1. Must have Ethernet/IP communication capabilities with Allen Bradley PLCs and manufacturer supported Add On Instruction for AB PLC programming integration. Preference given to drives that interface to Allen Bradley PLC with AB supported Add On Profile and Automatic Device Configuration. Provide sample code and AOI for non-AB drives.

2. Provide suitable drive input impedance to prevent damage due to power system transients.

   a. For drives without built-in inductors – add line impedance whenever the transformer kVA is more than 10 times larger than the drive kVA, or the percent source impedance relative to each drive is less than 0.5%. • For drives with built-in inductors – add line impedance whenever the transformer kVA is more than 20 times larger than the drive kVA, or the percent source impedance relative to each drive is less than 0.25%. Or follow tables in publication Drives-IN001 for Allen Bradley VFDs.

   b. Alternate requirements for the inclusion of added input impedance will be evaluated if the requirements are product specific and within

manufacturer published documents. The inclusion or omission of devices shall be documented with a reference to the source publication.

3. Provide Harmonic reduction devices as needed to prevent interference and impaired function of other equipment connected to the source transformer. Requirement is based upon IEEE 519. Distortion of voltage should be less than 5%. Suitable harmonic mitigation can be decided based on the size of the main power transformer. Contractor to verify if harmonic mitigation is needed and provide required harmonic mitigation.

    a. Preferred solution is the use of Active Harmonic Filter (AHF) sized to expected loads. If requirement 2 (above) does not indicate need for reactor and the AHF can be sized without input reactors, it is allowed to provide the drives without input reactor. Adding a 3% input reactor to all drives can reduce the size of AHF requirement and is suggested best practice.

    b. Passive Harmonic Filters (PHF), provided with each drive are acceptable means of harmonic mitigation. When provided, they shall be provided with means to disconnect internal capacitance when the VFD is running at low power level or not running.

    c. Active Front End (AFE) VFDs are acceptable when they are provided with isolating impedance and background distortion is lower than 3%. AFE drives shall have settings as needed for multiple input types such as utility power and backup generator. It is not recommended to mix and match different vendors of AFE drives or put drives on power systems that have unfiltered 6-pulse drives.

    d. Document using a harmonic calculation tool that the harmonics levels will meet requirements.

        i. Results/calculation output provided by a manufacturer provided tool such as those from drive and filter manufacturers is acceptable. (Does not have to be provided by a professional engineering tool.)

4. When using an AHF, contact the manufacture for their recommendations on active harmonic filters sizing and suitability.

    a. Preferred manufacturer is Mesta/Hammond

    b. Include documentation of sizing provided by manufacturer.

5. Provide long lead length protection as needed to prevent motor failures. Follow drive manufacturer instructions on lead length recommendations. Mitigation/protection shall be manufacturer specific and shall follow published guidelines. Application must consider if the motor meets inverter rated duty and use minimum voltage rating of the inverter motor standard (1488V). If the motor

does not meet inverter duty rated standards, apply suitable devices to protect the motor.

a. Allen Bradley 7-class drives 3-300 HP do not require any output devices when powering inverter duty rated motors at distance up to 300 feet. For distance from 300 to 600 feet it is preferred to use AB motor terminator (connects at motor) so that drive enclosure can be kept small. It is acceptable to use an output reactor for distance up to 600 ft. For distance above 600 feet it is allowed to use a dV/dT or Sine filter. Note that other AB drives and other manufacturers do exactly follow the previous recommendations. See publication drives-in001.

b. Use of reactors/terminators/filters shall follow the published guidelines of their respective manufacturer. The inclusion or omission of devices shall be documented with a reference to the source publication.

6. VFD cable shall be installed on the output of the VFD to the Motor to assure suitable insulation rating, protection against noise interference and to help mitigate bearing failures and other common mode related problems. Grounding practice and wire type and composition must follow manufacturer guidelines.

a. Document the source publication(s) used as reference.

b. For Allen Bradly drives the best practice document is Publication Drives-IN001. It also covers lead length and input impedance. The publication 750-IN001 also covers some drive specific guidelines for installation of 750 class drives.

7. Complete schematic, wiring and interconnection diagrams showing connections to both internal and external devices:

a. Include terminal number and wire numbers.

8. Complete single-line and 3-line diagrams including, but not limited to, circuit breakers, motor circuit protectors, contactors, instrument transformers, meters, relays, timers, control devices, and other equipment comprising the complete system:

a. Clearly indicate device electrical ratings on the drawings.

9. The VFD manufacturer shall be responsible for start-up of the VFDs in the presence of the equipment suppliers, Contractor, Engineer, and Owner.

10. Approved manufacturers are:

a. Allen Bradley

b. Eaton

c. ABB

d. No equivalent allowed.

F. Pressure Transducer

1. Standardize with GE UNIK5000UK 0-150 PSI Part # PTX5032-TA-A2-CA-HO-PF.

2. No equivalent allowed.

G. Wet Well Monitoring

1. Wet wells shall be equipped with an E&H radar sonic liquid level indicator probe and level transmitter.

2. Low level cut off switch (float) shall be provided to send a discrete signal to the PLC to shut down the pumps on low wet well level.

H. Programmable Logic Controller

1. Provide a programmable logic controller (PLC) to control all functions of the station. Relays may be used for interface purposes only. The PLC shall include non-volatile EEPROM memory (no battery needed) that prevents loss of program or settings during power failures; POWER, RUN, BATTERY, ERROR, and I/O status lights; a Modbus TCP or Ethernet port for SCADA communications; an Ethernet port for HMI communications, 2 amp rated dry contact relay outputs (solid state outputs are not allowed); 24 VDC inputs standard and high-speed digital inputs; analog inputs; and an analog output. The PLC shall be rated for locations where electro-magnetic noise, voltage spikes, high temperature, humidity, and mechanical shock exist.

2. All logic for system control, timing, and control of VFD speed shall be handled by the PLC. No external relay logic or timers are permitted. A separate set point controller is not acceptable.

3. The City shall be provided with an unlocked PLC program.

4. Approved PLC manufacturers are:

a. Allen Bradley Studio 5000 Platform

b. Mitsubishi.

c. No equivalent allowed.

I. Human Machine Interface

1. A UL Type 4 rated, 24 VDC powered color touch screen operator interface shall be provided. 120 VAC powered interfaces are not acceptable. The interface shall be a high resolution, backlit color, LCD touch screen. Should the interface fail, a signal shall be sent to the PLC, and the station will continue to run normally.

The interface shall also provide protected access to changing all operational settings as well as a re-load factory settings function.

2. HMI program shall be unlocked and copy of program given to City of Greeley I&C department after commissioning of pump station.

3. Approved HMI manufacturers are:

    a. Redlion G15C1100

    b. Maple Systems

    c. Or approved equivalent.

4. Human Machine Interface screen shall provide access to operator controls, alarms, and system data such as:

    a. Operator set points.

    b. Pump HAND-OFF-AUTO selector switches.

    c. An inverter TEST-OFF-AUTO selector switches.

    d. An inverter SETUP MODE button.

    e. A DISABLE-ENABLE switch to prevent the low system pressure and high flow rate alarms from shutting down the station.

    f. An ALARM RESET push button.

    g. An ALARM LIGHT TEST button.

    h. Flood Alarm. Provide flood alarm sensor to detect a flooding in the building.

    i. Irregular Power.

    j. Runtime for each pump. – Reset yearly.

    k. Runtime for each filter. – Reset yearly.

    l. Count of filter back flushes.

    m. Total pump starts.

    n. Flow Rate.

    o. Total Gallons Pumped – YTD.

    p. Total Gallons Pumped – Previous day total.

    q. System Efficiency (Watts/Gallon) including trending.

r. System Pressure.

s. Filter inlet and outlet pressure.

t. VFD/Pump speed for all pumps.

u. VFD/Pump feedback speed for all pumps.

v. VFD/Pump current draw for all pumps.

w. VFD/Pump Voltage for all pumps.

x. On/Off control of pump station.

y. Vibration sensors on motors.

z. Provide VFD speed reference and speed feedback.

aa. ON/OFF/faulted/manual/auto status of VFDs/soft starters and motor starters.

bb. Ability to change pumps in manual or auto.

cc. Pond level.

dd. Wet Well level.

ee. Alarms page. Show existing and acknowledged alarms.

ff. Valve positions.

gg. Password protected.

i. Operator level

ii. Admin level

J. Alarms and Shutdown

1. Pumps shall be shutdown with the appropriate alarm whether they are operating in HAND or AUTO mode.

2. Alarms:

a. A power failure alarm with trip delay, manual and delayed automatic reset.

b. An irregular power alarm with trip delay, manual and delayed automatic reset.

c. A leak detection alarm with manual reset.

d. low pressure alarm with trip time delay and manual reset.

e. A high-pressure alarm with trip time delay and manual reset.

f. A high flow rate alarm with trip delay and manual reset.

g. A low-level alarm with trip delay and manual reset.

h. A high panel temperature alarm trip delay.

i. A manual and automatic reset.

j. An individual motor overload alarms with manual reset.

k. A contactor fault alarms with manual reset.

l. A pressure transducer failure alarm with manual reset.

m. A level transducer failure alarm with manual reset.

n. A flow meter failure alarm with manual reset.

o. An inverter (VFD) fault alarm with a two-attempt automatic reset,

p. A third trip lockout function with timed rollover, and manual reset.

q. A PLC failure alarm with automatic reset, and display failure alarm with automatic reset,

r. A low battery alarm with automatic reset, an input failure alarm with automatic reset.

3. The following specific alarm conditions along with procedures for correction will be displayed in English on the HMI:

a. Low discharge pressure (with override switch)

b. High discharge pressure

c. Low wet well level (Attempts restart)

d. Phase loss (Attempts restart)

e. Low voltage (Attempts restart)

f. Phase unbalance (Attempts restart)

g. Individual motor overload/phase loss (indicates which individual motor was shut down)

h. VFD fault (shutdown VFD pump only and attempts restart)

2.6 SCADA

A. General

1. Coordinate SCADA requirements with the City of Greeley I&C Department. The City shall be provided with an unlocked the PLC program. Programming of SCADA system shall be done by an approved and qualified controls contractor. Use approved City of Greeley radio system.

2. Provide 40-foot pole for SCADA radio antenna. Alternatively, the SCADA radio antenna can be integrated with light pole. Ground antenna mast according to NEC guidelines and provide lighting protection isolators on all cables between antenna and control panel. Install conduit from antenna pole and SCADA control panel.

3. A SCADA radio shall be mounted in the control cabinet. A 15 amp 120 Volt AC circuit shall be made available to power up the SCADA radio.

4. If mounted on the exterior wall, install mast through the pump station building wall and then overhead or under floor to the pump control panel.

5. 120 Volt AC outlet for chemical feed pump. Outlet to be on if main pumps are on.

6. Contractor to build and test SCADA screens before starting up the pump station. Provide one workshop to review design of new SCADA screens.

7. Contractor to setup and test SCADA alarming and program SCADA phone to call out.

B. Radio Equipment

1. Provide and install the following radio equipment.

a. Cambium - 3 GHz 450b High Gain, Single Radio - Requires High Gain Antenna Assembly (PN # C030045B032A)

b. Cambium - 3 GHz 450b High-Gain Antenna Assembly (PN # N030045D001A)

c. Cambium - PoE Gigabit DC Injector, 15W Output at 30V, Energy Level 6 Supply (PN # N000900L001D)

d. Cambium - AC US Line Cord, C5 Connector (PN # N000900L001D)

e. Radio can’t be power up until coordinating with I&C department. Contractor to support alignment of radio.

f. Must use outdoor rated, shielded, gel or gel tape CAT6e cable

g. Radio can’t be power up until coordinating with I&C Staff. Contractor to support alignment of radio.

h. Install Cat6e cable from SCADA control panel to radio

i. Install moxa ethernet switch in control panel.

C. Contractor to verify with COG I&C Department that we have align of sight from existing radio tower to new radio.

1. Controls, Alarms & Data.

a. Flood Alarm. Provide flood alarm sensor to detect a flooding in the building.

b. Irregular Power.

c. Runtime for each pump. – Reset yearly.

d. Runtime for each filter. – Reset yearly.

e. Count of filter back flushes.

f. Station Flow Rate GPM.

g. Total Gallons Pumped – YTD.

h. Total Gallons Pumped – Previous day total.

i. System Pressure.

j. VFD/Pump speed for all pumps.

k. VFD/Pump feedback speed for all pumps.

l. VFD status - ON/Off status bits for all pumps.

m. On/Off control of pump station.

n. Wet Well level.

o. Pond level.

p. Vibration sensors on motors.

q. VFD faulted. – On all VFDs.

r. Building temp.

s. Remotely Start and Stop Pump Station.

t. VFD amperage for all VFDs and soft-starts.

u. Low discharge pressure alarm.

v. High discharge pressure alarm.

w. Low and high wet well level alarms.

x. Phase loss alarm.

y. Low voltage alarm.

z. Phase unbalance alarm.

aa. Individual motor overload/phase loss alarm.

bb. VFD Voltage – on all VFDs.

cc. VFD/Pumps Efficiency (Watts/Gallon).

dd. Flume level in inches.

ee. Flume flow in GPM.

ff. Flume Total Gallons.

gg. Flume Yearly total in Gallons x 1,000.

hh. Wet well level in feet

ii. Pump runtimes in hours

jj. Building Temperature in degrees F°

kk. Total number of pump starts and number of pump start for yesterday; twenty-four (24) hour period.

ll. Total filter runtime and total filter runtime for yesterday; twenty-four (24) hour period.

mm. Pump Station Control Panel Main Power Voltage

nn. Pump Station Control Panel Main Power Current

oo. Instantaneous Efficiency – (Voltage * Current) / Flow Rates – Sampled (15) seconds and stored 24 hours.

pp. Average Efficiency – (Average Voltage * Average Current) Average Flow Rates – Averaged for 15 min intervals stored 30 Days.

2. Common alarms:

a. Pump run status

b. Low level well

c. High level well

d. Filter fault alarm

e. Irregular power

f. High panel temperature alarm

g. Station in remote shutdown

h. Filter run status

i. Reset station alarms

j. Station shutdown

k. Station restart

l. Flow totals should be messaged via Ethernet.

m. HMI shall indicate if the pump station is in shutdown mode due to SCADA input.

3. SCADA historical data.

a. Flow data

b. Pressure sensor data

c. Vibration sensor data

d. Start and Stop Pump Station.

e. VFD or soft-starts feedback speed.

f. VFD Voltage

g. VFD/Pump Current

h. VFD/Pump Efficiencies (Watts/Gallon)

i. Wet Well level.

j. Pond level

k. System Pressure

4. Status Colors

a. Motor Status

i. Green - Running in Auto

ii. Red - Off

iii. Yellow – Running in Hand or Manual

iv. Red flashing – Faulted

b. Valve position

i. Green – Open and Auto

ii. Yellow – Open and Manual

iii. Red – Closed in Auto

iv. Red Flashing - Faulted

2.7 MISCELLANEOUS ELECTRICAL COMPONENTS

A. Pump Station should have an arc flash study and labeled per the NEC and NFPA 70E. Labels shall be designed to meet the NFPA 70E.

B. Pump Station shall meet the NEC standard for electrical equipment work space clearances.

C. Lightning Arrestor

1. The main power supply feeding the pumping station shall be equipped with a three (3) phase secondary lighting arrestor having a breakdown current rating of not less than 60,000 amps at 14,000 volts discharge.

2. Power supplies, 300 volts and less, shall use 300 volt rated arrestor with an 800 volt spark-over voltage.

3. Power supplies 301-600 volts shall use 600 volt rated arrestors with a 1,000-volt spark-over voltage.

4. Main Station Disconnect

a. The disconnect shall conform to the requirements of the NEC and applicable local codes.

b. The main station disconnect shall have an operating handle on the front of the panel.

5. Secondary Control Circuit Fuses

Single-pole secondary distribution fuses with appropriate ratings shall supply power to each pump starter coil circuit, the control system, and to other circuits as required.

2.8 FLOW SENSOR

A. Provide a meter readout on OID for monitoring the flow rate, totalizing gallons used, and for shifting the flow sequencing set point range. Total gallons for previous day.

B. Adjustable settings for pipe diameter, and analog outputs shall be provided. The totalizer shall be capable of counting to two (2) billion gallons and it must be resettable. Both settings and the gallons total shall be held in non-volatile memory (no battery required) and protected by a user defined password with a hidden override key.

C. The flow sensor shall have the following requirements:

1. Liner Material – PTFE

2. Ethernet or Modbus TCP. Must be able to get flow and flow totals off of the flow meter.

3. Flow Measurement – as low as 6.0 micromhos/cm

4. Empty pipe detection

5. Bi-directional flow sensing/totalization

6. Automatic zero point stability

7. 1% repeatability or better

8. Sensor or remote wall mount

D. Acceptable flow sensor manufacturers are:

1. E&H Magnetic flow meter

2. Rosemount Magnetic flow meter

3. No equivalent allowed.

2.9 BUILDING

A. The structure shall be designed by a Colorado licensed Architect in accordance with currently adopted building code. Building specific construction specifications (ie. building materials, electrical) shall be provided. Considerations of the building design shall include the following:

1. Concrete floor with floor drains connected to the wet well.

2. Roof hatches or scuttle located directly above each vertical turbine pumps and wet well slide gate for removal and placement

3. LED interior lighting with minimum lighting levels within the building of 30fc with a 90CRI.

4. LED exterior lighting to operate under an automatic day/night switch, photometric study compliant with municipal code is required with submittals.

5. Exhaust fans and louvers for ventilation

6. Electrical heaters controlled by remote, wall mounted thermostat

7. Vandal-proof hardware on exterior

8. Precast Concrete Building

9. Wet well equipped with LED light, vapor proof with minimum 4000 lumens and located for easy maintenance and replacement.

B. Provide materials required by local codes for installation of the pump building.

1. Minimum inside dimensions as shown on the drawings.

2. Simulated formliner exterior finish sealed with clear coat graffiti guard.

3. Welding plates shall be inside the building and left exposed to view.

4. Provide entry doors as indicated on plans. Door handles to be Best Lock. Include hydraulic arms to each door intended for slow closing and providing means to keep doors open.

5. Provide roof hatch per the drawings and installation details.

6. Precast concrete roof and walls with cast out openings for fans, louvers, conduit and piping as shown in the details. Thicken roof slab at seam and slope roof slab away from the seam. Piping penetrations to be core drilled and sealed per the plans.

7. Wall Penetration Seal: Use hydraulic cement.

8. Manufacturers:

a. Stresscon Corporation

b. Wells Precast Innovations

c. Approved equal.

C. Electrical Components:

1. Refer to Electrical drawings and specifications.

2. Fan: Refer to drawings and installation details.

3. Louver: Refer to drawings and installation details.

4. Heater: Refer to drawings and installation details.

5. Conduit:

a. Use galvanized, rigid or flexible, conduit in the pump building.

b. Use PVC type, approved waterproof conduit for buried underground installations.

c. All conduit which conforms to Underwriters Laboratories specifications.

d. Furnish inert plastic yellow warning tape, minimum 3-inches wide, imprinted with "CAUTION: BURIED ELECTRIC LINE BELOW" above all direct buried conduit.

2.10 SUBSTITUTIONS

A. Make complete submittals of all manufacturer's data showing compliance with the Contract Documents.

B. In making a request for a substitution, the Contractor represents that he:

1. Has investigated the proposed substitution and found that it is the same or better quality, level, capacity, function, or appearance than the specified product, and can demonstrate that to the City and the Design Engineer.

2. Will coordinate the installation and make all modifications to the work, which are required for the complete installation and operation of the system.

C. The Design Engineer and City will determine acceptability of the proposed substitution and will notify Contractor of acceptance or rejection.

PART 3 – EXECUTION

3.1 PUMPS AND MOTORS

A. Shipping, off-loading, mounting details, and the technical start up shall be furnished by the pump station manufacturer. City of Greeley I&C Department representative shall be onsite for startup.

B. Affix pump system to concrete mounting pad and complete all piping connections prior to startup and operation of the pump system.

C. Electrical connection shall consist of a single conduit from three (3) phase, 480 volt, 200 amp disconnect to the pump station main disconnect.

D. Pump electrical connections shall use an Insulated Multitap Connector.

1. Manufacturers.

a. Polaris insulated Multitap connector.

b. Or approved equivalent.

E. Technical startup procedures by the pump station manufacturer shall include the following:

1. Station start up and pressurization

2. Pressure and flow

3. Programming adjustments

4. Monitoring of irrigation cycle

F. A manufacturer's representative/technician will instruct City personnel as to the operation, adjustment and maintenance of the pump station.

G. Provide the detailed start-up procedures from manufacturer to the City, a minimum two (2) weeks prior to start-up. City of Greeley I&C Department representative shall be onsite for start and review start-up procedures.

3.2 PRECAST CONCRETE BUILDING AND COMPONENTS

A. Precast Concrete Building: Construct precast building as shown in drawings. Submit shop drawings of proposed building prior to construction.

1. Compacted subgrade, slab and foundation per soils report.

2. Install buried conduit prior to building slab installation.

3. Install building per manufacturer's instructions. Seal all joints and penetrations. Use caulking consisting of 1 part urethane sealant.

4. Install galvanized vandal proof screens for all louvers. Paint screens to match building exterior.

B. Concrete Building Floor/Slab: Refer to Structural drawings and specifications.

1. Coordinate location and installation of building welding plates with building manufacturer prior to construction.

3.3 INSTALLATION OF PIPING COMPONENTS

A. Wall Penetration Seal:

1. Install hydraulic cement where indicated on drawings.

3.4 INSTALLATION OF ELECTRICAL

A. Refer to Electrical drawings and specifications. All installation of electrical components shall be performed by a licensed electrician (Colorado) and conform to the National Electric Code and all local building codes.

B. Conduit:

1. Install a continuous run of warning tape, placed in the backfill 6-inches above all direct buried conduit.

3.5 INSTALLATION OF OTHER COMPONENTS

A. Tools: Prior to substantial completion, supply to the Owner operating keys, servicing tools, test equipment, and any other items indicated on the drawings.

B. Other Materials: Install other materials or equipment shown on the drawings or installation details to be part of the pump building and mechanical system, even though such items may not have been referenced in these specifications.

3.6 TESTING

A. Notify the City two (2) week in advance of testing.

B. Pump System:

1. On completion of assembly of the pumping stations, all discharge pipe and valves shall be hydrostatically tested at 150% of the maximum pump shutoff head.

2. Test, verify, and demonstrate to the City the proper operation of all control and safety shut off devices.

3. Verify flow and discharge pressure from the pump system and demonstrate to the City system performance based on the specified values.

4. Coordinate availability of water with the City.

C. Building:

1. Operate fans, heaters, outlets, and building lights.

2. Adjust, move, repair system components to correct deficiencies. Repeat the test until the Owner's Representative approves the test results.

3. Cement or caulking to seal piping leaks is prohibited.

3.7 OTHER ITEMS

A. Prior to the pump start-up, the City shall be supplied with operating keys, servicing tools, test equipment, and any other items required for proper operation and maintenance of the pump station.

B. Install all materials or equipment shown on the Construction Drawings to be part of the non-potable irrigation pumping system, even though such items may not have been referenced in these specifications.

C. At the completion of project construction, As-Constructed Record drawings shall be submitted to the City in accordance with construction specification *Section 01785, Project Record Documents*.

3.8 PROJECT RECORD (AS-BUILT) DRAWINGS

A. Maintain on-site and separate from documents used for construction, one complete set of contract documents as Project Documents. Keep documents current. Do not permanently cover work until as-built information is recorded including photos of work as performed.

B. Record pipe and wiring network alterations. Record work which is installed differently than shown on the construction drawings. Record accurate reference dimensions, measured from at least two permanent reference points.

C. Prior to Final Review, obtain from the Engineer a reproducible copy or CAD files of the drawings. Using pen or CAD, duplicate information contained on the project drawings maintained on site. Label each sheet "Record Drawing". Completion of the Record Drawings will be a prerequisite for substantial completion.

D. Provide copy of all Record Drawings for Electrical and Instrumentation Controls wiring diagrams and programming information within a SCH 40 PVC conduit, large enough to hold documents, painted “SAFETY ORANGE” capped on both ends and labeled with 2” tall blocked black letters “RECORDS DRAWING” securely mounted to the wall inside the building, located in easily accessible and visible location adjacent to electrical equipment. Include CAD AND PDF versions of the drawings on a flash drive attached to a lanyard attached to the top cap of the container. Both ends shall have screwed on caps, not plugs, for easy removal and to shed water.

3.9 MAINTENANCE

A. Upon completion of Final Review, maintain the pump building mechanical system for a duration of 30 calendar days. Make periodic examinations and adjustments to the system components so as to achieve the most desirable operating conditions.

3.10 CLEANUP

A. Upon completion of work, remove from the site all machinery, tools, excess materials, and rubbish.

B. Remove all debris and foreign material from the construction area and pump building prior to operating the system.