Development Construction Standards.

Water
Wastewater
Stormwater

Revised 06/02/2017

City of Fort Collins Utilities

DIVISION 1

GENERAL REQUIREMENTS

01000	APPROVED PRODUCT LISTING	01000-1 – 01000-11
01110	GENERAL PROVISIONS	01110-1 – 01110-8
01600	MATERIAL, EQUIPMENT AND WORKMANSHIP	01600-1 – 01600-2
01710	SITE CLEANUP	01710-1 – 01710-2
01720	FIELD ENGINEERING AND SURVEYING	01720-1 – 01720-2
01780	RECORD DRAWINGS	01780-1 – 01780-2

Revisions/Approvals

12/16/2011: Approved by Ordinance No. 164, 2011

3/23/2016: Division 1 Technical Corrections Approved by Utilities Executive Director pursuant to Fort Collins City Code Section 26-29(b)

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SECTION 01000

APPROVED PRODUCT LISTING

PART 1- GENERAL

1.1 DESCRIPTION

A. This section lists the required manufacturers and/or products referred to in the following sections of the standard construction specification.
B. This to be used as a summarized list of approved products and manufacturers. Specifications and Construction Details shall be reviewed in addition to this list.
C. An Approved Equal is determined by the Water Engineering and Field Services Operations Manager or his/her authorized representative.

1.2 APPROVED MATERIALS LIST REVIEW PROCEDURES

A. City of Fort Collins Utilities reviews this list yearly for modifications, additions and removals.
B. To have a material added to this list, see the Approved Materials List Review Procedures at the end of this Appendix.

PART 2 - PIPE CASING, BORING AND JACKING

2.1 CASING SEALS:

A. Pipeline Seal and Insulator Co. (GPT Industries), Model W. (“Wrap Around”)
B. Cascade Waterworks Mfg., Model CCES.
C. Or An Approved Equal.

2.2 CASING CHOCKS/SPACERS:

A. Cascade Waterworks Mfg., CCS Models.
B. Advanced Products & Systems, Inc., Model SS1
C. Pipeline Seal and Insulator Co. (GPT Industries), Model S.
D. Or An Approved Equal.

2.3 ANODES:

A. Farwest Corrosion Control Company
B. Or An Approved Equal.

2.4 ANODE WIRE SPLICE CONNECTIONS:

A. Pre-manufactured cathodic protection splice kits shall be Royston “MINI SPLICE-RIGHT” with a copper crimp it connector
B. Or An Approved Equal.

2.5 EXOTHERMIC WELDS:

A. Erico Products Inc. “CADWELD”
B. Burndy “THERMOWELD” or approved equal.

2.6 PIPELINE AND EXOTHERMIC COATINGS:

A. Pipe line coatings for ductile iron pipe:

a. Koppers “Bitumastic 50"
b. Royston Mfg. “Roskote A51"
c. Or Approved Equal.

B. Pre-filled weld caps shall be:

a. Royston “Handicaps”
b. Or An Approved Equal.

C. Pipeline coatings for steel pipe:

a. Polyken 927 primer and 934 Tape
b. Or An Approved Equal.

PART 3 - MANHOLES, VAULTS AND INLETS

3.1 PIPE PENETRATION GASKETS – CAST-IN-PLACE STRUCTURES

A. Indiana Seal – Manhole Adapter
B. Standard “O” ring gasket
C. Or an Approved Equal

3.2 PIPE PENETRATION GASKETS – PRECAST STRUCTURES

A. Kor-N-Seal, Dukor Company
B. PS-10, Press Seal Gasket Corp.
C. A-Lok, A-Lok Corp.
D. Lock Joint Flexible Manhole Sleeve, Interpace Corp.
E. Or An Approved Equal.

3.3 MANHOLE FRAMES AND COVERS

A. Neenah – R1706, w/ type “K” cover pattern,
B. Deeter Foundry, Inc. – Model 1258,
C. Castings, Inc.,
D. Or An Approved Equal

3.4 MANHOLE STEPS

A. M.A. Industries, Model PS2-PF.

B. Or An Approved Equal.

3.5 JOINT SEALANTS

A. "Rub'r-Nek:, K.T. Snyder Co.
B. "Kent Seal", Hamilton-Kent Manufacturing Co.
C. GS #79, 44, or 4, General Sealants.
D. ConSeal, CS202.
E. Or An Approved Equal.
F. "Ram-Nek" is not acceptable.

3.6 GROUT

A. Pre-mixed: Master Builders “Set Grout”, Sika “Grout 212”.
B. Or An Approved Equal.

PART 4 - WATER DISTRIBUTION PRODUCTS

4.1 DUCTILE IRON PIPE AND FITTINGS

A. PIPE:

a. American Cast Iron and Pipe Company
b. U.S. Pipe
c. McWane Ductile
d. Or an Approved Equal

B. FITTINGS:

a. Star Pipe Products (Epoxy Coated)
b. Tyler Union (Epoxy Coated)
c. SIP Industries (Epoxy Coated)
d. Castings, Inc. (Epoxy Coated)
e. Sigma Corporation (Epoxy Coated)

C. FOSTER ADAPTER:

a. INFACT Corporation (Epoxy Coated)
b. Or An Approved Equal

D. MECHANICAL JOINTS RESTRAINTS:
(Type 304 stainless steel bolts and tie rods on all restraints)

a. Megalug, Series 1100, EBAA Iron, Inc.
b. Stargrip, Series 3000, Star Pipe Products, L.P.
c. Uniflange, Series 1400, Ford Meter Box Co., Inc.
d. GripRing, Romac Industries, Inc.

e. One-Lok, Sigma Corporation

E. PUSH-ON JOINTS RESTRAINTS:
(Type 304 stainless steel bolts and tie rods on all restraints)

a. Megalug Series 1700, EBAA Iron, Inc.
b. Stargrip, Series 4000, Star Pipe Products, L.P.
c. Uniflange Series UFR 1390-C, Ford Meter Box Co., Inc.
d. Romac 600 Series Style 611, Romac Industries, Inc.
e. One-Lok, Sigma Corporation

4.2 PLASTIC PRESSURE PIPE

A. PIPE:

a. Diamond Plastics Corporation
b. J-M Eagle
c. North American Pipe Corporation
d. VinylTech Pipe
e. North American Specialty Products (Certa-Lok)
f. Underground Solutions, Inc. (Fusible C-900)
g. Or an Approved Equal

B. MECHANICAL JOINTS RESTRAINTS:
(Type 304 stainless steel bolts and tie rods on all restraints)

a. Megalug, Series 2000PV or 2000SV, EBAA Iron Inc.
b. Stargrip, Series 4000, Star Pipe Products, L.P.
c. Uniflange Series 1500, Ford Meter Box Co., Inc.
d. GripRing, Romac Industries, Inc.
e. One-Lok, Sigma Corporation

C. PUSH-ON JOINTS RESTRAINTS:
(Type 304 stainless steel bolts and tie rods on all restraints)

a. Megalug, Series1600, EBAA Iron Inc.
b. Stargrip, Series 4100, Star Pipe Products, L.P.
c. Uniflange Series UFR 1390-C, Ford Meter Box Co., Inc.
d. Romac, 600 Series Style 611, Romac Industries, Inc.
e. One-Lok, Sigma Corporation

4.3 VALVES

A. GATE VALVES:

a. Mueller
b. American Flow Control
c. Clow
d. M & H Valve Company
e. US Pipe.

B. BUTTERFLY VALVES:

a. Mueller
b. Pratt
c. American Darling (Val-Matic)
d. DeZurick
e. M & H Valve Company.

C. VALVE BOXES:

a. East Jordan Iron Works 8560 series
b. Casting Inc 6860 series
c. Tyler 6860 series

D. COMBINATION AIR RELIEF/VACUUM RELIEF VALVES:

a. Val-Matic Valve and Mfg. Corporation (series 200C).
b. APCO Combination Air Release Valve, by Valve and Primer Corporation.
c. Crispin Universal Air Valve, by Multiplex Manufacturing.
d. CAV Combination Air Release and Vacuum Valve, by G.A. Industries Inc.
e. D-040 Combination Air Valve, by A.R.I. Flow Control Accessories
f. D-060 Combination Air Valve, by A.R.I. Flow Control Accessories

4.4 TAPPING SLEEVES FOR DISTRIBUTION LINES

A. TAPPING SLEEVES:

a. Romac: FTS 420, Stainless Steel
b. Smith Blair, Inc. Stainless Steel
c. Ford Meter Box Co, Stainless Steel

4.5 HYDRANTS

A. FIRE HYDRANTS:

a. Mueller: No. A-423 (5-1/4" Super Centurion 250), Aqua-Grip restraint system may be used with Mueller hydrant, no other options required.
b. Waterous: Pacer 250 with Weather-Shield nut (5-1/4"), shall include a bronze bushed shoe providing bronze to bronze seating for the main valve complete with O-ring for sealing.
c. No substitutions allowed.

4.6 TRACER WIRE AND LOCATING STATIONS

A. TRACER WIRE:

a. 12AWG Solid Core Wire, Copperhead Industries, LLC
b. Or Approved Equal

B. WIRE CONNECTORS:

a. SnakeBite Connectors (12 AWG), Copperhead Industries, LLC
b. Or Approved Equal

C. GROUND RODS:

a. Magnesium Drive in Anode, #ANO-12, Copperhead Industries, LLC
b. Or Approved Equal

D. LOCATOR STATION BOXES WITH LID LABELED “LOCATOR STATION”:

a. Tyler 6855 Series
b. East Jordan Iron Works (EJIW) 8555 Series

4.7 WATER SERVICE LINES AND APPURTENANCES

A. TAPPING SADDLES:

a. Mueller.
b. Ford.
c. James Jones Co.
d. No substitutions allowed.

B. CORPORATION STOPS:

a. Mueller; #B25008.
b. Mueller, #N35008 (If insulated corp is required)
c. Ford (quick joint coupling only); #FB1000-Q.
d. A. Y. McDonald; #74701BQ.
e. No substitutions allowed.

C. COUPLINGS:

a. Mueller; #H-15403.
b. Ford (quick joint coupling only); C44-Q.
c. A. Y. McDonald; #4758Q.
d. No substitutions allowed.

D. CURB STOPS:

a. 3/4-inch and 1-inch curb stops:

i. Mueller; B25155 (with Minneapolis top threads).
ii. A. Y. McDonald; #6104Q (with Minneapolis top threads).
iii. Ford; B44-MQ (quick joint coupling only with Minneapolis top threads).
iv. No substitutions allowed.

b. 1 ½-inch curb stops:

i. Mueller; B25155 (with Minneapolis top threads).
ii. A. Y. McDonald; #6104Q (with Minneapolis top threads).
iii. Ford #B44-MQ (quick joint coupling with Minneapolis top threads).
iv. No substitutions allowed.

c. 2-inch curb stops:

i. Mueller; B25155 (with Minneapolis top threads).
ii. A. Y. McDonald #6104Q (with Minneapolis top threads).
iii. Ford #B44-MQ (quick joint coupling with Minneapolis top threads).
iv. No substitutions allowed.

E. CURB BOXES FOR CURB STOPS

a. Mueller; #H-10302.
b. No substitutions allowed.

4.8 METERS AND APPURTENANCES

A. METERS AND STRAINERS

a. Neptune
b. Badger
c. No Substitutions Allowed

B. METER SETTERS

a. 5/8 x ¾ inch copperhorns (interior meter settings)

i. Ford #CH88-233 with B-11-233 ball valve on each end with HB-2 handles on both valves and ¼-inch tag mounting hole in both handles.
ii. A.Y. McDonald #43-2 MM33 M style with 6101 ball valve on each end with 6120 handle on both valves and ¼-inch tag mounting hole in both handles.

b. 5/8 x 3/4-inch coppersetters (exterior meter settings)

i. Ford XV82W-44-33
ii. Mueller #H-1440 with ¾-inch 110 compression connections.
iii. A.Y. McDonald #A.Y. 731-2-WXQQ 33
iv. No Substitutions Allowed

c. 1-inch coppersetters (exterior meter settings)

i. Ford V84-44-44 pack joint type
ii. Mueller #H1440 with 1-inch compression #H15451
iii. A.Y. McDonald – 731-410WXQQ 44
iv. No Substitutions Allowed

d. 1½-inch and 2-inch meter setters

i. Ford
1. 1½-inch #VV76B-11-66NL
2. 2-inch #VV77-12B-11-77NL
3. No Substitutions Allowed

ii. Mueller
1. 1½-inch #H-1423
2. 2-inch #H-1423
3. No Substitutions Allowed

iii. A.Y. McDonald
1. 1½-inch #720B618WWFF 665
2. 2-inch #720B712WWFF 775
3. No Substitutions Allowed

C. METER BOXES

a. 5/8 x 3/4-inch and 1-inch meter boxes:

i. DFW Plastics #DFW 20 x 48.
ii. Mid States Polyethylene, # 20 x 48.
iii. No substitutions allowed.

b. Covers and lids for 5/8 x 3/4-inch and 1-inch meter boxes:

i. Ford; #W3 cover with a WA3L-TP lid.
ii. No Substitutions Allowed

c. 3-inch extensions for 5/8 x 3/4-inch and 1-inch meter boxes:

i. DFW Plastics, DFW-203R
ii. Mid States Polyethylene, 81R03.
iii. No Substitutions Allowed.

D. METER PITS AND VAULTS

a. Meter pits and vaults for 1 ½-inch and larger meters are:

i. Oldcastle Precast Concrete
ii. Aguilar's Precast Concrete
iii. Colorado Precast Concrete
iv. Panhandle Concrete Products
v. Or an Approved Equal

b. Meter pit and vault covers for 1 ½-inch and larger meters are:

i. Casting Incorporated #MH-125-24 AL-WATER.
ii. No substitutions allowed.

c. AMR Pods for Meter pits and vaults 1 1/2 -inch and larger meters are:

i. AMR POD (FORD yoke box part # YUC-7 with FORD yoke box lid part # YL-TP with 1 27/32" dia. hole and removable plug).
ii. No Substitutions Allowed

PART 5 - WASTEWATER COLLECTION PRODUCTS

5.1 PLASTIC PIPE

A. PIPE:

a. Diamond Plastics Corporation
b. J-M Eagle
c. North American Pipe Corporation
d. VinylTech Pipe
e. North American Specialty Products (Certa-Flo)
f. Or an Approved Equal

B. JOINT WRAP:

a. Mar Mac Construction Products Co.
b. Or an Approved Equal

5.2 MANHOLE LINING

A. INTERIOR LINING

a. Spectra Shield Liner System, SpectraShield
b. Sewer Shield, Environmental Coatings, LLC
c. Raven 405, RLS, Inc.
d. Or an Approved Equal

B. EXTERNAL DAMPPROOFING

a. Hydrocide 600, Sonneborn
b. Damp Proof Coating, DECO 20
c. Or an Approved Equal

5.5 PIPE COUPLING DEVICES

A. PIPE COUPLINGS:

a. Pipe Coupling, Fernco
b. Or an Approved Equal

PART 6 - STORMWATER COLLECTION PRODUCTS

6.1 MANHOLE AND INLET COVERS (Must be stamped “Dump no waste Drains to Waterways”)

A. AREA INLETS:

a. East Jordan Iron Works
b. Neenah Foundry
c. Or An Approved Equal

B. CURB INLETS:

a. East Jordan Iron Works
b. Neenah Foundry
c. Or An Approved Equal

6.2 SAND OIL SEPARATOR

A. SNOUT:

a. Best Management Products, Inc.
b. Or An Approved Equal.

6.3 PIPE JOINT WRAP

A. EXTERNAL PIPE WRAP

a. Rubr-Nek External, Henry
b. EZ-Wrap, Press-Seal Gasket Corporation
c. Or An Approved Equal

PART 7 - EXECUTION – (Not Applicable)

*****END OF SECTION*****

APPROVED MATERIALS LIST REVIEW PROCEDURES

1. Contractors, Suppliers and Manufacturers who desire to have alternate materials approved for inclusion into these standards, shall submit such material data by the Third Friday of December to the Utilities Department (attention Water Field Operations Manager). Any information received after this date will not be reviewed.

   Water Field Operations
   Attn. Operations Manager
   700 Wood Street
   Fort Collins, CO 80522

2. The Department may request additional information to supplement or clarify the submitted material data. All received information will be reviewed during the months of January and February. At the Departments discretion the review may take up to a year in which the decision will be made the following calendar year.

3. The Department will complete the review and make a final decision regarding approved materials, by the end of February. The updated Approved Materials List will be posted on the internet on the City of Fort Collins Utilities Website. Contractors, Suppliers and Manufacturers desiring to appeal the Department's final decision, shall submit a written appeal to the Water Engineering and Field Services Operations Manager within 30 days after final decision.

4. The Operations Manager shall review the appeal and render a decision by the end of April. The decision of the Operations Manager will be final.

5. It is the Departments preference that all materials and equipment be Made in America. Contractors, Suppliers and Manufacturers desiring to submit materials for approval, review and inclusion in these Standards, shall submit, at a minimum, the following information:

   Manufacturer's standard drawings, schematics, diagrams and brochures;

   i. Description of the material, part or equipment to be considered.
   ii. Supplemental standard information to provide information specifically applicable to the material or equipment.
   iii. Detailed operation, maintenance and disassembly information for maintenance if applicable.
   iv. Manufacturer's name, type, model number and warranties of material or equipment.
   v. Applicable standards, (ASTM, AWWA, Federal Specifications numbers, etc.)
   vi. The Department will likely request samples of parts and materials be shipped for review, trial and testing at the requestor's expense.
   vii. Contractors, Suppliers and Manufacturers may be asked to visit the Department for a review and discussion in person.
   viii. Drawings, catalogs or parts thereof, manufacturer's specifications and data, instructions, performance characteristics and capacities, and other information specified or necessary.
   ix. Descriptive literature for paint and coating systems.
   x. Description of where parts may be ordered, where manufactured and anticipated time for delivery.
   xi. Contact information of local municipalities that also use the product.

*****END OF SECTION*****

SECTION 01110

GENERAL PROVISIONS

PART 1 GENERAL

1.01 PURPOSE AND SCOPE

A. The purpose of these technical specifications is to set forth the minimum standards for construction and installation of: 1) 15-inch and smaller sewer mains, sewer services and all appurtenances associated with these mains and services; 2) 16-inch and smaller water mains, water services, cathodic protection test stations and all appurtenances associated with these mains and services; and 3) storm drainage facilities within the City of Fort Collins and its Urban Growth Area. Subdivisions, planned unit developments, or other proposed construction shall include an adequate plan for storm drainage in accordance with the Storm Drainage Design Criteria. Prior to construction, approval of Plans/Drawings shall be made by the City Engineer.

B. In the case of sanitary sewer mains larger than 15-inches or the water mains are larger than 16-inches, the Developer or his/her representative shall use the City's standard specifications developed for Capital improvement projects.

C. In some cases when construction occurs in areas with existing water, wastewater and stormwater there will be the need to repair or rehabilitate the existing facilities. The Utility may require specific work or materials not covered in these specifications.

D. As with any construction standards, occasions may arise where the minimum standards are either inappropriate or cannot be justified economically. In these cases a variance to these standards shall be considered. Written requests for variance should be directed to the Utilities.

E. The Contractor shall make himself thoroughly familiar with the provisions and the content of the Specifications.

F. These specifications are composed of written material specifications. The interpretation of these specifications shall be made by Utilities.

G. When a conflict occurs within these specifications, an interpretation shall be made by Utilities.

H. In the event that a conflict between water mains and services, other utilities, and other departments within the City is identified during construction, Contractor shall contact the Engineer/Utility to interpret these specifications or to determine if the standards of other utilities or departments apply.

1.02 REVISIONS TO THE CONSTRUCTION STANDARDS

A. These standards shall be periodically revised and amended.

1.03 DEFINITIONS AND TERMS

A. Definitions

Whenever the definitions, abbreviations and terms listed in this section are used in these standards they shall be defined as follows:

1. **City** – The City of Fort Collins
2. **City Code** – The latest officially adopted City Code Regulations of Fort Collins, Colorado.
3. **Construction Drawings** – Details and working drawings, including plan, profile, and detail sheets of proposed utility improvements, approved by the Engineer/Utility.
4. **Consultant** – A person, partnership, or corporation duly registered as a professional engineer according the Colorado Statutes who is hired by the land owner or developer and is empowered to act as his/her agent.
5. **Contractor** – A person, partnership, or corporation duly licensed and bonded in the City of Fort Collins in accordance with the requirements of the City Code.
6. **Design Engineer** –The partnership, corporation, or individual who is registered as a professional engineer, according to Colorado Statutes, and who is hired by the owner, and is empowered to act as his/her agent for the project.
7. **Developer**– The person or persons, public or private, legally responsible for construction of improvements within a specific development.
8. **Engineer** – The City Engineer, City of Fort Collins, Colorado, or his/her authorized representative acting on behalf of the City.
9. **Engineer/Utility** – A term used in situations where a decision or action may be required by the Utility, but the request for the decision or the action must be routed through the Engineer.
10. **Acceptance** – the date that all public improvements are accepted by the Engineer.
11. **Inspector** – The authorized representative of the Engineer or Utility assigned to make detailed inspections for contract performances, standards and contract compliance.
12. **May** – A permissive condition. No requirement for design or application is intended.
13. **Or An Approved Equal** – as approved to being acceptable by the Utility.
14. **Record Drawings** - detailed drawings which have been prepared by the Design Engineer, upon completion and prior to final acceptance, and show actual construction and contain field dimensions, elevations, details, changes made to the Construction Drawings by modification, details which were not included on the Construction Drawings, and horizontal and vertical locations of underground utilities which have been impacted

or found during the utility installation. Horizontal and vertical locations should be shown with coordinates that are tied to the two approved project benchmarks. Record Drawings are usually Construction Drawings which have been modified to contain the information listed above.

15. **Right-of-Way** – A general term denoting land, property, or interest therein, usually in a strip acquired for or devoted to a street or utility.
16. **Shall** – A mandatory condition. Where certain requirements in the design or application are described with the "shall" stipulation, it is mandatory that these requirements be met.
17. **Should** – An advisory condition. Where the word "should" is used, it is considered to be advisable usage, recommended but not mandatory. Deviations may be allowed when reasons are given which show intent of the design standards is met.
18. **Standard Street Specifications** – The current City of Fort Collins adopted Larimer County Urban Area Street Standards (LCUASS).
19. **Street** – A general term denoting a public way for purposes of vehicular travel, including the entire area within the right of way (including alleyways).
20. **Storm Drain** – Any conduit and appurtenance intended for the reception and transfer of storm water.
21. **Storm Drainage Design Criteria**– The current City of Fort Collins Stormwater Criteria Manual.
22. **Utility** – Utilities Executive Director or his/her authorized representative.
23. **Water Quality Lab** – A division of the Utility that conducts water quality tests.
24. **Work** – the entire completed construction of the various separately identified parts required to be furnished for the project. Work is the result of performing services, furnishing the labor and furnishing and incorporating materials and equipment into the construction.

B. Terms

1. Wherever the words "**as described**," "**as required**," "**as permitted**," or words of like meaning are used, it shall be understood that the direction, requirements or permission of the City Engineer is intended. Similarly, the words "**approved**," "**acceptable**," "**satisfactory**" shall refer to approval by the Engineer or Utility.
2. References to standards, methods of testing materials, testing materials codes, practices or other requirements refer to the latest edition, including amendments in effect and published at the time of approval in issuing a permit.
3. "**These Standards**" or words of similar connotation shall mean the City of Fort Collins specifications including all parts, supplements, and revisions pertaining thereto.
4. "**Provide**" shall mean furnish and install complete in place.
5. "**Remove**" shall mean remove and dispose of properly.
6. "**Shall**" shall mean a mandatory condition.
7. "**Ability**" shall mean that which a person can do on the basis of present development and training.
8. "**Competent**" shall mean a person who has the natural powers, physical, or mental to meet the demands of a situation or work. The word is widely used to describe the ability to meet all requirements, natural, legal, or other of a given task.

9. "**Qualified**" shall mean acquired abilities, skills, knowledge, experience, that fits a person for a position, office, or profession.
10. These Specifications contain many command sentences which are directed at the CONTRACTOR unless otherwise stated.

1.04 AUTHORITY OF THE ENGINEER

A. The City Engineer or their designated representative shall have the authority on behalf of the CITY to ascertain that all design and construction is equal to or exceeds the minimum requirements set forth in these standards.

1.05 AUTHORITY OF UTILITY

A. The Utilities Executive Director or their designated representative shall have the authority on behalf of the CITY to ascertain that all design and construction is equal to or exceeds the minimum requirements set forth in these standards.

1.06 AUTHORITY OF THE INSPECTOR AND/OR ENGINEER/UTILITY

A. The Inspector shall have authority on behalf of the City Engineer and Utilities Executive Director to make detailed inspections for compliance with Construction Drawings and specifications.

1.07 CONTRACTORS LICENSED AND BONDED

A. The Contractor shall be licensed and bonded with the City of Fort Collins prior to construction of facilities for acceptance by the City.

1.08 CONTRACTOR'S RESPONSIBILITY

A. The Contractor shall be responsible to comply with these standards and other applicable laws and regulations.

B. The Contractor shall furnish conveniences and assistance to the Inspector and Engineer/Utility for inspection of materials used and workmanship involved in construction.

C. Contractor shall request clarification of all apparent conflicts by contacting the Engineer/Utility. The Engineer/Utility will not be responsible for any explanations, interpretations, or supplementary data provided by others.

1.09 NOTICE BEFORE BEGINNING WORK

A. The Contactor shall notify the City Engineer's office a minimum of 48 hours before beginning construction.

1.10 CONNECTION TO EXISTING PIPELINES AND STRUCTURES

A. All connections to existing water, sewer, stormwater pipelines and structures shall be made at a time authorized by the Engineer/Utility.

1.11 TRAFFIC CONTROL

A. The Contractor shall provide an approved traffic control plan and shall comply with the City of Fort Collins Work Area Traffic Control Handbook. If the City Engineer finds the construction area to have inadequate traffic control he has the authority to stop that portion of work until corrective measures are taken.

1.12 PRESERVATION OF PROPERTY

A. Existing improvements, adjacent property utilities, trees, and plants that are not to be removed shall be protected from injury or damage resulting from the Contractor's operations.

1.13 REPLACEMENT OF SURFACE IMPROVEMENTS

A. All improvements removed within the public right of way shall be replaced in accordance with the Larimer County Urban Areas Streets Standards (LCUASS). Other improvements shall be replaced as shown on the Construction Drawings.

1.14 REJECTED MATERIALS

A. The Contractor shall remove defective or inferior materials from the work area within a reasonable length of time. The Contractor shall separately stockpile rejected materials until they are removed from the work area.

1.15 SITE MAINTENANCE AND CLEANUP

A. Throughout all phases of construction, including suspension of work, and until final acceptance of the project, the Contractor shall keep the work site clean and free from rubbish and debris. Materials and equipment shall be removed from the site as soon as they are no longer necessary. Upon completion of the work, the Contractor shall clear the work site of equipment, unused materials, and rubbish.

1.16 SAFETY REQUIREMENTS

A. The Contractor shall comply with Federal, State, and local safety requirements.

B. Contractor shall be responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work. Contractor shall take all necessary precautions for the safety on, and shall provide the necessary protection to prevent damage, injury or loss to:

1. Employees on the work and other persons who may be affected.

2. The work and materials or equipment to be incorporated therein, whether in storage on or off the site.
3. Other property at the site or adjacent thereto, including, but not limited to trees, shrubs, lawns, walks, pavements, roadways, structures and utilities not designated for removal, relocation or replacement in the course of construction.

1.17 ENFORCEMENT – EROSION CONTROL

A. Changes to the erosion control plan or time sequence must be submitted in writing to the City for approval prior to implementing changes. Deviations from the plan or original time sequence without City approval may result in:

1. Stoppage of all or part of the work,
2. Holding of building permits,
3. Holding of certificates of occupancy to commercial/industry sites, and/or
4. Calling of the security.

B. Approval or disapproval of plan or sequence changes will be made in five working days.

1.18 WARRANTY – EROSION CONTROL

A. The Developer shall warrant that the measures shown on the approved erosion control plan are properly constructed, installed, and are free from defective materials and/or workmanship with said warranty to continue for the terms set forth below.

B. The Developer shall warrant and maintain all structural measures and vegetative measures for a two-year (2) maintenance guarantee and a five-year (5) guarantee covering all errors and omissions in the design and/or construction of the improvements and which guarantees shall run concurrently and shall commence upon the date of completion of the improvements and acceptance thereof by the City. Any acceptance of installed measures shall not be construed to relieve the Developer of the duty to warrant and maintain as aforesaid.

1.19 WARRANTY

A. Developer shall maintain and repair all work that was installed incorrectly, or otherwise prove to be defective. Developer shall provide a two-year (2) maintenance guarantee and a five-year (5) guarantee covering all errors and omissions in the design and/or construction of the improvements and which guarantees shall run concurrently and shall commence upon the date of completion of the improvements and acceptance thereof by the City.

1.20 UNDERGROUND UTILITIES

A. It shall be the responsibility of the Contractor to verify the existence and location of all underground utilities, including service connections, along the route of the work at least

48 hours prior to interruption of service or operation and to coordinate the construction schedules with these utility owners. See Section 01180 for a list of Utility Sources.

B. The Contractor shall field verify all utilities and coordinate construction with utility owners prior to starting construction. The Contractor shall be responsible for protecting utilities during construction and scheduling utility adjustments to eliminate conflict with progress of the work. Any damage to existing utilities shall be repaired.

C. The Contractor shall notify the Engineer/Utility and Design Engineer immediately of any field condition not consistent with the Construction Drawings.

1.21 SPECIAL REQUIREMENTS

A. All items and work not covered by these specifications shall be discussed with the Utility, and the Contractor shall receive approval from the Utility, in writing, prior to beginning work.

B. All work must be accepted by the Engineer/Utility prior to being placed in service.

C. No work shall take place on weekends or holidays without prior authorization from Engineer. Contact Engineer at least 48 hours (exclusive of holidays and weekends) prior to working in areas near underground utilities, pole lines, or on private property. Utility will make every effort to assist with notifications received less than the 48 hours required.

D. Prior to commencing work, Contractor shall designate, an authorized representative who shall have complete authority to represent Contractor and shall be on construction site at all times during work activities.

E. Developer’s Contractor shall not be allowed to start construction of above ground structures until all underground construction problems have been resolved, and tests have been performed and accepted.

1.22 FIELD CHANGES

A. Field changes from the approved plans shall not be permitted without prior permission from the Utility.

1.23 UTILITY FURNISHED MATERIALS

A. If Utility furnishes any materials, Contractor shall be responsible for such materials once materials have been picked up or delivered to job site.

B. Contractor shall repair, in a manner acceptable to Engineer/Utility, or replace any 'Utility furnished material', which has been damaged or stolen, at his/her own expense.

C. Contractor is responsible for careful inspection of 'Utility furnished material' at time of delivery.

D. Utility is responsible for quality and operational design aspects of furnished material.

1.24 QUALITY CONTROL

A. Inspection.

1. Engineer shall make periodic checks to verify the quality and progress of Work. The authorized agents and their representatives of the Engineer/Utility shall be provided safe access to the work, whenever it is in preparation or progress.

2. Contractor shall provide for such access and for inspection, including maintenance of temporary and permanent access.

3. Materials and equipment rejected by Engineer shall be identified and remain on site until approved for removal by Engineer.

1.25 LAND MONUMENTS

A. Private monuments shall be preserved, or replaced by a licensed surveyor at the Contractor's expense.

1.26 EROSION CONTROL

A. Contractor shall conform to the requirements set forth in the Erosion Control section of the Fort Collins Stormwater Criteria Manual and Amendments. www.fcgov.com/erosion

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

SECTION 01600

MATERIAL, EQUIPMENT AND WORKMANSHIP

PART 1 GENERAL

1.01 MATERIALS AND EQUIPMENT

A. Contractor shall furnish all materials, equipment, labor, and all other facilities and incidentals necessary for the execution, disinfection, testing, and completion of the work, with the exception of certain Utility furnished material.

1. Reference Section 01110 and 02646.

B. All materials and equipment shall be of good quality and new, except as otherwise provided on the Construction Drawings.

1. When requested by the City, the Contractor shall furnish satisfactory evidence (including manufacturer's certification) as to the kind and quality of materials and equipment, and their compliance with these specifications.

a. It is the Contractor's responsibility to insure that the manufacturer's materials supplied, meet these specifications.

b. The City shall test any manufacturer's material it deems necessary.

2. Prior to using existing materials, written approval must be obtained from the Utility.

C. All materials and equipment shall be installed and used in accordance with the instructions of the applicable manufacturer, fabricator, supplier or distributor, except as otherwise provided in these specifications.

D. The specification of materials and equipment shall be understood to be representative of a quality of performance, operation and construction acceptable to the Utility.

1. The Utility shall evaluate all written requests for product substitution.

a. Such requests shall include detailed product literature and a description of benefits which might be achieved by this substitution.

E. In approving materials or equipment for installation, the Utility assumes no responsibility for injury or claims resulting from failure of the materials or equipment to comply with the applicable National, State, and local safety codes or requirements, or the safety requirements of a recognized agency; or failure due to faulty design concepts, or defective workmanship.

1.02 WORKMANSHIP

A. Contractor shall provide competent, disciplined, suitably qualified personnel to supervise the work and perform the construction.

1. Any workmen deemed not qualified, in the opinion of the City, shall not be allowed to perform any construction, and shall be restricted from participating in the Work.

B. The construction standards, tests and methods outlined in these specifications are considered adequate to produce the product desired by the Utility.

1. The Utility shall evaluate alternative methods of construction upon request.

a. Requests for alternative methods of construction shall include detailed descriptions of the equipment, methods and controls needed for the alternative, and a description of the benefits which might be achieved by this substitution.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

SECTION 01710

SITE CLEANUP

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General:

1. This Section includes requirements for cleanup of the construction site.

2. When the work is being done as a part of a contract between a Developer and a Contractor, this Section shall be used as a guideline. The actual requirements should be contained in the contract between the Developer and Contractor.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 SITE CLEANUP

A. Site cleanup shall be executed during the progress of the work, and at completion of the work.

B. Site cleanup shall be maintained in a safe condition at all times.

C. Construction materials shall be neatly stored.

D. Containers shall be provided for the collection of waste material and debris.

1. Containers shall not be stored in any existing public right-of-way without the written permission of the City.

E. Construction materials, equipment, waste containers, construction buildings, parking, etc., shall not be allowed within any existing public right-of-way without written permission from the City.

1. Any off-site storage of construction material, equipment, waste containers, construction buildings, parking, etc., shall be allowed only after the Contractor has obtained the written permission of the property owner.

a. A copy of the agreement shall be available at the job site at all times.

F. During construction the job site shall be adequately protected from soil erosion in accordance with these Specifications and 1.26 Erosion Control in Section 01110.

G. Sanitary facilities shall be provided for all workers whom are working outdoors.

H. Upon completion of the construction, the job site shall be restored in accordance with these Specifications.

I. All exterior paved surfaces shall be broomed and/or washed clean and left in good repair.

1. Engineer and Contractor shall inspect all exterior paved surfaces before and after construction to insure their condition.

J. In order to maintain an orderly site, waste material and debris shall be removed weekly.

K. Volatile wastes shall be stored in clearly marked, covered, metal containers and removed daily in accordance with federal, state and local requirements.

L. Contractor shall conform to the requirements set forth in the City's Erosion Control Reference Manual.

END OF SECTION

SECTION 01720

FIELD ENGINEERING AND SURVEYING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Surveying: It shall be the responsibility of the Developer to provide construction staking for horizontal and vertical alignment of the centerline, grading, and all appurtenant features of the work including all offset lines necessary for construction.

B. All construction surveying provided by the Developer shall be completed under the supervision of a Colorado Registered Land Surveyor.

The Design Engineer shall provide the elevations and descriptions of the original and temporary project benchmarks.

Adequate staking shall be provided to establish acceptable horizontal and vertical control.

Offsets shall be staked so that vertical and horizontal alignment may be checked.

All survey data, which is developed by the Contractor or the Design Engineer in performing surveys which are required by the work, shall be available to the City for examination throughout the construction period.

C. Supervision: The Contractor shall have supervision, knowledge of the project requirements and proper installation, and construction procedures, available in the field at all times that work is progressing.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

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SECTION 01780

RECORD DRAWINGS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Final Paperwork:

The Contractor shall deliver the following items to the Engineer/Utility upon completion of the Work:

1. Record Drawings

a. Record Drawings should be prepared with a cooperative effort of the Design Engineer and the Contractor.

b. Record Drawings shall be provided to the Utility/Engineer from a Colorado registered professional engineer verifying that construction of the utilities were to plan. If utilities are constructed not to plan they need to be accurately depicted on the record drawings with the following criteria.

c. Each drawing shall be labeled: ”RECORD DRAWING” in neat large printed letters.

d. Construction information shall be recorded concurrently with construction progress.

e. Record Drawings shall record actual construction and contain the following:

1) Field dimensions, elevations, and details.
2) Horizontal coordinates and elevations tied to the approved project benchmarks and datum.
3) Field changes which are made by modification.
4) Details that are not on the original Construction Drawings.
5) Elevations of manhole inverts in relation to project datum.

f. Record Drawings shall be submitted to the Engineer/Utility containing the following:

1) The signature of the Colorado registered professional engineer, and his/her professional engineering stamp and date.

g. Record Drawings shall be submitted in a 24” x 36” format and shall include six (6) sets of paper copies and one (1) set on reproducible, double matte Mylar.

h. The Engineer shall provide to the Utility in AutoCAD version 2007 or newer; Horizontal Coordinates, Elevations, Utility Linework, Project Basemaps, and other pertinent information for the purposes of the Utility revising and maintaining their utility system maps. This file shall be in NAD83 State Plane and NGVD88 vertical datum.

i. Receipt, review, and acceptance of the Record Drawings by the Utility/Engineer shall be a condition for acceptance of the Work.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION (Not Applicable)

END OF SECTION

DIVISION 2

SITE WORK

02100	SITE PREPARATION	02100-1 – 02100-2
02224	PIPE BORING AND JACKING	02224-1 – 02224-4
02225	TRENCHING, BEDDING AND BACKFILL	02225-1 – 02225-9
02240	WATER CONTROL AND DEWATERING	02240-1 – 02240-4
02315	EXCAVATION AND EMBANKMENT FOR DETENTION PONDS	02315-1 – 02315-6
02321	CONTROLLED LOW STRENGTH MATERIAL BACKFILL (FLO-FILL)	02321-1 – 02321-4
02375	RIPRAP, BEDDING AND FEATURE BOULDERS	02375-1 – 02375-8
02605	MANHOLES, VAULTS, AND INLETS	02605-1 – 02605-8
02610	STORM DRAINAGE PIPE	02610-1 – 02610-9
02613	PRECAST REINFORCED CONCRETE BOX CULVERT	02613-1 – 02613-2
02615	DUCTILE IRON PIPE AND FITTINGS	02615-1 – 02615-8
02621	PLASTIC PRESSURE PIPE	02621-1 – 02621-6
02622	PLASTIC NON-PRESSURE PIPE	02622-1 – 02622-4
02636	SNOUT OIL-WATER SEPARATOR	02636-1 – 02636-3
02640	VALVES	02640-1 – 02640-6
02644	TAPPING SLEEVES FOR DISTRIBUTION LINES	02644-1 – 02644-2
02645	HYDRANTS	02645-1 – 02645-6
02646	WATER SERVICE LINES AND APPURTENANCES	02646-1 – 02646-6
02650	METERS AND APPURTENANCES	02650-1 – 02650-8
02675	DISINFECTION OF WATER SYSTEMS	02675-1 – 02675-10
02676	DOMESTIC WATER SYSTEM HYDROSTATIC TESTING	02676-1 – 02676-4

02713	WATER DISTRIBUTION SYSTEM	02713-1 – 02713-10
02722	WASTEWATER COLLECTION SYSTEM	02722-1 – 02722-6
02740	GREASE AND SAND & OIL INTERCEPTORS	02740-1 – 02740-7

Revisions/Approvals

12/16/2011: Approved by Ordinance No. 164, 2011

06/02/2017: Division 2 Technical Corrections Approved by Utilities Executive Director pursuant to Fort Collins City Code Section 26-29(b)

SECTION 02100

SITE PREPARATION

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section covers the removal, stockpiling, replacement and disposal of materials existing on site.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 STRIPPING

A. Any material containing roots, grasses and other deleterious or organic matter generally found in the top twelve inches of undisturbed natural terrain shall be stripped from all areas requiring excavation, grading, trenching, subgrade preparation for foundations and embankment work. The Developer will require stripped top soil deemed suitable for spading over the finished grades to be stockpiled and preserved until the finished grading operation, at which time it shall be spread uniformly over areas to be seeded or sodded.

B. Whenever it is necessary to disturb existing grass or soil, from the yards of existing residences, care shall be taken so as to strip existing grass and topsoil in a manner that will permit the replacement thereof as close as possible to the original condition and to the satisfaction of the homeowner and Developer. Tarps or suitable drop cloths shall be spread over all undisturbed areas in such a manner that will protect all areas adjacent to excavations.

3.02 REMOVAL OF EXISTING IMPROVEMENTS

A. Bituminous Pavement - Bituminous pavement and concrete pans (and sidewalks, if required).

The Contractor shall be responsible for removal and disposal of all bituminous pavement and concrete to be removed as part of the project.

END OF SECTION

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SECTION 02224

PIPE BORING AND JACKING

PART - 1 GENERAL

1.01 DESCRIPTION

A. This section is a minimum guideline and concerns the furnishing and the installation of casing pipe, either by boring or jacking.

B. Each casing pipe installation shall be specifically designed by Design Engineer.

C. Each specific crossing shall be detailed on the Construction Drawings as to type of installation required.

1.02 QUALITY ASSURANCES

A. Design Criteria.

1. Specified thickness for pipe and casings are based upon the superimposed loads and not upon the loads which may be placed on the pipe as a result of jacking operations.

a. Increased pipe strength shall be provided as necessary to withstand jacking loads and other loads not accounted for in the design.

B. Construction Criteria.

1. Developer shall obtain the necessary permits from the entity which owns or has governmental control of the roadway, railroad, utility, irrigation ditch, etc. which is being crossed, prior to commencing construction.

2. Developer shall obtain the bonds or the indemnity which are required by the permits, for protection against any damage and interference with traffic and service, which are caused by the construction activities.

C. All excavations shall meet the trenching, backfilling and compaction requirements set forth in Section 02225 - Trenching, Bedding and Backfill.

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PART - 2 PRODUCTS

2.01 CASING PIPE - SMOOTH STEEL

A. The minimum yield point of smooth steel casing pipe shall be 35,000 psi and conform to ASTM 139, Grade B (No hydro).

B. The minimum wall thickness of smooth steel casing pipe shall be determined by the agency granting the crossing permit.

1. In instances where the City is granting the crossing permit, the minimum thickness of the casing pipe shall be 1/4-inch.

C. The ends of smooth steel casing pipe shall be beveled for field welding.

1. All field welds shall be painted with a coal-tar enamel exterior coating, which conforms to AWWA C203, Section 2.

D. Smooth steel casing pipe shall have an epoxy polyamide coating of sixteen (16) mils.

1. If the CONTRACTOR elects to omit the epoxy polyamide exterior coatings, 1/16-inch shall be added to the required thickness of the casing pipe.

2.02 ACCESSORIES

A. Casing Seals

1. Casing seals shall be constructed of either high density rubber casing seals with stainless steel straps.

2. The acceptable type and manufacturer of high density rubber casing seals are:

a. Reference Section 01000 – Approved Product Listing

b. Or an approved equal.

B. Casing Spacers or Chocks

1. Casing spacers/chocks shall be constructed of stainless steel with polymer runners.

a. Stainless steel casing spacers with polymer runners shall be manufactured by an Approved Product Listing in Section 01000.

2. Casing spacers/chocks shall be twelve inches (12”) long.

3. Three (3) casing spacers/chocks shall be installed on each joint of pipe.

C. Anodes and Accessories

1. Reference Section 01000 – Approved Product Listing, for approved accessories for connection of anodes.

2. Twenty pound (20 lb) high-potential magnesium anodes shall meet the following requirements.

a. Anode backfill material shall consist of 75 percent gypsum, 20 percent bentonite, and 5 percent sodium sulfate, and shall be of the quick wetting type. The backfill shall have a grain size such that 100% is capable of passing through a 20 mesh screen and 50% will be retained by a 100 mesh screen.

b. Anodes shall be:
i. Reference Section 01000 - Approved Product Listing

PART - 3 EXECUTION

3.01 CASING INSTALLATION

A. General

1. Wherever it is indicated in the Drawings, the casing pipe shall be installed by open-cut methods in accordance with Section 02225 - Trenching, Bedding and Backfill.

B. Smooth Steel Pipe

1. Contractor shall provide a smooth, continuous, and uniform casing pipe with no exterior voids.

2. Each section of casing pipe shall be welded with a full penetration butt weld around the entire circumference of the joint to form a watertight continuous conduit capable of resisting all stresses, including jacking stresses.

3. A high-potential magnesium anode shall be installed at each end of the casing.

a. Anode wire connection to buried pipe shall be accomplished by exothermic welding. The surface of the pipe shall be cleaned with a grinder or metal file to a bright, shiny condition. The exothermic weld shall be completed using by appropriate weld charge and

welder per the manufacturer's recommendations. For #12 AWG or smaller wire, a properly sized copper wire sleeve shall be installed around the bare wire end prior to welding to improve weld strength and thermal capacity. Completed welds shall be capable of withstanding moderate hammer blows.

For steel pipe the weld and surrounding cleaned metal surface shall be lightly coated with a cold applied mastic compound or pipeline coating primer and covered with an exothermic weld cap.

C. Grouting

1. All spaces between the casing pipe and the earth shall be filled with cellular concrete.

3.02 CARRIER PIPE INSTALLATION

A. Carrier pipe shall be installed at the grade shown on the Construction Drawings.

B. Each section of pipe shall have either a minimum of 3 casing spacers/chocks centered every 120 degrees around the pipe.

C. All joints of the carrier pipe shall be restrained inside of the casing.

D. The annular space between the casing and the carrier pipes shall be left vacant.

E. The ends of the casing pipe shall be sealed with casing seals.

F. Reference Section 02225 - Trenching, Bedding and Backfill.

END OF SECTION

SECTION 02225

TRENCHING, BEDDING AND BACKFILL

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Labor, equipment, and materials necessary for excavation and trenching for water, sewer and stormwater conduits and appurtenances.

B. Provision of bedding and compacted fill over water, sewer and stormwater conduits and appurtenances.

1.02 RELATED WORK

A. Division 1 - General Requirements

B. Section 02315 – Excavation and Embankment

C. Section 02321 – Controlled Low Strength Material Backfill (Flo-Fill)

1.03 REFERENCES

A. ASTM C136 - Sieve Analysis of Fine and Coarse Aggregates.

B. ASTM D698 or AASHTO T99 - Tests for Moisture-Density Relations of Soils and Soil-Aggregate Mixture Using 5.5 lb (2.49 kg) Rammer and 12-inch (305mm) Drop (Standard Proctor).

C. ASTM D2049 - Test for Relative Density for cohesionless soils.

D. Testing Agency: All soils testing during construction will be performed by a testing laboratory selected and paid by the Developer.

E. Excavations - U. S. Department of Labor Occupational Safety and Health Administration latest revision thereto.

1.04 TESTING

A. In-place moisture density tests will be performed to ensure trench backfill complies with specified requirements. The following minimum tests should be expected to be performed:

1. Trench bedding - 1 per 200 feet

2. Backfill - 1 per 200 feet

1.05 SUBMITTALS

A. The Contractor shall cooperate with the geotechnical engineer in obtaining samples of all bedding materials.

1.06 PROTECTION

A. Sheeting and Shoring

The Contractor shall protect excavations by shoring, bracing, sheet piling, underpinning, or other methods required to prevent any excessive widening or sloughing of the trench which may be detrimental to human safety, to the pipe or appurtenances being installed, or to existing facilities or structures. The latest requirements of OSHA shall be complied with at all times including trenching and confined space entry requirements.

The Contractor must provide protection for individuals who require access to the trench.

The safety of the workers shall be provided for as required by the most recent standards adopted by the Colorado Occupational Safety and Health (COSH) Standards Board as enforced by the Colorado Department of Labor.

The Contractor shall be responsible for underpinning adjacent structures which may be damaged by excavation work.

B. Weather and Frost

The Contractor shall protect bottom of excavations and soil adjacent to and beneath foundations from frost.

1. Do not place backfill, fill or embankment on frozen surfaces.

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.

C. Drainage and Groundwater

The excavation shall be graded to prevent surface water run-off into trench or excavation.

1. Maintain excavations and trench free from water during construction.

2. Remove water encountered in the trench to the extent necessary to provide a firm subgrade, to permit joints to be made in the dry, and to prevent the entrance of water into the pipeline.

3. Divert surface runoff and use sumps, gravel blankets, well points, drain lines or other means necessary to accomplish the above.

4. Maintain the excavation or trench free from water until the structure, or pipe

to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

5. Water shall be prevented from entering into previously constructed pipe.

6. The pipe under construction shall not be used for dewatering.

D. Underground Facilities

1. Contractor shall expose and verify size, location and elevation of all utilities and obstructions sufficiently in advance in order to permit changes in the event of conflict. The Contractor shall be fully responsible for any and all damages which might be occasioned by his/her work and failure to locate and preserve any and all utilities and obstructions.

2. If Contractor elects to remove underground obstructions, such as sprinklers, drainage culverts, catch basins or other structures, the following shall apply:

   a. Drainage culverts may be salvaged, stored and reused if approval is obtained from the Engineer/Utility or property owner having jurisdiction thereof.

   b. Replace all other underground obstructions with new materials.

   c. Restore to original conditions or better.

   d. Maintain the flow in field drains at the quantity, quality, and velocity present prior to the temporary removal of the drain pipe.

PART 2 - MATERIALS

2.01 SUB-BEDDING:

A. Materials shall consist of:

1. Uniformly graded rock ranging from 3/4-inch to 1-1/2-inch.

2. Sub-bedding shall be used to provide a firm foundation in soils which are judged by the Engineer to be soft or unstable.

3. All situations where Sub-bedding material is required, geotextile fabric shall be placed between stabilization material, and pipe bedding.

   a) Geotextile fabric shall meet the requirements of CDOT 712.08 (AASHTO M-288) Class A Fabric.

2.02 BEDDING AND PIPE ZONE MATERIALS:

A. Water Distribution System Pipe Zone Bedding shall be granular material, uniformly graded, crushed material conforming to the following gradation, ("Squeegee"):

Water Distribution Bedding (Squeegee)	
Size	Percent Passing
1/2"	100
3/8"	85 - 100
#4	10 - 30
#8	0 - 10
#16	0 - 5

B. Wastewater Collection System Pipe Zone Bedding shall be granular material uniformly graded, crushed material, conforming to the following gradation, CDOT #67:

Wastewater Collection Bedding (CDOT #67)	
Size	Percent Passing
1"	100
3/4"	90 - 100
3/8"	20 - 55
#4	0 - 10
#8	0 - 5

C. Stormwater Collection System Pipe Zone Bedding shall be granular material uniformly graded, crushed material, conforming to the following gradation, CDOT #67:

Stormwater Collection Bedding (CDOT #67)	
Size	Percent Passing
1"	100
3/4"	90 - 100
3/8"	20 - 55
#4	0 - 10
#8	0 - 5

D. It will be the responsibility of the Contractor to locate material meeting the Specifications, to test its ability to consolidate to at least 65% relative density, and to secure approval of the Engineer before such material is delivered to the project. Relative density shall be determined as stipulated in ASTM-Designation: D-2049.

E. If the contractor is unable to locate material meeting the above Specifications than they may submit an approved equal to be determined by the Engineer/Utility prior to

the start of trenching and bedding activities.

2.03 BACKFILL

A. Backfill shall meet the following requirements:

1. Use only backfill for trenches which is free from boulders, large roots, other vegetation or organic matter, and frozen material. No boulders greater than three (3) inches in diameter shall be allowed.

2.04 CUT-OFF WALLS

A. Clay or controlled low strength material backfill cut-off walls are acceptable.

1. Clay cut-off walls

a. More than 50% shall pass a No. 200 Sieve. The plasticity index shall be greater than 12.

2. Controlled low strength material backfill cut-off walls

a. See Section 02321 for requirements.

2.05 PIPELINE MARKER OR DETECTION TAPE

A. Marker tape shall be 6” wide, minimum 0.04” thick polyethylene, metallic blue color, with “Caution Buried Water Line” printed on the top face. See Section 01000 Approved Product Listing.

PART 3 - EXECUTION

3.01 GENERAL

A. The following procedures shall be followed by the Contractor in sequencing his/her work.

1. No more than 150 feet of trench shall be left open at any time. The entire trench shall be backfilled upon conclusion of each day's work. The trench shall not be backfilled until the pipe installation is reviewed by the Engineer.

2. Trench shall be backfilled within 50 feet of the pipe installation at all times.

3. Clean-up shall be maintained within 400 feet of the trench excavation.

B. Prior to placement in the trench, all pipe, fittings, and appurtenances shall be cleaned and examined for defects by the Contractor. If found defective, the Contractor shall reject the defective pipe, fitting, or appurtenance. The Contractor shall advise the Engineer/Utility of all defective materials.

C. All sub-bedding, bedding, and pipe zone material shall be imported.

D. Topsoil shall be removed and stockpiled separately.

E. Upon completion of the work, all plants, rubbish, unused materials, concrete forms and other like material shall be removed from the jobsite. The site shall be left in a state of order and cleanliness.

3.02 MAINTENANCE AND CORRECTION

A. Scarify surface, reshape and compact to required density completed or partially completed areas of work disturbed by subsequent construction operations or by adverse weather.

B. Developer shall maintain and correct backfill, fill and embankment settlement and make necessary repairs to pavement, structures, seeding and sodding which may be damaged as a result of settlement, were installed incorrectly, or otherwise prove to be defective. Developer shall provide a two-year (2) maintenance guarantee and a five-year (5) guarantee covering all errors and omissions in the design and/or construction of the improvements and which guarantees shall run concurrently and shall commence upon the date of completion of the improvements and acceptance thereof by the City.

3.03 OBSTRUCTIONS AND DISPOSAL OF WASTE MATERIAL

A. The Contractor shall remove obstructions that do not require replacement from within the trench or adjacent areas such as tree roots, stumps, abandoned piling, buildings and concrete structures, frozen material, logs, and debris of all types without additional compensation. The Design Engineer and Engineer/Utility may, if requested, make changes in the trench alignment to avoid major obstructions, if such alignment changes can be made within the work limits without adversely affecting the intended function of the facility. Excavated materials unsuitable for backfill or not required for backfill shall be disposed of in accordance with local regulations.

3.04 TRENCH EXCAVATION

A. All existing asphalt or concrete surfacing shall be saw cut vertically in a straight line, and removed from the job site prior to starting the trench excavation. This material shall not be used in any fill or backfill.

The trench shall be excavated so that a minimum clearance of twelve (12) inches is maintained on each side of the pipe for proper placement and densification of the bedding or backfill material. The maximum clearance measured at the spring line of the pipe shall be eighteen (18) inches regardless of the type of pipe, type of soil, depth of excavation or the method of densifying the bedding and backfill.

All excavations shall be made to the lines and grades as established by the Construction Drawings. Pipe trenches shall be excavated to a minimum depth of four inches (4") or ¼ of the O.D. (Whichever is greater) below the bottom of the pipe. Deviation from grades or minimum depths will be allowed only when approved by the Engineer/Utility. Over excavation shall be rectified to the satisfaction of the

Engineer/Utility.

Except as otherwise dictated by construction conditions, the excavation shall be of such dimensions as to allow for the proper pipe installation and to permit the construction of the necessary pipe connections. Care shall be taken to insure that the excavation does not extend below established grades. If the excavation is made below such grades, the excess excavation shall be filled in with graded gravel stabilization Sub-bedding material deposited in horizontal layers not more than six inches (6") in thickness after being compacted and shall be moistened as required to within two percent (2%) of the optimum moisture content required for compaction of that soil. After being conditioned to have the required moisture content, the layers shall be compacted to the required density.

The Contractor shall stockpile excavated materials in a safe manner. Stockpiles shall be graded for proper drainage.

The Contractor shall place and grade the trench base to the proper grade ahead of pipe laying. The invert of the trench shall be compacted to provide a firm unyielding support along entire pipe length.

3.05 FOUNDATIONS ON UNSTABLE SOILS

A. If the bottom of the excavation is soft or unstable, and in the opinion of the Engineer/Utility, cannot satisfactorily support the pipe or structure, a further depth and width shall be excavated and refilled to six inches (6") below grade with rock uniformly graded between 3/4 inch and 1 1/2 inch (Sub-Bedding) to provide a firm foundation for the pipe or structure. From six inches (6") below grade to grade, the appropriate bedding material shall be placed to provide support for the pipe or structure.

3.06 PIPE BEDDING

A. After completion of the trench excavation and proper preparation of the foundation, a minimum of four inches (4") or ¼ O.D. (whichever is greater) of bedding material shall be placed on the trench bottom for support under the pipe. All pipe shall be installed in such a manner as to insure full support of the pipe barrel over its entire length. After the pipe is adjusted for line and grade and the joint is made, the bedding material shall be carefully placed and tamped under the haunches of the pipe. For all types of pipe, the limits of bedding shall be as shown on the trench section details in Standard Details (W-1, WW-1, SW-1) and on the Construction Drawings.

Non-cohesive bedding shall be compacted to 65% relative density in accordance with ASTM D2049. Care shall be exercised to assure sufficient tamping under the pipe to achieve uniform support. (See the Construction Drawings for a typical trench cross-section).

3.07 BACKFILL AND COMPACTION

A. Pipes:

1. The pipe trench shall be backfilled to the limits as shown on the Construction Drawings. The backfill in all roadway rights-of-way and paved areas shall be compacted by vibrating, tamping or a combination thereof to sixty-five percent (65%) relative density for sand material as determined by the relative density of cohesionless soils test, ASTM Standard Designation D2049 or to 95% of maximum density for cohesive soils as determined by ASTM Standard Designation D698. Required compaction in all other areas will be ninety percent (90%) ASTM D698 for cohesive soils or 65% relative density for cohesionless soils, unless otherwise specified.

2. All backfill shall be brought up to equal height along each side of the pipe in such a manner as to avoid displacement. Wet, soft or frozen material, asphalt chunks or other deleterious substances shall not be used for backfill. If the excavated material is not suitable for backfill, as determined by the Engineer/Utility, suitable material shall be hauled in and utilized and the rejected material hauled away and disposed of.

3. Backfilling shall be conducted at all times in a manner to prevent damage to the pipe or its coating and shall be kept as close to the pipe laying operation as practical.

4. Backfilling procedures shall conform to the additional requirements, if any, of appropriate agencies or private right-of-way agreements.

B. Structures

1. Backfill, and fill within three feet (3') adjacent to all structures and for full height of the walls, shall be selected non-swelling material. It shall be relatively impervious, well graded, and free from stones larger than three inches (3"). Material may be job excavated, but selectivity will be required as determined by the Engineer/Utility. Stockpiled material, other than topsoil from the excavation shall be used for backfilling unless an impervious structural backfill is specified. The backfill material shall be free from rubbish, stone larger than five inches (5") in diameter, clods and frozen lumps of soil. All backfill around the structures shall be consolidated by mechanical tamping. The material shall be placed in six inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety-five percent (95%) of maximum density for cohesive soils as determined by ASTM Standard Designation D698 or to seventy percent (70%) relative density for pervious material as determined by the relative density of cohesionless soils test, ASTM Standard Designation D2049.

2. Impervious structural backfill, where shown or specified, shall consist of material having 100% finer than three inches (3") in diameter and a minimum of twenty percent (20%) passing a #200 U.S. Standard sieve. The material shall be placed in six inch (6") loose lifts within a range of two percent (2%) above to two percent (2%) below the optimum moisture content and compacted to ninety five percent (95%) of maximum density for cohesive soil as determined by ASTM Standard Designation D698.

3.08 SURFACE RESTORATION

A. Unsurfaced areas

1. All surface cuts shall be, as a minimum, restored to a condition equal to, or better than, that prior to construction.

B. Surfaced areas

1. 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.

C. Grassed, Agriculture, or Landscaped Areas

1. In landscaped or agricultural areas, topsoil, to a depth of 12 inches, shall be removed from the area of general disturbance and stockpiled. After installation of all pipelines, appurtenances and structures and completion of all backfill and compaction, the stockpiled topsoil shall be redistributed evenly over all disturbed areas. Care should be taken to conform to the original ground contour or final grading plans.

3.09 BLASTING

A. Blasting is not permitted unless approved by the City.

END OF SECTION

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SECTION 02240

WATER CONTROL AND DEWATERING

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work of this section consists of controlling groundwater, site drainage, and storm flows during construction. The Contractor shall be cautious when work involves construction in and around drainage channels, local streams or rivers, and areas of local drainage. These areas are subject to frequent periodic inundation.

1.02 RELATED SECTIONS

A. Section 02225 – Trenching, Bedding and Backfill

B. Section 02315 – Excavation and Embankments

PART 2 PRODUCTS

2.01 MATERIALS

A. On-site materials may be used within the limits of construction to construct temporary dams and berms. Materials such as plastic sheeting, sand bags, and storm sewer pipe may also be used if desired by the Contractor.

PART 3 EXECUTION

3.01 GENERAL

A. For all excavation, the Developer shall provide suitable equipment and labor to remove water, and shall keep the excavation dewatered so that construction can be carried on under dewatered conditions.

1. Water control shall be accomplished such that no damage is done to adjacent channel banks or structures.

2. The Developer shall continuously control water during the course of construction, including weekends and holidays, and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

B. All excavations made as part of dewatering operations shall be backfilled with the same type material as was removed and compacted to 95% of Maximum

Standard Proctor Density (ASTM D698) except where replacement by other materials and/or methods are required.

C. The Developer shall conduct his/her operation in such a manner that storm or other waters may proceed uninterrupted along their existing drainage courses.

D. At no time during construction shall the Developer affect existing surface or subsurface drainage patterns of adjacent property.

1. Any damage to adjacent property resulting from the Developer's alteration of surface or subsurface drainage patterns shall be repaired by the Contractor.

E. Developer shall remove all temporary water control facilities when they are no longer needed or at the completion of the project.

F. Pumps and generators used for dewatering and water control shall be quiet equipment enclosed in sound deadening devices.

3.02 CONSTRUCTION

A. Surface Water Control

1. Surface water control generally falls in to the following categories:

a. Normal low flows along the channel.

b. Storm/flood flows along the channel.

c. Flows from existing storm drain pipelines.

d. Local surface inflows not conveyed by pipelines.

2. The Developer shall coordinate, evaluate, design, construct, and maintain temporary water conveyance systems.

a. These systems shall not worsen flooding, alter major flow paths, or worsen flow characteristics during construction. The Developer is responsible to ensure that any such worsening of flooding does not occur.

b. The Developer is solely responsible for determining the methods and adequacy of water control measures.

3. At a minimum, the Developer will be responsible for diverting the quantity of surface flow around the construction area so that the excavations will remain free of surface water for the time it takes to install these materials, and the time required for curing of any concrete or grout. The Developer

is cautioned that the minimum quantity of water to be diverted is for erosion control and construction purposes and not for general protection of the construction-site.

a. It shall be the Developer's responsibility to determine the quantity of water which shall be diverted to protect his work from damage caused by storm water.

4. The Developer shall, at all times, maintain a flow path for all channels.

a. Temporary structures such as berms, sandbags, pipeline diversions, etc., may be permitted for the control of channel flow, as long as such measures are not a major obstruction to flood flows, do not worsen flooding, or alter historic flow routes.

3.03 GROUNDWATER CONTROL:

A. The Developer shall install adequate measures to maintain the level of groundwater below the foundation subgrade elevation and maintain sufficient bearing capacity for all structures, pipelines, earthwork, and rock work.

1. Such measures may include, but are not limited to, installation of perimeter subdrains, pumping from drilled holes or by pumping from sumps excavated below the subgrade elevation.

B. The foundation bearing surfaces are to be kept dewatered and stable until the structures or other types of work are complete and backfilled.

1. Disturbance of foundation subgrade by Developer’s operations shall not be considered as originally unsuitable foundation subgrade and shall be repaired.

C. Developer shall dispose of groundwater as follows:

1. Developer shall obtain all necessary permits prior to starting dewatering operations.

2. If groundwater will be discharged into an irrigation ditch, pond, stream or other waterway, or will drain to an irrigation ditch, pond, stream or waterway, a Colorado Department of Public Health and Environment (CDPHE) dewatering permit and permission from the associated ditch company will be required.

3. Permit applications may take up to 30 days to be reviewed by the Colorado Department of Public Health and Environment (CDPHE).

4. Developer or their designated representative is required to complete and process Discharge Monitoring Reports (DMR) that are typically a part of the dewatering permit.

5. Treat water collected by dewatering operations as required by regulatory agencies prior to discharge.

6. Discharge water as required by discharge permit and in a manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed work, or adjacent properties.

7. Remove solids from treatment facilities and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

D. Upon finishing the work, Developer or their designated representative shall be responsible for completing a Colorado Department of Public Health and Environment Discharge Termination Notice.

END OF SECTION

SECTION 02315

EXCAVATION AND EMBANKMENT FOR DETENTION FACILITIES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This work shall consist of excavation, embankment fill, disposal of excess material, shaping, and compaction of all material encountered within the limits of work, including excavation and backfill for structures. The excavation shall include, but is not limited to, the native soils which must be excavated for the project work. All work shall be completed in accordance with these Specifications and the lines and grades on the Construction Drawings.

1.02 DEFINITIONS

A. Unclassified Excavation shall consist of the excavation of all materials on site to final grades.

B. Muck Excavation shall consist of the removal and disposal of mixtures of soils and organic matter not suitable for foundation material and replacement with approved material.

C. Rock Excavation shall consist of igneous, metamorphic and sedimentary rock which cannot be excavated without the use of rippers, and all boulders or other detached stones each having a volume of 1/2 cubic yard or more, as determined by physical or visual measurement. It shall also include replacement with approved material as required.

D. Embankment (Complete in Place): shall consist of placing all excavated material, except material being hauled and disposed, as embankment and compacted to final grades as specified in the Construction Drawings.

1.03 DESCRIPTION

A. This work shall consist of excavation, disposal, placement, and compaction of all material encountered within the limits of the work, and not being completed under some other item, necessary for the construction of the project in accordance with the Specifications and the lines, grades, and typical cross-sections shown on the Construction Drawings. All excavation will be classified, “unclassified excavation”, or “muck excavation” or “rock excavation”, as hereafter described. All embankment will be classified “embankment material” as hereafter described.

1.04 RELATED SECTIONS

A. Section 02240 – Water Control and Dewatering

B. Section 02225 – Trenching, Bedding and Backfill

1.05 QUALITY ASSURANCE

A. Final topography and/or cross-sections will be surveyed of areas that are to finished grade and compared to the design section for accuracy. Final grade shall match design grades within the tolerances discussed in PART 3 EXECUTION.

PART 2 PRODUCTS

2.01 MATERIALS

A. Embankment material may consist of approved material acquired from excavations or material hauled from outside the project limits. Soil material for backfill shall be soils free from debris, roots, organic material, and non-mineral matter containing no particles larger than three inches (3") in size.

B. Muck excavation shall also include the replacement of excavated muck with uniformly graded rock, riprap, on-site or imported soils, or other material whichever is most suitable for the specific situation encountered. The Design Engineer and Engineer/Utility will determine which type of aggregate or other material which shall be used after observing the specific site conditions.

PART 3 EXECUTION

3.01 GENERAL EXCAVATION/EMBANKMENT

A. General: The excavation and embankment for the project work shall be finished to reasonably smooth and uniform surfaces. Variation from the subgrade plane shall not be more than .08 feet in soil or more than .08 feet above or .50 below in rock. Where bituminous or concrete surfacing materials are to be placed directly on the subgrade, the subgrade plane shall not vary more than 0.04 feet. Excavation operations shall be conducted so that material outside of the limits of slopes will not be disturbed. Prior to beginning grading operations in any area, all necessary clearing and grubbing in that area shall have been performed in accordance with these Specifications.

B. Excavation:

1. Unclassified: All excess suitable material excavated from the project site and not used for embankment shall remain the property of the Developer. Where material encountered within the limit of the work is considered unsuitable for embankment (fills) on any portion of this project work, such material shall be excavated as directed by the Design Engineer and Engineer/Utility and replaced with suitable fill material. All unsuitable

excavated material from excavation consisting of any type of debris (surface or buried), excavated rock, bedrock or rocks larger than 3 inches in diameter and boulders shall be hauled from the project site and disposed of. Debris is defined as “anything that is not earth which exists at the job site”.

2. Muck: Where excavation to the finished grade section results in a subgrade or slopes of unsuitable soil, the Design Engineer may require the Contractor to remove the unsuitable materials and backfill to the finished graded section with approved material.
   Good surface drainage shall be provided around all permanent cuts to direct surface runoff away from the cut face.

3. Rock: Unless otherwise specified, rock shall be excavated to a minimum depth of 0.5 feet below subgrade within the limits of the pipe installation, and the excavation shall be backfilled with material shown on the Construction Drawings or as designated by the Design Engineer.

C. Embankment Construction: Embankment construction shall consist of constructing all fill areas, including preparation of the areas upon which they are to be placed, and the placing and compacting of embankment material in holes, pits and other depressions within the project area. Only approved materials shall be used in the construction of embankments and backfills.

Approved materials shall consist of clean on-site cohesive soils or approved imported soils. On-site cohesive soils are suitable for use as compacted fill provided the following recommendations are met:

Gradation	Percent Finer by Weight (ASTM C136)
½-Inch	100
3/8-Inch	70 – 100
No. 4 Sieve	50 – 100
No. 200 Sieve	60 (min)
• Liquid Limit	35 (max)
• Plasticity Index	20 (max)
• In-Situ Coefficient of Permeability	$1x10^{-6}$ cm/sec

On-site cohesive soils or imported soils should be placed and compacted in horizontal lifts, using equipment and procedures that will produce recommended moisture contents and densities throughout the lift and embankment height. On-site or imported cohesive soils should be compacted within a moisture content range of 2% below, to 2% above optimum moisture content and compacted to 95% of the Maximum Standard Proctor Density (ASTM D698).

When embankment is to be placed and compacted on hillsides, or when new embankment is to be compacted against existing embankments, or when embankment is built 1/2 width at a time, the slopes that are steeper than 4:1 when measured longitudinally or at right angles to the adjacent ground shall be continuously benched over those areas where it is required as the work is brought up in layers. Benching shall be well keyed and where practical a minimum of 8 feet. Each horizontal cut shall begin at the intersection of the original ground and the vertical sides of the previous cuts. Material thus cut out shall be recompacted along with the new embankment material.

The ground surface underlying all fills shall be carefully prepared by removing all organic matter, scarification to a depth of 8 inches and recompacting to 95% of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - 2% prior to fill placement.

Embankment material shall be placed in horizontal layers not exceeding 8 inches (loose measurement) and shall be compacted to 95% of the Maximum Standard Proctor Density (ASTM D698) at optimum moisture content + or - 2%. Effective spreading equipment shall be used on each lift to obtain uniform thickness prior to compacting. As the compaction of each layer progresses, continuous leveling and manipulating will be required to assure uniform density.

For embankments which serve as berms, the downstream portion shall be "keyed" into the subsurface soils a minimum of 3 feet to enhance the stability of the slope.

Materials which are removed from excavations beneath the water table may be over the optimum moisture content and will require that they be dried out prior to reusing them.

Cross hauling or other action as appropriate will be ordered when necessary to insure that the best available material is placed in critical areas of embankments, including the top 2 feet of all embankments.

Frozen materials shall not be used in construction of embankments.

During the construction of the channels, the channel bottom shall be maintained in such condition that it will be well drained at all times.

Excavation or Embankment (Fill), and Structural Backfill work either completed or in a stage of completion that is either eroded or washed away or becomes unstable due to either rains, snow, snow melt, channel flows or lack of proper water control shall be either removed and replaced, recompacted or reshaped as directed by the Engineer/Utility and in accordance with the Construction Drawings and Specifications.

D. Proof rolling with a heavy rubber tired roller will be required, if designated on the Construction Drawings or when ordered by the Engineer/Utility. Proof rolling

shall be done after specified compaction has been obtained. Areas found to be weak and those areas which failed shall be ripped, scarified, wetted if necessary, and recompacted to the requirements for density and moisture.

Proof rolling shall be done with equipment and in a manner acceptable to the Design Engineer and City.

3.02 EXCAVATION AND BACKFILL FOR STRUCTURES

A. Poor foundation material for any of the work shall be removed as directed by the Engineer/Utility.

Foundation materials which are: a) saturated by either surface or subsurface flows due to the lack of adequate water control or dewatering work; b) frozen for any reason; or, c) that are disturbed by the work or caused to become unacceptable for foundation material purposes by means of the equipment, manpower, or methods of work shall be removed and replaced.

Dewatering should not be conducted by pumping from inside footing, structural floor slab, or other structure foundation limits. This may decrease the supporting capacity of the soils.

Care should be taken when excavating the foundations to avoid disturbing the supporting materials. Excavation by either hand or careful backhoe soil removal, may be required in excavating the last few inches of material to obtain the subgrade of any item of the concrete work.

3.03 EXCAVATION FOR DETENTION PONDS

A. Subgrade for lined channel embankments shall be backfilled and compacted to 95% of maximum density as determined by ASTM D698.

3.04 SETTLEMENT

A. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify the ground surface, re-shape, and compact to required density prior to further construction.

B. Any settlement in backfill, fill, or in structures built over the backfill or fill, which may occur within the two (2) years guarantee period will be considered to be caused by improper compaction methods and shall be corrected. Any structure damaged by settlement shall be restored to their original condition by the Contractor.

END OF SECTION

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SECTION 02321

CONTROLLED LOW STRENGTH MATERIAL BACKFILL (FLO-FILL)

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The Developer shall furnish and place controlled low strength material (CLSM) backfill where required by the Engineer.

1.02 RELATED WORK

A. Section 02240 - Water Control and Dewatering

B. Section 02225 - Trenching, Bedding and Backfill

1.03 REFERENCES

A. ASTM C 33 - Concrete Aggregates

B. ASTM C 94 - Specification for Ready-Mixed Concrete

C. ASTM C 143 - Test Method for Slump of Hydraulic Cement Concrete

D. ASTM C 150 - Portland Cement

E. ASTM C 168 – Fly Ash

F. ASTM C 494 - Chemical Admixtures for Concrete

G. ASTM C 618 - Fly Ash in Portland Cement Concrete

H. ASTM D 4832 - Standard Test Method for Preparation and Testing of Soil-Cement Slurry Test Cylinders

I. ASTM PS 28 - Provisional Standard Test Method for Flow Consistency of Controlled Low Strength Material

J. ASTM PS 29 - Provisional Standard Test Method for Unit Weight, Yield and Air Content (Gravimetric) of Controlled Low Strength Material

K. ASTM PS 30 - Provisional Standard Practice for Sampling Freshly Mixed Controlled Low Strength Material

L. ASTM PS 31 - Provisional Standard Test Method for Ball Drop on Controlled Low Strength Material to Determine Suitability for Load Application

M. CDOT Section 206 – Structure Backfill (Flow-Fill), *Standard Specifications for Road and Bridge Construction.*

PART 2 PRODUCTS

2.01 MATERIALS

A. General: The CLSM shall consist of a mixture of sand, coarse aggregate, cement and water. Fly ash and approved admixtures may be used to obtain the required properties of the mix. The mix shall have good workability and flowability with self-compacting and self-leveling characteristics. Proportions of the mix shall be as given in the following table:

CLSM Mix Proportions

Component	Amount
Cement	30 lbs
Fly Ash	30 lbs
Fine Aggregate	1,845 lbs
Coarse Aggregate	1,700 lbs
Water	325 lbs

B. Flowable Fly Ash Fill (May Be Used If Approved By Engineer)

Materials	Pounds/Cubic Yard
Class C fly ash	200 to 400
Class F fly ash	1600 to 1800
Water	800 (96 gallons or as needed)

C. Cement: All cement used shall be Type II Portland cement, which shall conform to the requirements of ASTM C 150.

D. Fly Ash: Fly ash may be either Class C or Class F. The fly ash shall conform to ASTM C 618.

E. Aggregates:

1. Fine Aggregate: All fine aggregate shall conform to the grading and quality requirements of ASTM C 33.

2. Coarse Aggregate: Coarse aggregate shall conform to the grading and quality requirements of ASTM C 33 for size No. 57 or No. 67.

F. Water: The batch mixing water and mixer washout water shall conform to the requirements of ASTM C 94.

G. Admixtures: Chemical admixtures that do not contain calcium chloride and conform to ASTM C 494 for concrete may be used in the CLSM mix. All

chemical admixtures shall be compatible with the cement and all other admixtures in the batch.

H. CLSM Properties:

1. Strength:

a. CLSM shall have a minimum 28 day compressive strength of 50 psi when tested in accordance with ASTM D4832.

b. CLSM shall have a minimum 24-hour strength of 10 psi.

2. Air-Entrainment: All CLSM shall be air entrained to a total air content of 4 – 8 %.

3. Slump: The minimum slump shall be seven inches (7") and the maximum slump shall be nine ten (10") as when tested in accordance with ASTM PS 28.

4. Aggregate: Fine aggregate shall be between 50% and 60% by volume of the total aggregates in the CLSM mix.

5. Consistency: The consistency of the CLSM slurry shall be such that the material flows easily into all openings and the area to be filled. When trenches are on a steep slope, a stiffer mix of slurry may be required to prevent CSLM from flowing down the trench. When a stiffer mix is used, vibration shall be performed to ensure that the CLSM slurry completely fills all spaces between the pipe and the lower portion of the trench.

I. Flo-fill placed in areas that require future excavation, such as utility backfill shall have a Removability Modulus (RM) of 1.5 or less. (Refer to CDOT Section 206 – Structure Backfill (Flo-Fill)).

J. Flo-fill is prohibited as a temporary or permanent street surface.

K. No changes shall be made in the specified mix ingredients without the approval of the Engineer/Utility.

PART 3 EXECUTION

3.01 PLACEMENT

A. CLSM shall be used as an alternative to backfill, as directed by the Engineer/Utility, but may not be used as a substitute for bedding material.

Rodding, mechanical vibration and compaction of CLSM shall be performed to assist in consolidating the CLSM.

CLSM shall be placed as closely behind pipe laying operations as possible.

When required to prevent uplift, the CLSM shall be placed in two stages as required, allowing sufficient time for the initial set of the first stage before the remainder is placed. CLSM shall be deposited as nearly as practical in its final position and in no way disturb the pipe trench or cause foreign material to become mixed with the CLSM.

Soil backfill shall not be placed until the CLSM has reached the initial set. If backfill is not to be placed over the CLSM within 8 hours, a 6-inch cover of moist earth shall be placed over the CLSM surface.

If the air temperature is 50° F or less, the moist earth cover should be at least 18-inches thick. CLSM shall not be placed when the air temperature is below 40° F unless the air temperature is 35° F or more and the temperature is rising.

CLSM shall not be placed, if, in the judgment of the Engineer/Utility, weather conditions are unsuitable.

CLSM shall not be placed when the trench bottom or walls are frozen or contain frozen materials.

END OF SECTION

SECTION 02375

RIPRAP, BEDDING, AND FEATURE BOULDERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. The work of this section shall include excavation, grading, and installation of all riprap, bedding, boulders, grouted boulders, stacked grouted boulders, and grouted rock retaining walls placed at the locations shown on the Construction Drawings. Placement of all materials specified herein shall be verified by the Design Engineer and Engineer/Utility. The materials to be used and the construction of such structures shall be as specified herein.

1.02 RELATED SECTIONS

A. The following is a list of SPECIFICATIONS, which may be related to this section:

1. Section 02240 – Water Control and Dewatering

2. Section 02315 – Excavation and Embankment

3. Section 02225 – Trenching, Bedding, and Backfill

1.03 PROJECT REQUIREMENTS

A. Project Mockup: Prior to the construction of any grouted rock walls, the Contractor or Subcontractor who is constructing the walls for the Contractor, shall show the Engineer and Developer an example of similar rock walls that they have constructed previously. After acceptance of the previous work, the Contractor or Subcontractor shall construct approximately 100 square feet of grouted rock wall as shown on the Drawings for approval by the Engineer and Developer. If the construction is approved, the Contractor or Subcontractor shall construct the rest of the grouted rock wall. If the construction is not approved, the Contractor shall make any changes required by the Developer and Engineer to obtain approval, and construct the remainder of the wall as approved.

1.04 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):

a. T85, Standard Method of Test for Specific Gravity and Absorption of Coarse Aggregate.

b. T96, Standard Method of Test for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

c. T103, Standard Method of Test for Soundness of Aggregates by Freezing and Thawing.

d. T104, Standard Method of Test for Soundness of Aggregate by Use of Sodium Sulfate or Magnesium Sulfate.

e. T248, Reducing Field Samples of Aggregate Test Size.

2. ASTM International (ASTM): D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).

1.05 SUBMITTALS

A. CONTRACTOR shall cooperate with ENGINEER/UTILITY in obtaining and providing samples of all specified materials.

B. CONTRACTOR shall submit certified laboratory test certificates for all items required in this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. RIPRAP

1. Riprap used shall be the type designated on the Construction Drawings and shall conform to the following:

Riprap Design	% Smaller Than Given Size By Weight	Intermediate Rock Dimension (inches)	d_{50*} (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 H	70 – 100 50 – 70 35 – 50 2 – 10	30 24 18 6	18
Type VH	70 – 100 50 – 70 35 – 50 2 – 10	41 33 24 9	24

* d50 = Mean Particle Size

** Mix VL, L and M riprap with 35% topsoil (by volume) and bury it with 4 to 6 inches of topsoil, all vibration compacted, and revegetate.

2. The riprap designation and total thickness of riprap shall be as shown on the Construction Drawings. The maximum stone size shall not be larger than the thickness of the riprap.

3. Neither width nor thickness of a single stone of riprap shall be less than one-third (1/3) of its length.

4. The specific gravity of the riprap shall be two and one-half (2.5) or greater.

5. Broken concrete or asphalt rubble shall not be acceptable for use in the work.

6. Rounded riprap (river rock) is not acceptable unless specifically designated on the Construction Drawings.

7. Riprap specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.

8. The bulk density for the riprap shall be 1.3 ton/cy or greater.

9. The riprap shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.

10. The riprap shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.

11. The riprap shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.

12. Rock shall be free of calcite intrusions.

13. Gradation:

    a. Each load of riprap shall be reasonably well graded from the smallest to the largest size specified.

    b. Stones smaller than the two to ten percent (2 to 10%) size will not be permitted in an amount exceeding ten percent (10%) by weight of each load.

    c. Control of gradation shall be by visual inspection. However in the event ENGINEER determines the riprap to be unacceptable,

ENGINEER shall pick two (2) random truckloads to be dumped and checked for gradation.

i. Mechanical equipment and labor needed to assist in checking gradation shall be provided by Developer at no additional cost.

14. Color:

a. The color of the riprap shall be gray with gray/blue hues or other acceptable colors approved by Engineer/Utility prior to delivery to the project site.

b. Color shall be consistent on the entire project and shall match the color of rock to be used for all other portions of the work.

15. Grout:

a. 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.

b. Use of a stiffer mix or other measures as approved by the Engineer/Utility for steeper slopes or for vertical joints.

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

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

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

f. The grout shall contain both an air entraining admixture and water reducing agent. The job site air content shall be 6 ½% +/- 1 ½% by volume. A water reducing agent such as WRDA-64 or equal shall be used.

B. BOULDERS

1. Boulders used shall be the type designated on the Construction Drawings and shall conform to the following:

Boulder Classification	Nominal Size (inches)	Range in Smallest Dimension of Individual Rock Boulders (inches)	Maximum Ratio of Largest to Smallest Rock Dimension of Individual Boulders
B18	18	17 – 20	1.50
B24	24	22 – 26	1.50
B30	30	28 – 32	1.50
B36	36	34 – 38	1.50
B42	42	40 – 44	1.50
B48	48	45 – 51	1.50

2. The specific gravity of the boulders shall be two and one-half (2.5) or greater.

3. Boulder specific gravity shall be according to the bulk-saturated, surface-dry basis, in accordance with AASHTO T85.

4. The bulk density for the boulder shall be 1.3 ton/cy or greater.

5. The boulders shall have a percentage loss of not more than forty percent (40%) after five hundred (500) revolutions when tested in accordance with AASHTO T96.

6. The boulders shall have a percentage loss of not more than ten percent (10%) after five (5) cycles when tested in accordance with AASHTO T104 for ledge rock using sodium sulfate.

7. The boulders shall have a percentage loss of not more than ten percent (10%) after twelve (12) cycles of freezing and thawing when tested in accordance with AASHTO T103 for ledge rock, procedure A.

8. Rock shall be free of calcite intrusions.

9. Color:

   a. The color of the boulders shall be gray with gray/blue hues or other acceptable colors approved by ENGINEER prior to delivery to the project site.

   b. Color shall be consistent on the entire project and shall match the color of rock to be used for all other portions of the work.

C. SOIL RIPRAP

1. Rock requirements are to comply with riprap as specified in Article Materials.

2. The soil material shall be native or topsoil and mixed with sixty-five percent (65%) riprap and thirty five percent (35%) soil by volume.

3. Soil riprap shall consist of a uniform mixture of soil and riprap without voids.

D. BEDDING:

1. Gradation for Granular Bedding:

U.S. Standard Sieve Size	Percent by Weight Passing Square-Mesh Sieves	
	Type I (CDOT Sect. 703.01)	Type II (CDOT Sect. 703.09 Class A)
3 inches	-	90 – 100
1½ inches	-	-
3/4 inch	-	20 – 90
3/8 inch	100	-
No. 4	95 – 100	0 – 20
No. 16	45 – 80	-
No. 50	10 – 30	-
No. 100	2 – 10	-
No. 200	0 – 2	0 – 3

2. Granular bedding designation and total thickness of bedding shall be as shown on the Construction Drawings.

3. Granular bedding shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for riprap.

a. Broken concrete asphalt pavement or sledge, shall not be acceptable for use in the work. Rounded river rock is not acceptable unless specifically designated on the Construction Drawings.

b. The requirements for the wear test in AASHTO T96 shall not apply.

E. GEOTEXTILE FABRIC:

1. Where soil conditions dictate, geotextile fabric shall be placed directly on excavated slopes, channel beds, etc. prior to the placement of any riprap bedding or riprap.

2. The extent and location of geotextile placement will be shown on the Construction Drawings.

3. Geotextile fabric shall be Trevira S1135 or approved equal under all rock drop structures and Trevira S1120 or approved equal under all riprap.

F. FEATURE BOULDERS:

1. Feature Boulders shall consist of the same material as boulders, differing only by size.

2. Feature Boulders shall meet the same requirements for specific gravity, absorption, abrasion, sodium sulfate soundness, calcite intrusion, and freeze-thaw durability as required for boulders.

3. Feature Boulders shall have a minimum dimension of four (4) feet, or as shown on the Construction Drawings.

PART 3 EXECUTION

3.01 PREPARATION

A. Channel slope, bottom, or other areas that are to be protected with riprap, boulders or soil riprap shall be free of brush, trees, stumps, and other objectionable material and be graded to a smooth compacted surface as shown on the Construction Drawings.

B. Contractor shall excavate areas to receive riprap to the subgrade as shown on the Construction Drawings accounting for granular bedding.

C. Contractor shall excavate areas to receive boulders or soil riprap to the specified depth (bedding material is not required for boulders and soil riprap).

D. Subgrade Materials:

1. The subgrade materials shall be stable.

2. If unsuitable materials are encountered, they shall be removed and replaced as Muck Excavation in accordance with Section 02315, Excavation and Embankment, for subgrade that has been excavated in undisturbed soil.

E. Additional Compaction:

1. Additional compaction shall not be required unless specified by Engineer.

2. When subgrade is built up with embankment material it shall be compacted to ninety five percent (95%) maximum density (ASTM D698).

F. Bedding:

1. After an acceptable subgrade is established, bedding shall be immediately placed and leveled to the specified elevation on the Construction Drawings.

2. Immediately following the placement of the bedding material, the riprap shall be placed.

3. If bedding material is disturbed for any reason, it shall be replaced and graded at Contractor's expense.

4. Contamination:

a. In-place bedding materials shall not be contaminated with soils, debris or vegetation before the riprap is placed.

b. If contaminated, the bedding material shall be removed and replaced at Contractor's expense.

3.02 PLACEMENT

A. RIPRAP

1. Following acceptable placement of granular bedding, riprap placement shall commence as follows:

a. Machine Placed Riprap:

i. Riprap shall be placed on the prepared slope or channel bottom areas in a manner which will produce a reasonably well graded mass of stone with the minimum practicable percentage of voids.

ii. Riprap shall be machine placed, unless otherwise stipulated in the drawings or specifications.

iii. It is the intent of these specifications to produce a fairly compact riprap protection in which all sizes of material are placed in their proper proportions. Unless otherwise authorized by Engineer, the riprap protection shall be placed in conjunction with the construction of embankment or channel bottom with only sufficient delay in construction of the riprap protection, as may be necessary, to allow for proper construction of the portion of the embankment and channel bottom which is to be protected.

b. Slope Placement:

i. When riprap is placed on slope, placement shall commence at the bottom of the slope working up the slope.

c. The entire mass of riprap shall be placed on either channel slope or bottom so as to be in conformance with the required gradation mixture and to line, grade, and thickness shown on the drawings.

d. Riprap shall be placed to full course thickness at one operation and in such a manner as to avoid displacing the underlying

bedding material. Placing of riprap in layers, or by dumping into chutes, or by similar methods shall not be permitted.

e. All material used for riprap protection for channel slope or bottom shall be placed and distributed such that there shall be no large accumulations of either the larger or smaller sizes of stone. Some hand placement may be required to achieve this distribution.

f. The basic procedure shall result in larger materials flush to the top surface with faces and shapes arranged to minimize voids, and smaller material below and between larger materials.

g. Surface grade shall be a plane or as indicated, but projections above or depressions under the finished design grade by more than ten percent (10%) of the rock layer thickness shall not be allowed.

h. Smaller rock shall be securely locked between the larger stone. It is essential that the material between the larger stones not be loose or easily displaced by flow or by vandalism.

i. The stone shall be consolidated by the bucket of the backhoe or other means that will cause interlocking of the material.

j. All rock is to be placed in a dewatered condition beginning at the toe of the slope or other lowest point.

k. Contractor shall maintain the riprap protection until accepted. Any material displaced for any reason shall be replaced to the lines and grades shown on the Construction Drawings at no additional cost to owner. If the bedding materials are removed or disturbed, such material shall be replaced prior to replacing the displaced riprap.

2. Hand Placed Riprap:

a. Hand placed riprap shall be performed during machine placement of riprap and shall conform to all the requirements of Part 2, above.

b. Hand placed riprap shall also be required when the depth of riprap is less than two (2) times the nominal stone size, or when required by the Construction Drawings or Specifications.

c. After the riprap has been placed, hand placing or rearranging of individual stones by mechanical equipment shall be required to the extent necessary to secure a flat uniform surface and the specified depth of riprap, to the lines and grades as shown on the Construction Drawings.

3. Soil Replacement Over Riprap:

   a. Where riprap is designated to be buried, place onsite excavated material that is free from trash and organic matter in riprap voids by washing and rodding.

   b. Prevent excessive washing of material into stream.

   c. When voids are filled and the surface accepted by Engineer, place a nominal six (6) inches of topsoil over the area, or as designated on the Construction Drawings.

   d. Fine grade, seed, and mulch per the Specifications.

B. BOULDERS

1. Following excavation and acceptance of subgrade by Engineer Boulder placement shall commence as follows:

   a. Boulders shall be placed on the prepared subgrade in a manner which will minimize voids.

   b. Voids between boulders exceeding 4" shall be chinked.

C. SOIL RIPRAP

1. Adjacent stockpiles of riprap and soil shall be created and mixing done at the stockpile location, not at the location where soil riprap is to be placed.

2. Mix thirty-five percent (35%) soil by volume with stockpiled riprap, using additional moisture and control procedures that ensure a homogenous mixture; where the soil fills the inherent voids in the riprap without displacing riprap.

3. With prior approval of ENGINEER, layering the riprap and soil instead of premixing may be allowed if the native soil is granular.

4. Place a first layer of smaller soil riprap of approximate d50 thickness. Then place the top layer with surface rocks that are largely d50 or greater, filling voids as necessary with smaller planted riprap. Create a smooth plane as described in Paragraph A.

5. The mixture shall be consolidated by large vibratory equipment or backhoe bucket to create a tight, dense interlocking mass.

6. The soil shall be further wetted to encourage void filling with soil.

7. Any large voids shall be filled with rock and small voids filled with soil.

8. Excessively thick zones of soil prone to washing away shall not be created (for example, no thicknesses greater than six (6) inches).

9. For buried soil riprap, the top surface shall be covered with four (4) inches of topsoil such that no rock points are protruding.

10. The final surface shall be thoroughly wetted for good compaction, smoothed and compacted by vibrating equipment; the surface shall then be hand raked to receive planting or seeding.

D. FEATURE BOULDERS

1. Feature Boulders serve an aesthetic function and as such shall be placed and rotated into final position as directed by Engineer in order to achieve the desired result.

3.03 GROUTED RIPRAP AND GROUTED BOULDERS

A. Grouted riprap and the boulder lined channel edge shall be placed at the locations as shown on the Construction Drawings and installed with the following requirements:

NOTE: For purposes of Paragraph 3.03, the items “boulders”, “rock”, and “riprap” are used interchangeably.

1. The subgrade to receive each boulder 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 of each boulder.

2. Unstable material shall be removed from the project site and disposed of by the Contractor.

3. Removal and replacement of unstable material shall only be completed at the direction of the Engineer.

4. Backfill behind boulders shall be compacted to 95% Maximum Standard Proctor Density (ASTM D698). Care shall be taken during compaction to avoid disturbing and/or damaging the integrity of the boulder channel edge.

5. The top of all boulders shall be as indicated on the Construction Drawings. Finished grades and subgrades for boulders will be determined from the height of each boulder used.

6. The boulders shall be carefully picked and arranged so that adjacent rock surfaces match within 2 inches in top elevation and 2 inches along the vertical exposed face or channel side of rock.

7. Boulders shall be placed such that adjacent boulders "touch" each other and voids do not exceed 4 inches. It is the intent of construction to minimize voids and grout placed between boulders.

8. Smaller rocks shall be "chinked in" to fill all voids behind the boulders. Placement shall be approved by the Engineer prior to grouting.

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

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

11. Keep boulders receiving grout wet at all times prior to receiving grout.

12. 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 Construction Drawings.

13. Grout will be placed up to 6 inches from the top of boulders, 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.

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

15. Clean and wash any spillage before the grout sets. The visual surfaces of boulders will be free of grout to provide a clean natural appearance. If washing does not clean off grout residue, the Developer shall wash off any grout residue with muratic acid and water, using a brush to scrub off the residue.

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

17. The grout mix shall be stiffened and other measures taken to retain the grout between the boulders.

18. The Developer shall, if deemed necessary, support the boulders from falling over before and during the placement of riprap, grout, backfill, and compaction work on either side of the boulder.

19. Grout shall receive cold weather protection in accordance with Section 03615 of these Specifications.

3.04 REJECTION OF WORK AND MATERIALS:

A. Engineer will reject placed riprap, boulders, soil riprap and bedding that do not conform to this section. Contractor shall immediately remove and re-lay the riprap, boulders, soil riprap and bedding to conform to Specifications.

B. Riprap, boulders, soil riprap and bedding shall be rejected, which is either delivered to the job site or placed, that does not conform to this section.

C. Rejected riprap, boulders, soil riprap and bedding shall be removed from the project site by Contractor at Contractor's expense.

END OF SECTION

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SECTION 02605

MANHOLES, VAULTS AND INLETS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers the furnishing and placement of all manholes, vaults and inlets and related materials and other appurtenances for water, sanitary, and stormwater systems as detailed in the Construction Drawings.

B. Manholes shall be built according to the details shown on the Construction Drawings. Where invert elevations prohibit the use of a standard manhole, a shallow manhole with a flat top shall be used.

1.02 QUALITY ASSURANCE

A. Lay pipe and set manhole inverts true to line and grade shown on Construction Drawings. Under no circumstances shall pipe be laid which results in a level invert, reverse sloping invert, or a grade flatter than shown on the Construction Drawings.

1.03 JOB CONDITIONS

A. Use effective measures to prevent foreign material from entering the pipes into manholes, vaults, or inlets.

B. Use effective measures to prevent the uplift or floating of manholes, vaults or inlets prior to completion of the backfilling operation.

PART 2 PRODUCTS

2.01 CAST-IN-PLACE STRUCTURES

A. Manholes, Vaults, and Inlets

1. Concrete shall meet the requirements of Division 3.

2. Pipe penetration gaskets.

a. Reference Section 01000 – Approved Product Listing

b. Or An Approved Equal.

3. Reference Construction Drawings for type of base required.

2.02 PRECAST STRUCTURES

A. Manholes, Vaults, and Inlets

1. Precast base and first barrel section monolithic, conformance ASTM C478, Type II cement and shall be marked by the manufacturer.

2. Shall meet HS 25 traffic loading specifications and 300 PSF surcharge load.

3. Pipe penetration gaskets.

a. Reference Section 01000 – Approved Product Listing

b. Or An Approved Equal.

4. Invert

a. Material: reference Division

b. Compressive Strength: 4000 psi at 28 days.

c. Invert shall be poured in conformance with Section 02605.3.02.B of these Standards.

5. Reference Construction Drawings for type of base required.

B. Precast concrete sections shall be produced using Type II cement and fabricated in accordance with ASTM C-478.

2.03 Barrels, Cones, and Grade Rings

A. Material: Precast Concrete, ASTM C478.

B. Cement: Type II.

C. Manhole joints shall be made using male and female ends so that when assembled they make a continuous, uniform, and watertight manhole.

2.04 MANHOLE FRAMES AND COVERS

A. Manhole frames and covers shall be minimum 400 lb. cast iron, 24-inch I.D. (clear opening).,

B. The cover shall fit the ring in accordance with the manufacturer's dimensions. Manhole covers for water, sanitary sewer, or storm sewer structures shall have a concealed pick hole.

C. Covers with more than one lifting hole will not be accepted.

D. Bearing Surfaces: Machined, required for pavement and pedestrian locations, knobby (type K) pattern.

E. Castings shall be free from holidays.

F. Aluminum covers are required on all meter vaults placed within non-traffic areas and shall be locking type.

G. Manufacturers

1. Reference Section 01000 – Approved Product Listing

2. Or An Approved Equal.

H. Frost proof covers for water system appurtenances, if required, shall be grey iron conforming to ASTM A48-83 Class 35B, and shall have a minimum clear opening of 22".

2.05 MANHOLE STEPS

A. Manhole steps shall be polypropylene, and shall be either cast into the manhole wall or drilled into the manhole wall at the same time the manhole section is installed. The manhole steps shall be approximately 9 inches wide by 13 inches long, shall weigh approximately 2 pounds and shall be no more than 28 inches from the top of the manhole nor more than 18 inches from the floor of the manhole, vault, or inlet and shall be spaced no more than 12 inches apart.

B. Manufacturers

1. Reference Section 01000 – Approved Product Listing

2. Or An Approved Equal.

2.06 JOINTS

A. Mortar

1. Mortar used in jointing precast adjustment rings and pointing the inside of all joints between barrels shall be composed of one part Portland cement and not more than three nor less than two parts of fine aggregate. Portland cement shall meet the requirements of ASTM C150, Type II. Hydrated lime or masonry cement shall not be used. Fine aggregate shall consist of well graded natural sand having clean, hard, durable, uncoated grains, free from organic matter, soft or flaky fragments or other deleterious substances. The fine aggregate shall be thoroughly washed and shall be uniformly graded form coarse to fine with a minimum of 95% passing a #4 sieve and a maximum of 7% passing a #100 sieve. All mortar shall be fresh for the work at hand. Mortar that has begun to set shall not be used.

B. Sealants

1. The Contractor shall use preformed rope type plastic gaskets between precast sections.

2. Acceptable Manufacturers.

   a. Reference Section 01000 – Approved Product Listing

   b. Or An Approved Equal.

   c. "Ram-Nek" is not acceptable.

3. Two gaskets are required per joint.

4. Manufacturers approved primer required on both surfaces of joints.

5. Diameter:

   a. 1-1/2 inch for up to five (5) inch wall thicknesses.

   b. 2 inch for six (6) inch and greater wall thicknesses.

6. Gasket shall meet the requirements of ASTM C 443 or AASHTO M 198.

2.07 INSULATION

A. Insulation shall be installed on all air relief vaults.

B. Ridged board insulation shall be minimum 1" thick closed-cell insulation board suitable for use in contact with soil or water.

C. Sprayed foam insulation shall be minimum 1" thick closed-cell insulation suitable for use in contact with soil or water.

2.08 GROUT

A. Reference Section 01000 – Approved Product Listing

B. Or An Approved Equal.

PART 3 EXECUTION

3.01 PREPARATION

A. Perform excavation in accordance with Section 02225, Trenching, Bedding And Backfill.

3.02 CONSTRUCTION

A. Construct structures at locations and elevations indicated on the Construction

Drawings or otherwise designated by Engineer/Utility to accommodate field conditions. Size is indicated on the Construction Drawings.

B. Invert channels shall be smooth and conform to the details shown on the Construction Drawings. Changes in direction of flow shall be made with a smooth curve having as large a radius as the manhole will permit (See City Standard Detail). Terminate pipe flush with interior wall and construct transitions smooth and of proper radius for uninterrupted flow. In no case shall the invert flow section through the structure be greater than that of the outgoing pipe. Finish invert prior to adding any riser sections. Construct top of bench in manholes to match highest pipe crown or as shown on the Construction Drawings.

C. Set each section plumb. Use sections of various heights to bring ring and cover or top of vault or inlet to grade shown on the Construction Drawings. Where standard manholes are used, the internal diameter of manhole barrels shall be maintained to a distance of not more than 4 feet below finished grade. From that point the manhole barrel shall be tapered to a 24 inch internal diameter. The manhole barrels shall be tight at all joints. All manholes shall be watertight.

D. Cones shall not be less than 8 inches nor more than 16 inches from the top of the manhole ring. Precast adjustment rings shall be used on top of the cone to support and adjust the manhole frame to the required final grade. The outside of the adjust rings shall be covered by mortar, 5/8 inch thick and troweled smooth.

E. Join sections using preformed flexible plastic gaskets on both interior and exterior shiplaps unless otherwise noted on Construction Drawings. All joint surfaces shall be clean, dry, and warm during installation.

F. Fill all lifting holes and other imperfections with grout.

G. Neatly mortar the inside and outside of all horizontal joints. The mortar shall not be less than 5/8 inch thick over the joint, and shall extend at least 4 inches either side of the joint.

H. The joint between a cast-in-place base and the lowest precast section shall be grouted, inside and outside.

I. Install rings and covers above cone of the manhole. Set ring in a full bed of mortar, and encase in mortar around the entire perimeter, except in pavement areas. Mortar shall be fresh for the work at hand. Mortar that has begun to set shall not be used.

J. Do <u>not</u> preheat pre-formed plastic gasket material with a direct flame. Preheat the material by other means until it is pliable.

K. Where shown on the Construction Drawings a piece of pipe of the proper size shall be built into the manhole where future laterals may be connected. This pipe shall be sealed with a plug at its outer end and an invert shall be built into each manhole for such lateral connections.

L. The physical connection to the existing sewer system shall be plugged until the sewer has been completed to the satisfaction of the Engineer/Utility.

M. Sanitary sewer services shall not be connected to manholes. All services shall be tapped into the sewer main.

N. The minimum thickness of a cast-in-place base shall not be less than 8 inches under the invert of the manhole channel.

O. The storm sewer may be laid continuously through manhole locations wherever grade and alignment permit, and the manhole built later. In such cases, the base shall be laid and carried up approximately 2 inches above the top of the pipe. After manholes are built, the upper half of the pipe shall be cut out and the bottom finished.

P. Any curb opening greater than six (6) inches in height must have a metal bar welded horizontally across the inlet for public safety purposes such that no opening height is greater than 6 inches.

Q. All inlet covers must be stenciled or stamped with the following designation: **NO DUMPING - DRAINS TO RIVER**

3.03 CONNECTION TO EXISTING MANHOLES

A. Storm sewer connections to existing manholes, where there is no existing pipe stubbed out shall conform as nearly as possible to the essential requirements specified for new manholes. The Contractor shall break out as small an opening in the existing manhole as necessary to insert the new pipe. The existing concrete foundation bench shall be reshaped in order to form a smooth, rounded base similar to what should be formed in a new concrete base. Cement grout shall be used as necessary to smoothly finish the new base and to seal the new line so the junction is water-tight. New deflectors shall be installed to create a manhole consistent with the Construction Drawings.

B. Sanitary sewer connections to existing manholes, where there is no existing pipe stubbed out shall conform as nearly as possible to the essential requirements specified for new manholes. The Contractor shall core drill as small an opening in the existing manhole as necessary to insert the new pipe. The existing concrete foundation bench shall be reshaped in order to form a smooth, rounded base similar to what should be formed in a new concrete base. Cement grout shall be used as necessary to smoothly finish the new base. A penetration gasket shall be used to seal the new line so the manhole for a water-tight connection. Sanitary sewer services shall not be connected to manholes. All services shall be tapped into the sewer main.

3.04 MARKING COMPLETED MANHOLES IN NEW DEVELOPMENTS

A. Upon completion of backfill around manhole, a 4” x 4” timber shall be placed next to each manhole, the exposed portion of which shall be no less than 4 feet above the finished elevation of the subgrade.

3.05 FIELD QUALITY CONTROL

A. Sewer shall meet the requirements of the following tests. Furnish all equipment, labor and incidentals necessary and conduct tests in the presence of Engineer.

1. Vacuum tests and leakage tests shall be used to test the sanitary sewer manholes.

B. Vacuum Testing of Sanitary Sewer Manholes

1. Manholes shall be vacuum tested after assembly and prior to backfilling.

a. Care shall be taken to affect a seal between the vacuum base and the manhole rim. Pipe plugs shall be secured to prevent movement while the vacuum is drawn.

b. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

c. Acceptance shall be defined as when the time to drop to 9 inches meets or exceeds the following:

Diameter	Time to Drop 1" Hg
4 ft.	60 seconds
5 ft.	75 seconds
6 ft.	90 seconds
8 ft.	120 seconds

d. If the manhole fails the test, make necessary repairs. Repairs and repair procedures must be acceptable to Engineer.

e. If preformed plastic gaskets are pulled out during the vacuum test, the manhole shall be disassembled and the gaskets shall be replaced.

C. Each manhole shall be watertight and shall not have any visible leaks or damp spots.

D. Repair and retest manholes that fail tests until satisfactory results are obtained.

3.06 CLEANING

A. Prior to completion of the Work, remove all accumulated construction debris, rocks, gravel, sand, silt and other foreign material from the manhole.

B. Upon final inspection if any foreign matter is present in the system, re-clean the manhole as required.

Install ring and covers on one or a maximum of two precast adjusting rings of varying heights, not to exceed 4 inches in height each. The total allowable height of adjusting rings and the ring and cover shall be as shown on the Construction

Drawings. Set rings in a full bed of mortar and encase in mortar around the entire perimeter. Unless otherwise indicated, set the top of the rings such that no part of the ring or cover will project above a point 1/4 inch below the finish surface of pavement in paved areas subject to cleaning by snowplows.

At air valve and access manhole locations the concrete manhole barrel sections and flat lid shall be insulated with rigid insulation on the exterior or sprayed foam insulation on the interior, to a minimum depth of 4 feet below ground level.

Fill all lifting holes and other imperfections with mortar. Neatly point inside of joints no matter what joint material is used.

END OF SECTION

SECTION 02610

STORM DRAINAGE PIPE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. This Section includes construction of pipe for storm drainage systems, including appurtenances normally installed as a part of these systems. Construction may include surface preparation; trench excavation; shoring; dewatering; laying, aligning and joining pipe, installation of appurtenances; bedding and backfilling; surface restoration; and, other related work.

1.02 RELATED SECTIONS

A. Section 02240 – Water Control and Dewatering

B. Section 02225 – Trenching, Bedding and Backfill.

1.03 QUALITY CONTROL

A. All pipe shall be inspected by the Engineer/Utility prior to installation.

B. All pipe which does not meet the requirements of Part 2 of this section will be rejected and replaced.

C. Applicable Standards

1. Non-Reinforced Concrete Pipe, ASTM C 14

2. Reinforced Concrete Pipe, ASTM C76

3. Reinforced Concrete Arch Pipe, ASTM C508

4. Reinforced Concrete Elliptical Pipe, ASTM C507

5. Aluminized Corrugated Steel Pipe (Type II), AASHTO M 274 *(Note: Helical corrugations should be used whenever possible.)*

6. Corrugated Aluminum Pipe, AASHTO M 196 *(Note: Helical corrugations should be used whenever possible.)*

7. Type PSM Poly Vinyl Chloride (PVC) Pipe, ASTM D 3034

8. Plastic and Polyethylene (PE) Corrugated Pipe

a. ADS – N-12, ASTM D3212. Joints shall meet or exceed ASTM 3212 lab test and ASTM C969 watertight field test.

b. A-2000 PVC, ASTM F949 with minimum of 46 pipe stiffness for all diameters.

9. Arylonitrite-Butadiene-Styrene (ABS) Pipe, ASTM D 2680 & D 2751

10. Ductile Iron Pipe, ANSI A 21.51 (AWWA C 151)

11. Steel Reinforced High Density Polyethylene Pipe

a. DuroMaxx® - ASTM F-2562 “Standard Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fitting for Non-Pressure Drainage and Sewerage” or AASHTO Designation MP-20.

1.04 UNDERDRAINS OR SUBDRAINS

A. Shall be designed by a Licensed Engineer or Geotechnical Engineer experienced in the design of this type of improvement.

PART 2 PRODUCTS

2.01 MATERIALS

A. Unless otherwise specified by these standards or the Engineer/Utility, manufacturing, testing, inspection, marking, and acceptance of the storm sewer pipe and related products shall be in accordance with the standard specifications listed in this Section. Limitations for the use of pipe materials are outlined in the City of Fort Collins Storm Drainage Design Criteria.

B. The Contractor shall install storm sewer pipe of the type, diameter, load class, wall thickness and protective coating that is shown on the Construction Drawings. All pipe and appurtenances used shall conform to the following requirements:

C. Precast Concrete Pipe

1. General: Precast concrete pipe which does not conform to the applicable ASTM Standard Specifications listed below or to any other requirement specified herein will not be approved for the storm sewer installations.

2. Allowable ASTM Specifications: All material, manufacturing operations, testing, inspection, and making of concrete pipe shall conform to the requirements of the appropriate allowable ASTM Standard Specifications, latest revision thereof, listed below:

ASTM C-14 - Concrete Sewer, Storm Drain, and Culvert Pipe

ASTM C-76 - Reinforced Concrete Culvert, Storm Drain and Sewer Pipe

ASTM C-361 - Reinforced Concrete Low-Head Pressure Pipe

3. Diameter of Pipe: The diameter indicated on the Construction Drawings shall mean the inside diameter of the pipe.

4. Wall Thickness and Class of Pipe: The wall thickness and reinforcing steel, if any, shall comply with the appropriate ASTM Specification and the class of pipe designated on the Construction Drawings. No elliptical reinforcing will be allowed in any circular pipe.

5. Fittings and Specials: Details of all fittings and specials shall be furnished for approval by the Engineer/Utility. Fittings and specials shall be made up of pipe segments having the same structural qualities as the adjoining pipe and shall have the interior treated the same as the pipe.

6. Lifting Holes: Lifting holes will be allowed for storm sewer pipe provided, however, only two lifting holes per pipe length will be allowed and all pipe shall be installed such that the lifting holes are in the crown of the pipe. All lifting holes shall be properly grouted with cement mortar immediately after the pipe is installed prior to commencement of any backfilling.

7. Cement: Unless otherwise required by the Engineer/Utility, or specified otherwise on the Construction Drawings, Type II Modified Portland Cement complying with the requirements of ASTM Designation C-150 will normally be acceptable in the manufacture of concrete pipe.

8. Acceptance: In addition to any deficiencies not covered by the applicable ASTM Specifications, concrete pipe which has any of the following visual defects will not be accepted:

    a. Porous spots on either the inside or the outside surface of a pipe having an area of more than 10 square inches and a depth of more than 1/2 inch.

    b. Pipe which has been patched to repair porous spots, cracks, or other defects, when such patching was not approved by the Engineer/Utility.

    c. Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.

    d. Pipe that has been damaged during shipment or handling even previously approved before shipment.

    e. Concrete pipe, at delivery to the job site, will be at least 5 days (120 hours) old.

    f. Fractures or cracks passing through the wall, except for a single end crack that does not exceed the depth of the joint.

g. Defects that indicate imperfect proportioning, mixing, and molding.

h. Surface defects indicating honeycombed or open texture.

i. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

j. Any continuous crack having a surface width of 0.01 inch (0.25 mm) or more extending for a length of 12 inches (310 mm) or more, regardless of position in the wall of the pipe.

k. Acceptance of the pipe at point of delivery will not relieve the Contractor of full responsibility for any defects in materials due to workmanship.

9. Marking: The following shall be clearly marked on both the interior and exterior surface of the pipe:

a. ASTM and AASHTO specifications

b. Class and Size

c. Date of Manufacturer

d. Name or Trademark of Manufacturer

10. Joints: The joint design for concrete pipe shall be bell and spigot. The bell shall be grooved to properly contain and seat the rubber gasket. The joint assemblies shall be accurately formed so that when each pipe section is forced together in the trench the assembled pipe shall form a continuous watertight conduit with smooth and uniform interior surface, and shall provide for slight movement of any piece of the pipeline due to expansion, contraction, settlement or lateral displacement. The gasket shall be the sole element of the joint providing water tightness. The ends of the pipe shall be in planes at right angles to the longitudinal centerline of the pipe, except where bevel-end pipe is required. The ends shall be furnished to regular smooth surfaces.

All joints and jointing material shall conform to the following minimum requirements. Jointing material used shall be indicated on the Construction Drawings.

a. Rubber gasket joints for bell and spigot pipe shall consist of an O-ring rubber gasket or other approved gasket configuration and shall conform to the requirements of the appropriate ASTM Specification of the pipe designated. Unless otherwise approved by the Engineer/Utility the standard joint configuration shall be similar and equal to the Bureau of Reclamation's "R-4" joint designation. Joints shall be in accordance with ASTM C 76.

Gaskets: Gaskets may be either natural rubber or neoprene conforming to ASTM Designation C-443 and AASHTO M 198. All gaskets shall be stored in a cool place, preferably at a temperature of less than 70 degrees Fahrenheit (F.), and in no case shall the gaskets be stored in the open, or exposed to the direct rays of the sun. No gaskets that show signs of deterioration, such as surface cracking or checking, shall be installed in a pipe joint. The neoprene gaskets used when the air temperature is 10F or lower, shall be warmed to temperature of 60F for a period of 30 minutes before being placed on the pipe.

b. If the average joint gap in 36-inch diameter pipe or larger pipe exceeds ¾-inch, the void shall be filled and troweled smooth with an approved non-metallic, non-shrink grout conforming to ASTM C-827 or flexible plastic sealant conforming to Federal Specification SS-S-00210 so to provide a smooth interior surface at the joint.

For pipe sizes 18-, 24-, 27-, 30-, and 36-inch in diameter, the reinforcement in the bell and spigot shall conform to ASTM C-76 for the class of pipe specified or to ASTM C-361 for a minimum pressure head of 25 foot, whichever is greater.

11. Protective Coatings: Normally, no additional exterior or interior protective coatings will be required for concrete pipe. However, whenever adverse corrosive conditions warrant additional interior protection, those pipe segments will be noted on the Construction Drawings.

D. Metal Pipe

1. Joints for metal pipe shall meet the requirements in Article 1.03, above.

2. Connector bands shall have the same corrugations as the pipe unless otherwise specified.

3. Acceptance: In addition to any deficiencies not covered by the applicable Specifications, as listed above, metal pipe which has any of the following defects will not be accepted:

a. Uneven laps

b. Elliptical shaping

c. Variation for a straight center line

d. Ragged or diagonal sheared edges

e. Loose, unevenly lined or spaced rivets or spot welds

f. Poorly formed rivet heads or locked seams

g. Unfinished ends

h. Illegible brand

i. Lack of rigidity

j. Bruised, scaled, or broken spelter coating

k. Dents or bends in the metal itself that damage it structurally

E. Fittings and Specials

1. Fittings and specials shall be made of pipe segments having the same structural qualities, corrugations (where applicable), and coatings as the adjoining pipe.

2. Details of fittings and specials shall be approved by the Engineer/Utility before construction.

F. Underdrain or Subdrain Pipe

1. Subdrain pipe shall meet the requirements of Article 1.03, above, except that metal pipe shall not be used.

2. Perforations for subdrain pipe shall be in conformance with the manufacturer's and Design Engineer's recommendations. Subdrain pipe shall have the bottom ¼ of the pipe without perforations.

G. Steel Reinforced High Density Polyethylene Pipe

1. Resins shall conform to the minimum requirements for cell classification 345464C as defined and described in the latest version of ASTM D3350 "Standard Specification for Polyethylene Plastic Pipe and Fittings Materials".

2. Pipe lengths shall be joined on site using bell & spigot, or ElectroFusion couplers especially designed for DuorMaxx pipe.

3. Joints:

a. High Performance (HP) Joints (30" – 84") shall be gasketed, bell and spigot joints where both the bell and spigot are reinforced with steel that is fully encased in stress-rated high density polyethylene and thsat have been laboratory tested to 15 psi when tested in accordance with ASTM D3212 "Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

b. ElectroFusion (EF) Joints (36" – 120") shall utilize plain ended DuroMaxx pipe welded together utilizing exclusive pressure testable ElectroFusion couplers. The welded connections provide a true in-

field water tight system assured by the pressure testable welded sleeves at each welded connection. The field installed ElectroFusion joints shall remain watertight with a zero leakage rate up to a test pressure of 30 psi.

4. Fittings:

a. All fabricated fittings and couplings supplied by the manufacturer shall be constructed to ensure no loss of structural integrity or joint tightness at welded seams and joints. Only those fittings supplied by or recommended by the manufacturer shall be used.

H. Plastic and Polyethylene (PE) Corrugated Pipe

1. ADS – N-12, dual wall high-density polyethylene pipe shall have a smooth interior wall and corrugated exterior and meet a full 10.8 psi. Joints shall meet or exceed ASTM 3212 lab test and ASTM C969 watertight field test.

a. Fittings shall be manufactured by Nyloplast Engineered Surface Drainage Products

b. Or An Approved Equal.

2. A-2000 PVC with minimum of 46 pipe stiffness for all diameters.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Reference Section 02100 – Site Preparation

3.02 DEWATERING

A. Reference Section 02240 – Water Control and Dewatering

3.03 LAYING, ALIGNING, AND JOINING PIPE

A. Reference Section 02722 – Wastewater Collection System

3.04 BEDDING AND BACKFILLING

A. Reference Section 02225 – Trenching, Bedding and Backfill

3.05 ENCASEMENT AND CRADLES

A. Concrete for encasements shall be as specified in Section 03310.

Prior to placing the concrete for the cradles or encasement, temporary supports consisting of concrete blocks or bricks shall be used to support the pipe in place. Not more than two supports shall be used for each pipe length, one adjacent to the shoulder of the bell and the other near the spigot end. No encasement shall be poured until the Engineer/Utility has inspected and approved the pipe to be encased and its supports.

All ditch crossings shall be constructed in accordance with the Specifications and the Construction Drawings. Written approval of the irrigation company must be obtained prior to the crossing of any irrigation ditch.

3.06 GRATES FOR PIPES AND HEADWALLS

A. When called for on the Construction Drawings, grates shall meet the following requirements:

1. Grating shall be constructed of steel bars with a minimum diameter of 5/8". Reinforcing bars shall not be used.

2. Welding connections shall be ¼" minimum.

3. Spacing between bars shall normally be five inches (5") unless site conditions are prohibitive.

4. All exposed steel shall be galvanized in accordance with AASHTO M 111.

5. Welded joints shall be galvanized with a rust preventive paint.

6. Grates shall be secured to the headwall or end section by removable devices such as bolts or hinges to allow maintenance access, prevent vandalism, and prohibit entrance by children.

3.07 SURFACE RESTORATION

A. All streets, alleys, driveways, sidewalks, curbs or other surfaces broken, cut or damaged by the Developer shall be replaced in kind or as shown on the Construction Drawings.

3.08 CONCRETE CUTOFF COLLARS

A. Concrete shall meet the requirements of Section 03310.

3.09 UNDERDRAIN OR SUBDRAIN PIPE

A. Underdrains/subdrains shall only be tied into storm sewer manholes, back or sides of stormwater inlets, or discharged directly to drainage channels or water courses.

1. Penetrations at tie-ins must be grouted to prevent water from entering the manhole or inlet from around the exterior of the pipe.

B. Cleanouts shall be designed at regular intervals so the pipe can be cleaned from the surface over the pipe.

3.10 STEEL REINFORCED HIGH DENSITY POLYETHYLENE PIPE

A. Installation shall be in accordance with ASTM D2321 “Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications” along with product-specific recommendations for DuroMaxx pipe.

END OF SECTION

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SECTION 02613

PRE-CAST REINFORCED CONCRETE BOX CULVERT

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers pre-cast reinforced concrete box culverts (RCBC).

1.02 STANDARDS

A. ASTM C789 (AASHTO M259) – Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewer.

B. ASTM C850 (AASHTO M273) – Standard Specification for Precast Concrete Box Sections for Culverts, Storm Drains, and Sewers with Less Than 2 Feet of Cover Subject to Highway Loadings.

C. ASTM C1433 – Standard Specification for Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers

PART 2 PRODUCTS

2.01 MATERIAL

A. Angles or deflections in the culvert shall be specially manufactured by the pre-cast manufacturer and shall not be special cast in the field.

B. Qualification of Manufacturers: All pre-cast reinforced concrete box culvert shall be manufactured in an ACPA Q-Cast certified plant.

PART 3 EXECUTION

3.01 INSPECTION

A. Examine upon delivery and do not use individual sections with any defect, including the following:

1. Fractures or cracks passing through the wall.

2. Defects that indicate imperfect proportioning, mixing, and molding.

3. Surface defects indicating honeycombed or open texture.

4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.

5. Continuous cracks having a surface width of 0.01 inch or more extending for a length of 12 inches or more regardless of position in the pipe wall.

B. Mark rejected items and remove from the site.

3.02 INSTALLATION

A. Lay true to line and grade.

B. As each length of box culvert is placed in the trench, complete the joint and adjust to the correct line and grade. Make adjustments by scraping away or filling bedding under the body and not by wedging or blocking.

C. Lay upgrade from the lowest point, with the bell end pointing upgrade.

3.03 JOINTING

A. Join in accordance with pipe manufacturer's recommendations.

END OF SECTION

SECTION 02615

DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers ductile iron pipe and fittings for water line installation and replacement.

B. Pipe shall be furnished complete with all fittings, flanges, specials and other accessories.

1.02 QUALITY ASSURANCE

A. Manufacturer

1. All ductile iron pipe shall be supplied by one manufacturer.

2. Reference Section 01000 – Approved Product Listing

1.03 PRODUCT DELIVERY

A. 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 coating or lining.

5. Special care to be taken when handling epoxy coated specials & fittings.

6. Do not use hooks.

7. Pipe shall not be handled in any manner which will cause damage.

8. Care shall be taken to prevent damage to pipe and fittings by impact, bending, compression, or abrasion.

9. Damaged pipe or fittings shall not be installed, and shall be immediately removed from the work site.

B. Storage:

1. Store and use lubricants in a manner which will avoid contamination.

2. Pipe shall be delivered to the site and stored with plastic end plugs to ensure it is kept free from dirt, debris, animals, etc.

3. Store rubber gaskets in a cool, dark location away from grease, oil, and ozone producing electric motors.

4. Do not exceed maximum stacking heights listed in AWWA C600, Tables 1 and 2.

PART 2 MATERIALS

2.01 DUCTILE IRON PIPE AND FITTINGS

A. Specifications

The pipe shall be designed, manufactured, tested, inspected and marked in accordance with the provisions of this Specification and AWWA. Standard C151, "American Standard for Ductile Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds for Water or Other Liquids", except as herein modified.

B. Dimensions

Nominal pipe lengths shall be 18 feet or 20 feet, with shorter lengths provided as required by Construction Drawings, alignment and profile. Random pipe lengths are not acceptable, except when using restrained joint pipe. Permissible variations in length, diameter, weight, wall thickness and straightness shall comply with the allowable tolerances specified in the applicable AWWA Standards. The minimum finished inside diameter of the pipe, after lining is placed, shall be as set forth in the applicable AWWA Standards.

C. Ductile Iron Pipe Diameter and Rated Working Pressure Class

Pipe Size (inches)	Pressure Class
3 through 12	350
16 through 20	250

D. Joint Design and Fabrication

The standard joints shall be push-on rubber gasket joints conforming to AWWA Standard C-111. The joint shall be a single rubber gasket joint designed to be assembled by the positioning of a continuous, molded rubber ring gasket in an annular recess in the pipe or fitting socket and the forcing of the plain end of the entering pipe into the socket, thereby compressing the gasket radially to the

pipe to form a positive seal. The joint shall be suitable for a minimum of 250 psi working pressure.

The manufacturer shall furnish all joint materials including rubber gasket and joint lubricant. The mechanical joint restraint shall be designed to resist thrusts resulting from internal pressure acting at bulkheads, bends, valves and extending over the distances as shown on the Construction Drawings. The joint restraint shall be designed for a minimum working pressure of 250 psi. Although thrust blocks may also be required, joint restraint is to be designed without consideration given to any support derived from these blocks. The Engineer/Utility may request that the Design Engineer furnish joint restraint calculations including all design considerations and assumptions prior to and/or during installation in order to accommodate specific site conditions.

In addition to restraint systems manufactured into the pipe, joint restraint devices may include:

1. Mechanical joints shall be restrained with any of the following:

    a. Reference Section 01000 – Approved Product Listing.

2. Push-on joints may be restrained with any of the following:

    a. Reference Section 01000 – Approved Product Listing.

All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

Flanged ductile iron pipe with threaded flanges shall have a working pressure rating of 250 psi.

E. Specials and Fittings

Unless otherwise shown on the Construction Drawings, all specials and fittings shall conform to the dimensions and requirements of AWWA Standards. Fittings shall be made of gray iron or ductile iron and have fusion bonded epoxy Coating designed for 250 psi minimum working pressure and shall have the same lining and coating as the abutting pipe.

Specials and fittings shall have fusion bonded epoxy coating in accordance with ANSI/AWWA C116/A21.16 and shall be applied to interior and exterior surfaces. Areas of lining and coating that have been damaged shall be repaired by hand application in accordance with applicable AWWA Standards.

Moderate deflections and long radius curves may be made by means of bends or fittings, by deflecting straight pipe, by using short lengths of pipe, or by a combination of any of these methods.

All fittings and couplings shall have one of the following types of connections:

1. Flanged joint (meter vaults only).
2. Mechanical joint.
3. Push-On joint shall not be allowed.

All ductile iron pipe with threaded flanged joints for meter vaults shall be manufactured in accordance with ANSI A21.15-83 (AWWA C115)

1. All flanges shall be sized and drilled in accordance with ASME/ANSI B16.1: Cast Iron Pipe Flanges and Flanged Fittings, Class 125; or Ductile Iron Pipe Flanges and Flanged Fittings, Class 150.

F. Cement-Mortar Lining

Interior surfaces of all pipe, fittings and specials shall be lined in the shop with cement-mortar in accordance with AWWA Standard C104. The cement shall meet the requirements of "Standard Specifications for Type II Portland Cement", ASTM Designation C150. The sand shall conform to that prescribed in AWWA C-104. The cement mortar shall contain not less than one part of cement to two parts of dry sand.

Every precaution shall be taken to prevent damage to the lining. If lining is damaged or found faulty, the unsatisfactory pipe shall be replaced.

All ductile iron pipe shall have a standard thickness cement mortar lining.

1. Ductile iron pipe which is twelve inches (12”) and smaller in diameter shall have a cement mortar lining with a minimum thickness of 1/16 inch.

2. Ductile iron pipe which is larger than twelve inches (12”) in diameter shall have a cement mortar lining with a minimum thickness of 3/32 inch.

G. Exterior Coating

The outside coating shall be a bituminous coating of either coal tar or asphalt base approximately 1 (one) mil thick. The finished coating shall be continuous, smooth, neither brittle when cold nor sticky when exposed to the sun, and shall be strongly adhered to the pipe.

H. Polyethylene Encasement

All ductile iron pipe and fittings shall be polyethylene encased. The polyethylene encasement material shall be manufactured in accordance with

AWWA. Standard C 105, "Polyethylene Encasement for Ductile Iron Pipe Systems" with the following additional requirements or exceptions.

1. Material - High density, cross-laminated polyethylene film. The raw material used to manufacture polyethylene film shall be Type III, Class A, (natural color) Grade P-33 in accordance with ASTM Standard Designation D-1248.

3. Physicals - The polyethylene film shall meet the following test requirements:

Tensile Strength	5000 psi minimum
Elongation	100% minimum
Dielectric Strength	800 V/mil thickness minimum
Thickness	0.004" (4 mils) minimum with minus tolerance not exceeding 10% of nominal thickness

I. Tapping Sleeves.

Reference Sections 02644 and 02713 of these specifications.

J. Seals:

For penetrations into Precast Concrete structures use two sets of Thunderline Link-Seal units w/stainless steel hardware.

PART 3 EXECUTION

3.01 DUCTILE IRON PIPE INSTALLATION

A. Handling

Ductile iron pipe and fittings shall be handled at all times by lifting with padded cradles of canvas, leather or other suitable material so as to avoid shock or damage. Pipe shall be so handled that the coating and lining will not be damaged. If, however, any part of the coating or lining is damaged, the repair shall be made by the Developer in a manner satisfactory to the Engineer/Utility. Pipe handling equipment is to be approved by the ENGINEER. The use of bare metal cables, chains, or hooks, etc. will not be permitted.

Stockpiled ductile iron pipe shall be supported on wood blocks and/or sandbags placed under the uncoated ends of the pipe. Bags shall be of sufficient size to prevent contact of the pipe coating with the ground or any obstruction. Rolling the pipe on coated surface will not be permitted. Adequate strutting shall be provided if necessary to prevent damage to pipe lining and coating.

B. Subgrade

No blocking of pipe will be permitted. Before the pipe is laid, the subgrade shall be prepared by backfilling with clean uniformly graded sand so as to provide a uniform and continuous bearing and support for the pipe at every point between bell holes, except that it will be permissible to disturb or otherwise damage the subgrade surface over a maximum length of 18-inches near the middle of each length of pipe by the withdrawal of pipe slings or other lifting tackle.

C. Joining Stab Joints

Immediately before joining two lengths of ductile iron pipe, the inside of the bell end, the outside of the spigot end and the rubber gasket shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter. The rubber gasket shall be flexed inward and properly inserted in the gasket recess of the bell socket. Caution shall be exercised to insure the correct type of gasket is used.

A thin film of gasket lubricant shall be applied to either the inside face of the gasket or the spigot end of the pipe or both.

The spigot end of the pipe shall be placed in the socket with care to prevent the joint from contacting the ground. The joint shall be completed by pushing the pipe home with a slow steady pressure without jerky or jolting movements. Pipe furnished without a depth mark shall be marked before assembly to assure insertion to the full depth of the joint. The spigot end of field cut pipe lengths shall be filed or ground to resemble the spigot end of such pipe as manufactured.

Whenever it is desirable to deflect stab joint pipe in order to form a long radius curve, the deflection shall not exceed eighty percent (80%) of the pipe manufacturer's recommendations for maximum deflection.

D. Joining Mechanical Joint Pipe

Before joining mechanical joint ductile iron fittings to the ductile iron pipe, the outside of the spigot, the inside of the bell and the rubber gasket shall be thoroughly cleaned to remove oil, grit, excess coating, and other foreign matter.

Normal practice is to lubricate the joint with a soap solution; however, in cold weather the joint may be assembled dry if approved by the Engineer/Utility. Extreme care shall be exercised in making the dry joint.

The ductile iron gland shall be slipped on the spigot end of the pipe with the lip extension of the gland toward the socket, or bell end. The rubber gasket shall be placed on the spigot end with the thick edge toward the gland.

The pipe shall be pushed forward until the spigot end fully penetrates the bell. The gasket shall then be pressed into place in the bell evenly around the entire

joint. The gland shall be moved along the pipe into position for bolting, the bolts inserted, and the nuts screwed finger tight, then tightened with a torque limiting wrench. The torque for the various sizes of bolts shall be as follows:

Pipe Size (inches)	Bolt Size (inches)	Range of Torque (ft.-lbs.)
2-3	5/8	60
4-24	3/4	75-90

Nuts spaced 180 degrees apart shall be tightened alternately in order to produce an equal pressure on all parts of the gland.

Whenever it is desirable to deflect mechanical joint pipe in order to form a long radius curve, the deflection shall not exceed eighty percent (80%) of the pipe manufacturer's recommendations for maximum deflection.

E. Flanged Joint

Before the joint is assembled, the flange faces shall be thoroughly cleaned of all foreign material with a power wire brush. The gasket shall be centered and the connecting flanges drawn up watertight without unnecessary stressing of the flanges. All bolts shall be tightened in a progressive diametrically opposite sequence using torque wrenches at settings recommended by the manufacturer (75 lb. min.). Only EPDM (ethylene propylene diene monomer) rubber gaskets or Styrene-Butadiene (SBR) Skirtboard gaskets shall be used. Where steel flanges are connected to ductile iron flanges, an insulating connection shall be provided.

F. Polyethylene Wrap

Ductile iron pipe and fittings shall be polyethylene encased (cross-laminated HDPE) in accordance with AWWA Standard C-105, "Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids," and as detailed on the Drawings.

G. Cutting and Fitting

The Developer shall make all pipe cuts required to conform to location, line and grade. All cuts on ductile iron pipe shall be made by the use of pipe cutters or pipe saws. All cuts shall be straight and true.

3.02 PIPE INSTALLATION - GENERAL

A. Underground Interference

It shall be the responsibility of the Developer to verify the locations shown on the Construction Drawings. The Developer shall exercise care when working in

order to protect all underground interference and shall be fully responsible for any and all damage caused by his/her operations.

B. Temporary Bulkhead

Whenever the pipe is left unattended, temporary plugs shall be installed at all openings. Temporary plugs shall be watertight and of such design as to prevent children, animals, or debris from entering the pipe. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

C. Pipeline Marker or Detection Tape

Polyethylene warning tape shall be installed approximately one (1) foot above the pipe, centered over all buried waterlines.

END OF SECTION

SECTION 02621

PLASTIC PRESSURE PIPE

PART 1 - GENERAL

1.01 DESCRIPTION

This section covers the furnishing and installation of plastic pressure pipe and fittings.

1.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Handling.

1. Pipe shall not be handled in a manner which will cause damage to the pipe.

2. Pipe or fittings shall not be dropped.

3. Pipe shall be handled in a manner as to keep the pipe clean and free from dirt and debris.

4. Care must be taken to prevent damage to the pipe and fittings by impact, bending, compression or abrasion.

5. Damaged pipe or fittings shall not be installed, and shall be immediately removed from the site.

B. Storage.

1. Lubricant shall not be stored or handled in a manner which will cause contamination to the lubricant.

2. Rubber gaskets shall be stored in a location which protects them from deterioration.

3. Pipe shall be delivered to the site and stored with plastic end plugs to ensure it is kept free from dirt, debris, animals, etc.

4. Pipe shall be stored in accordance with the manufacturer's specifications.

5. Pipe shall be stored on a surface which provides even support for the pipe barrel.

a. Pipe shall not be stored in such a way as to be supported by the bell.

6. Care shall be taken to ensure plastic pipe is not exposed to sunlight (UV) for extended periods of time to cause UV discoloration. Any pipe with UV discoloration shall immediately be removed from the site.

1.03 QUALITY ASSURANCE

A. Standard:

1. AWWA C900 or C909: PVC Pressure Pipe and Fabricated Fitting, 4"- 12", For Water Distribution

2. AWWA C905: PVC Pressure Pipe and Fabricated Fitting, 16"- 48", For Water Transmission and Distribution

3. ASTM F477: Elastomeric Seals (Gaskets) for Joining Plastic Pipe

4. ASTM D1784: Specification for Rigid PVC Compounds and CPVC Compounds

5. ASTM D3139: Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals

B. Manufacturers:

1. Reference Section 01000 – Approved Product Listing

2. Or An Approved Equal

PART 2 - PRODUCTS

2.01 MATERIALS

A. PVC Pressure Pipe (4 inch through 12 inches).

1. Conformance: AWWA C-900 DR-18 Class 150 and AWWA C909 Class 200.

2. O.D. Base: Cast Iron equivalent.

3. Pipe Joints:

a. Direct Bury: Bell ends with elastomeric gaskets. Solvent cement joints are strictly prohibited.

b. Horizontal Directional Drilling:

i. Fusible C-900™ manufactured by Underground Solutions, Inc.

ii. Low profile restrained joint pipe such as C900/RJ system manufactured by CertainTeed or approved equal.

4. All joints on plastic pressure pipe shall be push-on, using an integral bell with an elastometric gasket.

5. Color of the pipe shall be blue to distinguish as potable water.

6. All plastic pressure pipe shall have a nominal laying length of twenty feet (20').

    a. Random pipe lengths are not acceptable.

B. PVC Pressure Pipe (16 inch through 20 inches).

1. Conformance: AWWA C-905.

2. O.D. Base: Cast Iron equivalent.

3. Pressure Rating: Refer to drawings for minimum pressure class.

4. Joints: Bell ends with elastomeric gaskets. Solvent cement joints are strictly prohibited.

5. Color of the pipe shall be blue to distinguish as potable water.

C. Mechanical Joint Restraints:

1. Reference Section 01000 – Approved Product Listing

2. Or An Approved Equal

D. Fittings: Ductile Iron.

1. Standard: AWWA C-104, C-110, C-111, or C-153.

2. Lining: Epoxy.

3. Coating: Epoxy.

4. Pressure rating: minimum 250 psi.

5. Connections: mechanical joint unless specified otherwise indicated.

    a. All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

E. Tracer wire.

1. Tracer wire shall be #12 AWG high strength single strand solid copper clad steel conductor. Wire shall be insulated with a 30 mil, high density polyethylene (HDPE) insulation and rated for direct bury use at 30 volts. The tracer wire shall be continuous (without splices) whenever possible.

2. When splices are required, an approved wire connector shall be used (Reference section 01000 – Approved Product Listing).

F. Locator Stations:

1. Reference standard details for Locator Box and PVC Water main tracer wire detail.

2. Marked: “LOCATOR STATION”.

G. Warning Tape

1. Tape to read: CAUTION: BURIED WATER LINE BELOW

2. Colors: Blue background with black text

3. APWA & AASHTO compliant

4. Tape shall be detectable 5 mil foil for plastic piping or other detectable non-degradable material

H. Joint Restraining Devices

3. Mechanical joints may be restrained with any of the following:

a. Reference Section 01000 – Approved Product Listing.

3. Push-on joints may be restrained with any of the following:

a. Reference Section 01000 – Approved Product Listing.

PART 3 - EXECUTION

3.01 INSPECTION

A. Examine the pipe and fittings for cracks, dents, abrasions or other flaws prior to installation. Mark defective pipe and remove from the site.

3.02 INSTALLATION

A. Install pipe in accordance with Section 02713 – Water Distribution System.

B. Cutting the pipe.

1. Cut the pipe square with saws or pipe cutters designed specifically for the material.

2. Bevel the end in accordance with the manufacturer's recommendations.

3. Locate a depth mark with a marker or crayon to assure the spigot end is inserted to the recommended depth.

4. Remove burrs and wipe off all dust from the jointing surfaces.

C. Gasketed joints.

1. Remove all dirt and foreign material from the spigot, gasket an gasket groove.

2. Apply lubricant furnished by the pipe manufacturer.

3. Insert the spigot to the depth recommended by manufacturer.

4. Do not disturb previously completed joints during jointing operations.

D. Do not bend pipe on any radius. Joints may be deflected if manufacturer's written literature allows, but bending of pipe is not allowed.

E. Joints of all pipe in the trench shall be completed before work is stopped. If water accumulates in the trench, the plugs shall remain in place until the trench is dry.

F. PVC to ductile iron pipe joints shall be made with epoxy coated mechanical joint solid sleeves.

G. Tracer wire.

1. Tracer wire shall be installed in a manner as to conform to the PVC Water Main Tracer Wire Detail shown in Standard Details.

2. Tape to top centerline pipe every 5 feet with tape such that wire remains in place during bedding of pipe.

3. Secure tracer wire to fire hydrant be wrapping twice around riser to hydrant. Terminate end of tracer wire in a pre-fabricated Locator Box with two (2) feet of wire shall be coiled inside each box. Place locator box 12 to 24 inches in front of fire hydrant.

4. When splices are required, an approved wire connector shall be used (Reference section 01000 – Approved Product Listing). With approval from Engineer/Utility wire splices may be made with an approved equal product/method.

5. Attach one pound (1 lb) sacrificial anodes to tracer wire every 500 feet.

6. Testing.

a. Pass current through wire and demonstrate that wire is capable of locating the pipe.

b. If wire will not pass current, locate break in circuit and test until tracer wire works in accordance with its intended use.

H. Warning Tape

1. Place twelve (12) inches above top of pipe and centered over pipe in backfill.

2. Tape shall run continuous with pipe.

3.03 TAPPING

A. Reference Sections 02644 and 02713 of these specifications.

END OF SECTION

SECTION 02622

PLASTIC NON-PRESSURE PIPE

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers plastic non-pressure sanitary sewer pipe and fittings to be furnished complete with all jointing materials.

1.02 SUBMITTALS

A. Certification: Submit manufacturer's certification that products meet requirements of referenced specifications.

B. Shop Drawings: Submit Shop Drawings and data showing details of joints, gasket material and pipe length.

1.03 PRODUCT DELIVERY

A. Do not damage the pipe by impact, bending, compression or abrasion during handling and storage.

B. Store PVC sewer pipe on a flat surface which provides even support for the barrel with bell ends overhanging.

C. Do not stack pipe higher than 5 feet.

D. Do not use pipe and fittings stored in direct sunlight for periods in excess of 18 months. Any pipe with UV discoloration shall immediately be removed from the site.

E. Use only nylon protected slings or hands to handle pipe. Do not use hooks or bare cable.

PART 2 - PRODUCTS

2.01 POLYVINYL CHLORIDE (PVC) PIPE

A. Pipe and fittings:

1. 4" through 15", ASTM D3034, type PSM, SDR 35.

2. 18" through 27", ASTM F679 (T1).

3. All pipe shall have the A.S.T.M. Specification, nominal diameter, and name or trade mark of the manufacturer imprinted on the outside of the pipe.

4. Fittings shall be of the same material and class as the pipe to which it is attached.

5. Plugs: P.V.C., size shall be the same as for the pipe. Plugs shall be air tight for testing of the lines.

B. Joints: ASTM F477 push-on. Joints: ASTM D3212, push-on with an O-ring rubber gasket conforming to ASTM Designation D3034. Solvent cement joints are strictly prohibited.

C. Pipe lengths: maximum pipe length shall be twenty (20) feet and no shorter than fourteen (14) feet, except service tees and closure pieces.

D. Markings: All sizes of PVC pipe shall have the SDR rating, the ASTM Specification, nominal diameter, and name or trademark of the manufacturer imprinted on the outside of the pipe.

PART 3 - EXECUTION

3.01 INSPECTION

A. In addition to any deficiencies covered by ASTM D3034, PVC 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 length.

2. Pipe which is sufficiently out-of-round to prohibit proper jointing.

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. Mark rejected pipe and remove from the site.

3.02 INSTALLATION

A. Install pipe in accordance with Section 02722, Wastewater Collection System.

B. Cutting the pipe.

1. Cut pipe square with saw or pipe cutter designed specifically for the material.

2. Bevel the end in accordance with the manufacturer's recommendations.

3. Insert the spigot to the reference mark, according to manufacturer's recommendations.

4. Do not disturb previously installed joints during jointing operations.

3.03 FIELD QUALITY CONTROL

A. Reference Section 02722, Wastewater Collection Systems.

END OF SECTION

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SECTION 02636

SNOUT OIL-WATER-DEBRIS SEPARATOR

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section covers the technical requirements for the furnishing and installation of the SNOUT Oil-Water Debris Separator. All materials used shall meet the requirements of this specification, and all work shall be performed in accordance with the procedures provided herein and the Construction Drawings.

1.02 DEFINITIONS

For the purposes of this specification guideline, the following terms are defined below:

A. SNOUT. A patented plastic composite hooded outlet cover that attaches to the wall of an inlet or other water-quality structure over the outlet pipe in such a manner as to prevent the exit of floating debris and oil.

B. MANUFACTURER

1. Reference Section 01000 – Approved Product Listing

2. On An Approved Equal

PART 2 - PRODUCTS

2.01 GENERAL

A. Inlets shall be outfitted with the SNOUT Oil-Water-Debris Separator as identified on the Construction Drawings. The size and position shall be as shown in the Construction Drawings. The hood shall be securely attached to the inlet wall with 6-3/8” diameter stainless steel bolts and sealed to the structure with gasket material supplied in the installation kit.

2.02 MATERIALS

A. The SNOUT Oil-Water-Debris Separator components consist of the following:

1. Standard size composite Hoods

2. Gasket, screw down, watertight, clean-out access port

3. Stainless steel mounting hardware

4. PVC SCH40 fittings and pipe for anti-siphon device

5. Pressure sensitive oil resistant foam rubber gasket

PART 3 - EXECUTION

3.01 INSTALLATION

A. Select the SNOUT Oil & Debris Separator of size and configuration to fit application. Select F for flat-walled structures and R for round-walled structures.

B. Center the SNOUT directly over the exit pipe so that the entire pipe is covered and so that the lower edge of the hood is at least 1/2 the pipe diameter below the lowest inside point of the pipe.

C. Drill equally spaced 7/16" holes through the SNOUT flange. (*Number of holes vary depending on size of SNOUT.)

D. Mark and drill catch basin and install the tamp-in lead anchors.

1. Drill a 3/4" hole into the base material to the required depth (approximately 1-1/4" deep).
2. Blow the hole clean of dust and other material.
3. Insert the anchor into the hole (Lead shield out).
4. Position the setting tool or a 9/16 socket against the anchor outer cone. (The outer rim of the tool or socket should seat onto the lead shield rim.)
5. Using the tool, set the anchor by driving the lead sleeve over the cone using several sharp hammer blows. (Be sure the anchor is at the required embedment depth.)

E. Attach the vent pipe adapter in the predrilled hole in the top of the SNOUT using the 2 flat O ring gaskets and PVC lock-nut supplied in kit. Install with the female slip adapter up and a washer on each side of the SNOUT shell. Tighten lock-nut hand tight.

F. Remove PSA backing and with firm pressure, attach gasket strip to back of flange and trim excess.

G. Attach the SNOUT to the catch basin wall with 3/8" diameter stainless steel bolts in lead expansion anchors. Do not over tighten; 10-15 foot pounds should be sufficient.

H. Cut the anti-siphon vent stack to length and attach to hood at pipe adapter with PVC cement.

I. Attach 90 degree elbow to vent stack with PVC cement. Ensure that the elbow opening is accessible for maintenance and inspection.

END OF SECTION

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SECTION 02640

VALVES

PART 1 - GENERAL

1.01 DESCRIPTION:

This section covers the furnishing and installation of butterfly line valves, air release and vacuum valves, gate valves, valve boxes, and valve appurtenances used for water distribution lines.

1.02 RELATED SECTIONS

Section 02605 – Water System Manholes and Vaults

Section 03310 - Structural Concrete

Section 03210 - Reinforcing Steel

1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Precautions shall be taken to prevent damage to materials during delivery and storage.

B. Valves shall be stored off of the ground and away from materials that could contaminate potable water systems.

C. Precautions shall be taken to keep all joints and internal parts clean.

PART 2 - MATERIALS

2.01 GENERAL

A. All valves shall open clockwise (right).

2.02 BUTTERFLY VALVES

A. Butterfly valves shall be used when pipe is larger than 12-inches in diameter.

B. All butterfly valves shall conform to AWWA C504.

1. All butterfly valves shall have an epoxy coated interior and exterior.

2. All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

3. All flanged butterfly valves shall be the short body type.

4. All butterfly valves shall be Class 150B.

5. Valve operator torque shall be as specified in Appendix A, of AWWA C504.

6. Acceptable manufacturers of butterfly valves are:

    a. Reference Section 01000 – Approved Product Listing.

7. All butterfly valves shall be placed in a manhole or vault.

    a. Reference Butterfly Valve Vault Detail Drawing.

8. All butterfly valves shall have a disc position indicator.

2.03 GATE VALVES

A. All gate valves shall be a resilient seat type and manufactured in accordance with AWWA C509.

1. All gate valves shall have an epoxy coated interior and exterior.

2. All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

B. All gate valves shall be provided with two O-ring type stem seals in accordance with Section 4.8 of AWWA C509.

C. If the operating nut on gate valves is more than five (5) feet below finish grade, a valve extension shall be used.

1. When a valve extension is installed, the top of the extension shall be set two (2) feet below finished grade.

    a. Valve Extension shall <u>not</u> be pinned to operator nut on valve.

A. Reference Valve Extension Detail Drawing.

D. Manufacturers:

1. Reference Section 01000 – Approved Product Listing.

2.04 COMBINATION AIR RELEASE VALVES

A. Combination air release valves shall be designed to exhaust large volumes or air when the system is filled with water and to allow large volumes of air to enter the pipeline when the system is drained. The air and vacuum relief portion of the valve

shall have a discharge orifice area which is equal to or greater than the valve inlet. The valve shall also be capable of venting small quantities of entrained air which typically accumulate at high points in the pipeline during system operation. Entrained air shall be vented under pressure by means of a small, independently controlled orifice. The combination air release valve shall be designed for water-tight operation and a minimum working pressure of 200 psi and a hydrostatic test pressure of 250 psi.

B. The combination air release valve body, cover and baffle shall be high strength plastic or cast iron conforming to ASTM A48 or ASTM A126. The valve float shall be stainless steel conforming to ASTM A240. The float retainer, outlet orifice plug, float cushion retainer, restraining screws and internal lock nuts and washers shall be stainless steel conforming to ASTM A276. The float cushion and outlet orifice seat shall be synthetic Buna-N rubber manufactured in compliance with ASTM SB800.

C. Unless prior permission is obtained from Utility, size of air relief and vacuum relief valves shall be a minimum of 2-inches in diameter.

D. Taps for air relief and vacuum relief valves shall be made with a tapping saddle and at the 12' O clock position on the pipe with a 2" corporation stop.

E. All pipes shall be brass.

F. Connections:

1. Between the corporation stop and the air relief and vacuum relief valve shall be 2" brass tee with test port installed off of the tee branch (see approved details).

2. The inlet connection for air relief and vacuum relief valves shall be 2-inches in diameter with a tapered iron pipe thread conforming to AWWA C800.

3. Connections on the outlet side of air relief and vacuum relief valves shall be threaded and shall be protected to minimize entry of debris and dirt into the valve.

G. Acceptable Manufacturers:

1. Reference Section 01000 – Approved Product Listing

2.05 VALVE BOXES

A. General

The manufacturer of valve box components shall be experienced in the design and construction, shall be regularly engaged in the manufacture and shall have produced valve boxes which have given successful service for a period of at least five (5) years.

Valve boxes herein described are for 4" or larger main and service lines.

B. Material

Valve box parts shall be made of gray cast iron in compliance with the requirements of ASTM A48 or ASTM A 126.

C. Approved Patterns

1. Valve boxes shall be screw-type with the word "WATER" cast into the lid.

2. Valve Box Bases, Reference Section 01000 – Approved Product Listing

3. Valve Box for all main line valves, Reference Section 01000 – Approved Product Listing

PART 3 - EXECUTION

3.01 VALVES

All valves shall be handled in such a manner as to prevent any injury or damage. All joints shall be thoroughly cleaned before installation.

Valves shall be located as shown on the Construction Drawings. Any deviations from this shall be at the discretion of the Engineer/Utility.

Valves shall be set and joined to pipe in the manner previously specified for cleaning, laying and joining the appropriate joints as provided with the valves. Valves shall be set in such a manner that the valve stems are plumb.

Valves shall be examined for cracks, dents, abrasions, and other flaws prior to installation. Defective valves shall be marked and removed from the site.

All valves shall be installed a minimum of 4 feet from any fence, bush, building or structure.

With the exception of tapping valves, flanged valves shall not be buried.

Valves shall be installed in such a manner that the operating nut is perpendicular to the ground surface.

Installed valve shall be supported in place with concrete bricks and then backfilled underneath and around the valve with compacted granular material.

Tapping valves shall be installed in accordance with the manufacturer’s recommendations.

Tapping valves and sleeves are to be water pressure tested to 150 psi for 5 minutes with no leakage allowed, prior to proceeding with the wet tap.

3.02 VALVE BOXES

A valve box shall be provided for every valve of size 12" and smaller or as shown on the Construction Drawings. The valve box shall not transmit shock or stress to the valve and shall be centered and plumb over the wrench nut of the valve, with the box cover set to the

elevation determined by the Design Engineer. Compact around barrel with hand equipment to minimize misalignment and settling of backfill.

Drop inserts are not allowed to raise a valve box. Valve box shall be raised and adjusted by turning the box to raise or lower to the appropriate elevation.

Valve boxes shall be examined for cracks, dents, abrasions, and other flaws prior to installation. Defective valve boxes shall be marked and removed from the site.

3.03 AIR RELIEF/VACUUM RELIEF VALVES

Air relief and vacuum relief valves shall be installed at high points, and as shown on the Construction Drawings.

3.04 OPERATION

Valves which have been accepted by the City shall be operated by City personnel only.

END OF SECTION

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SECTION 02644

TAPPING SLEEVES FOR DISTRIBUTION LINES

PART 1 GENERAL

1.01 WORK INCLUDED

Furnish and install all tapping sleeves as either shown or implied on the Construction Drawings.

1.02 RELATED WORK

Section 02615 – Ductile Iron Pipe and Fittings

Section 02621 – Plastic Pressure Pipe

PART 2 MATERIALS

2.01 General

Tapping sleeves shall be used to tap into existing waterlines. The sleeves shall be designed for a minimum working pressure of 150 psi. Sleeves for 12 inch and smaller mains shall be stainless steel with stainless steel nuts and bolts.

2.02 Sleeve Body

The sleeve body shall be fabricated stainless steel or steel with epoxy lining and coating. The sleeve body shall have a flanged outlet for the branch connection with dimensions and drillings complying with ANSI B16.1 and AWWA C207 Class D, ASNI 150 lb. drilling. The sleeve body shall form a water tight seal at the main line tap by means of a synthetic rubber gasket.

Full circle gaskets are required for all size on size taps.

2.03 Nuts and Bolts

All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

2.04 Gaskets

Gaskets shall be a resilient, synthetic rubber material subject to the manufacturer's specification and formulated to resist oil, water, acids and alkalis and aliphatic hydro-carbons.

2.05 Acceptable Manufacturers

Reference Section 01000 – Approved Product Listing.

PART 3 EXECUTION

3.01 GENERAL

A. Install tapping sleeves in accordance with the manufacturer's recommendations.

B. Prior to installation, thoroughly remove all oil, scale, and dirt from the saddle and provide a clean seat for the gasket.

C. Wipe gasket clean prior to installation.

D. Final nut tightening shall be performed with a torque-limiting wrench to the torque level recommended by the Manufacturer.

E. Taps larger than two inches (2") shall not be closer than five feet (5') from each other, measured from the center of the tap.

F. Taps shall not be made within five feet (5') of a bell or spigot end of the pipe being tapped unless approved by the Engineer/Utility.

END OF SECTION

SECTION 02645

HYDRANTS

PART 1 GENERAL

1.01 WORK INCLUDED

The Developer shall furnish all labor, materials, tools, equipment and perform all work and services necessary for, or incidental to, the furnishing and installation, complete, of all dry-barrel hydrants as shown on the Construction Drawings and completely coordinated with the work of other trades.

1.02 RELATED WORK

A. Section 02640 – Valves

1.03 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.

1.05 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with specifications, products of the following manufacturers are accepted for use as approved by the City.

1. Reference Section 01000 – Approved Product Listing.

PART 2 MATERIALS

2.01 GENERAL

All fire hydrants shall be designed and manufactured in strict compliance with AWWA Standard C-502 entitled “AWWA Standard for Dry-Barrel Fire Hydrants”.

2.02 SERVICE

All fire hydrants shall be designed for working pressure of 250 psi and each factory assembled unit shall be hydrostatically tested in accordance with applicable Standards noted in this specification. Shop tests for the body and main valve will be subjected to a hydraulic pressure of 300 psi.

2.03 SIZE OF HYDRANT

Hydrants shall have a main valve opening size of five and one quarter (5-1/4) inches.

2.04 TYPE OF HYDRANT

Hydrants shall be a three-way type with two (2) hose nozzles and one (1) pumper nozzle located on the same plane with the center line of the pumper nozzle, at least eighteen (18) inches above ground line.

2.05 INLET CONNECTION

Hydrant shall be provided with a mechanical joint inlet to accommodate 6-inch diameter ductile iron or PVC pipe complete with plain rubber gasket, gland, bolts and nuts all in accordance with ANSI A21.11.

All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

2.06 MAIN VALVE ASSEMBLY

Main valve of the hydrant shall be 5-1/4-inch diameter compression type which closes with the water pressure. Seat ring shall be bronze with a machined face and external threads for threading into a bronze drain ring or a bronze bushed shoe to provide bronze to bronze seating for the main valve, complete with O-rings for sealing.

Gasket for valve shall be a replaceable type fabricated of a resilient material with a threaded bottom plate or nut complete with seal to prevent leakage from the hydrant.

The valve assembly shall include one or more drain valves which will work automatically with the main valve and drain the barrel when the main valve is in the closed position. All drain tubes shall be bronze lined and sized large enough for the barrel to drain within 12 minutes when the barrel is sized for a five (5) foot trench depth.

All parts of the main valve assembly shall be so designed that removal of the assembly from the barrel is accomplished without excavation in accordance with Section 3.2 of the referenced specifications.

2.07 OPERATING SHAFT NUT

The operating nut shall be 7/8-inch tapered square. Bushings in bonnet shall be so constructed that it will prevent the operating nut from traveling during opening or closing operation; also the bushing shall house a gasket or seal to prevent moisture or foreign material from entering the lubricant reservoir.

The hydrant shall open by turning the operating nut to the right in a clockwise direction and shall have an arrow on top of the bonnet to designate the direction of opening.

2.08 PUMPER NOZZLE AND CAP

The pumper nozzle shall be 4-1/2-inch nominal diameter with four (4) threads per inch NST; threads shall be open right (clockwise).

Nozzle cap shall be furnished with a synthetic rubber gasket installed in a retaining groove and the dimensions and shape of the nozzle cap nut shall be the same as the operating shaft nut as described in Paragraph 2.8 of the specifications.

Nozzle caps shall be furnished with security chains with one end of each securely attached to the upper barrel section of the hydrant.

2.09 HOSE NOZZLES AND CAPS

The two hose nozzles shall be 2-1/2-inch nominal diameter with seven and one-half threads per inch (2.5 – 7.5 N.H.). Threads shall be open right(clockwise) and National Standard in accordance with NFPA No. 194. Each hose nozzle shall include a nozzle cap with nut and security chain.

2.10 NOZZLE ATTACHMENT

The hose and pumper nozzles shall be threaded and locked in place by a stainless steel pin or screw. Sealing of the threaded connections shall be accomplished by the use of O-ring gaskets.

2.11 COLOR

The upper exposed section of the hydrant above ground shall be given a prime coat of synthetic red lead primer, Type IV-TFP-86a, followed by one shop coat of heavy duty alkyd enamel paint conforming to the City's standards. Acceptable paint and manufacturers: Diamond Vogel Nu-Cling; 100% acrylic latex enamel gloss Part #MH3533 Safety Yellow or approved equal from the Utility.

The buried portion of the hydrant shall be given a bituminous coating in accordance with Section 6-8.1 of AWWA C-106 Standards.

2.12 HYDRANT GRAVEL

Hydrant Gravel shall be a well graded crushed stone or gravel, conforming to ASTM-D448, CDOT #67, as listed below:

SIZE	PERCENT PASSING
1"	100
3/4"	90 - 100
3/8"	20 - 55
#4	0 - 10
#8	0 - 5

PART 3 EXECUTION

3.01 PRIOR TO INSTALLATION

A. Carefully clean hydrants of all foreign material and inspect hydrant's valves in open and closed positions. Notify the Engineer/Utility and do not install the hydrant if it does not function properly.

3.02 INSTALLATION

A. Installation practices shall conform to the manufacturer's recommendations.

B. Install hydrants as shown on the Construction Drawings and set plumb.

C. All joints on fire hydrant lateral (lead) shall be restrained from main to hydrant.

D. All underground valves shall be installed with cast iron valve boxes set over the valve with no weight bearing on the valve or pipe. All under ground valves shall be coated with bituminous material and encased in polyethylene.

E. Developer shall provide offset staking for both vertical and horizontal control.

F. Joining of laterals, valves, and hydrants shall be handled in the same manner as pipe.

1. Fire hydrant shall be installed vertically plumb with pumper nozzle facing direction shown on Construction Drawings.

    a. The vertical distance from any finished surface to centerline of pumper nozzle shall not be less than eighteen (18) inches, nor greater than twenty (22) inches.

2. Fire hydrant shall be set to elevation staked, to insure that bury line is at final grade.

3. Hydrant, piping and valve shall be encased in eight (8) mil polyethylene.

    a. When hydrant is connected to a PVC water main, the locator wire for the PVC main shall be wrapped around the lower barrel and then placed in locator station box (reference section 02621 – Plastic Pressure Pipe).

4. All joints on fire hydrant laterals shall be restrained joint.

G. All fire hydrants shall be supported on a minimum of eighteen (18) inches of compacted Hydrant Gravel and supported on a concrete brick.

H. If the Contractor chooses to install concrete thrust block than Concrete thrust block shall have a minimum bearing surface area of 4.5 square feet and shall be placed behind hydrant shoe.

1. A sheet of eight (8) mil polyethylene film shall be placed between hydrant shoe and concrete thrust block.

2. Care shall be taken when placing thrust blocks so that hydrant drain holes remain free of obstructions.

3. After pouring thrust block, Hydrant Gravel shall be placed to a depth of twelve (12) inches above hydrant shoe.

4. Hydrant drain holes shall remain free of obstructions.

I. Following placement of Hydrant Gravel, area around hydrant shall be backfilled with Flo-fill.

1. Reference Section 02321.

J. Fire hydrants which are placed in concrete sidewalks or pavement, shall maintain twelve inches of horizontal clearance between the concrete and the hydrant barrel.

1. Space between concrete and barrel shall be filled with asphalt or gravel.

K. When installation of fire hydrant in parking or driveway area is approved by Utility, bollards shall be installed around the fire hydrant.

L. No post, fence, vehicle, trash, storage, or other permanent or temporary material or item, shall be within four (4) feet of a fire hydrant.

M. No tree shall be within 10 feet of a fire hydrant and no bush shall be within 4 feet of a fire hydrant.

N. Ground surrounding the fire hydrant shall slope away from the hydrant at a minimum grade of 2%, toward street.

O. After installation of fire hydrant is complete, oil/grease reservoir shall be checked to insure that it is full.

1. If necessary to fill reservoir, it shall be filled with oil/grease which is specified by hydrant manufacturer.

P. If hydrant must be raised, no more than one (1) extension section can be used, unless approved by Engineer/Utility.

1. All adjustments must meet manufacturer’s recommendations for final bury.

2. Breakaways on stem must be relocated up relative to the height that the hydrant is being raised to the upper portion of the extension and meet manufacturer's recommendations.

3. Contact Engineer/Utility for final approval of hydrant adjustment.

Q. Reference standard detail.

3.03 OPERATION

A. Fire hydrants which have been accepted by the City, shall be operated by City personnel only.

B. Fire hydrants shall be booted or bagged until they have been accepted for service by the City.

3.04 TESTING

Hydrants shall be tested at the same time that the adjacent pipeline is tested. Joints shall show no visible leakage under test. The Developer shall repair joints that show signs of leakage prior to final acceptance.

END OF SECTION

SECTION 02646

WATER SERVICE LINES AND APPURTENANCES

PART 1 - GENERAL

1.01 DESCRIPTION

A. This section concerns materials and installation of corporation stops, curb stops, service lines less than two (2) inches in size, backflow prevention assemblies, stop & waste valves and appurtenances.

1.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Products shall be handled, stored, and protected in a manner which will prevent damage to materials, coatings and finishes.

B. All material shall be kept clean and free from dirt.

C. No galvanized pipe or fittings shall be used.

D. All brass fittings shall be no lead brass.

1.03 INSTALLATION OF SERVICE TAPS

A. Reference Typical Water Service Detail for 5/8 x 3/4-inch through 2-inch services.

1. All residential water service shall be installed in the center of the lot unless otherwise approved by the Engineer/Utility.

2. All water and sanitary sewer services shall have a minimum horizontal separation of ten feet.

B. Contractors licensed by City for utility work in the public right-of-way shall be allowed to make service taps on new water mains which have been initially accepted.

C. Contractor shall not make service taps on existing water mains without permission from the Engineer/Utility.

1. Engineer/Utility may authorize Contractor to make service taps or to use a licensed or authorized tapping Contractor to make service taps on existing mains. The Engineer/Utility representative will observe the tapping operation.

2. The Engineer/Utility shall be notified forty-eight (48) hours before making a

tap.

D. Utility reserves the right to make taps in lieu of Contractor and the right to deny permission for any main to be tapped.

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

F. All ¾-inch and 1-inch taps, on ductile iron pipe, shall be installed by direct tapping.

G. On ductile iron pipe, 1 ½-inch and 2-inch taps shall be installed by one of the following methods:

1. Taps on new construction shall be a mechanical joint tapped tee with an iron pipe thread inlet corporation.

2. Taps on existing lines shall be made with a tapping saddle.

H. Service connections larger than 2-inch shall be installed by one of the following methods**:**

1. Reference Sections 02644 and 02713.

I. Unless otherwise approved by Engineer/Utility, all taps on plastic pressure pipe shall be made with a tapping saddle in accordance with manufacturer's recommendations.

1.04 MAINTENANCE AND CORRECTION

A. Developer shall maintain and repair all service lines and any associated appurtenances which leak, were installed incorrectly, or otherwise prove to be defective. Developer shall provide a two-year (2) maintenance guarantee and a five-year (5) guarantee covering all errors and omissions in the design and/or construction of the improvements and which guarantees shall run concurrently and shall commence upon the date of completion of the improvements and acceptance thereof by the City.

PART 2 - PRODUCTS

2.01 TAPPING SADDLES

A. Tapping saddles for 2-inch and smaller services shall have either a bronze or brass body with bronze single or double flat straps and bronze nuts.

1. Outlet threads on tapping saddles shall be "cc" type.

2. Acceptable manufacturers of tapping saddles are:

a. Reference Section 01000 – Approved Product Listing.

2.02 CORPORATION STOPS

A. All corporation stops shall conform to AWWA C800.

1. All corporation stops shall be constructed of no lead brass.

2. Corporation stop inlet threads for tapping saddles shall be "cc" type.

3. Corporation stop inlet threads for tapped tees shall be IP type.

4. All corporation stop outlets shall use a compression connection.

5. All corporation stops shall be ball type valves only.

6. Corporation stops shall be used for all taps which are 2-inches and smaller.

7. Corporation stops shall have uniform size on inlet and outlet.

B. Acceptable manufacturers of corporation stops are:

1. Reference Section 01000 – Approved Product Listing.

2.03 WATER SERVICE LINES

A. Copper pipe shall be used for service lines 3/4” and 1” and may be used for 1-1/2” and 2” service lines.

1. All copper services shall conform to the Appendix to AWWA C800.

2. All copper services shall be Type K copper.

B. DR 9 High Density Polyethylene (HDPE) Pipe may be used for 1-½inch and 2 inch services instead of copper.

1. HDPE pipe shall conform to ASTM D2737 Copper Tube Size (CTS).

2. Stiffeners are required when making a compression connection on HDPE pipe.

3. Tracer wire is required for all plastic service lines and shall be terminated in a locator station box in conformance with Section 02621 – Plastic Pressure

Pipe.

2.04 COUPLINGS

A. All couplings shall use a compression connection.

B. Acceptable couplings are:

1. Reference Section 01000 – Approved Product Listing.

2.05 CURB STOPS

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

B. Top threads for all curb stops shall be Minneapolis type.

C. Curb stops shall be used for services which are 2-inches and smaller.

D. Curb stops shall be ball type valves only.

E. Curb stops shall not be of the “Stop & Waste” type.

F. Curb stops shall have positive stop at 90 degrees on or off.

G. Acceptable curb stops are:

1. Reference Section 01000 – Approved Product Listing.

H. Acceptable 2-inch curb stops are:

1. Reference Section 01000 – Approved Product Listing.

2.06 CURB BOXES FOR CURB STOPS

A. Minneapolis pattern base shall be used for all curb stops.

B. Acceptable curb boxes are:

1. Reference Section 01000 – Approved Product Listing.

2.07 VALVES AND VALVE BOXES FOR 3-INCH AND LARGER SERVICES

A. Reference Section 02640 – Valves.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall make all taps and install the service line to the curb stop prior to disinfection and pressure testing of the water main.

B. The Contractor shall adjust stop boxes to horizontal location and to final grade as determined by a grade stake.

1. Grade stakes shall be a placed a minimum of five feet from the location of the stop box.

2. Grade stakes shall not be disturbed prior to inspection of the service by the Engineer/Utility.

3.02 CORPORATION STOPS

A. Taps shall not be made within three (3) feet of any joint or fitting.

B. Taps shall be separated by a minimum of three feet (3') (measured along the pipe length), even when taps are made on opposite sides of pipe.

C. ¾" and 1" taps shall be positioned at either the 10:00 O'clock or 2:00 O'clock position unless otherwise approved by the Engineer/Utility.

D. 1½" and 2" taps shall be positions at either the 9:00 O'clock or 3:00 O'clock position unless otherwise approved by the Engineer/Utility.

E. Taps which are made on the same side of the pipe and within 10 feet of each other (measured along the pipe length), shall be staggered fifteen degrees.

F. Taps made to plastic pressure pipe shall be made in accordance with the manufacturer's recommendations.

1. Use tapping saddles only.

2. Use shell cutters to make tap.

3.03 SERVICE LINES

A. All service lines shall be a minimum of 54 inches and a maximum of 66 inches below the final grade.

B. There will be a maximum of one coupling per service, between the main and the curb stop.

1. Service lines (3/4-in. through 2") shall be uniform in size from the corporation stop to 5 feet past the meter.

2. An exterior meter setting will be required if the customer's service line is not uniform in size from the corporation stop to the building.

C. When backfilling the service trench, squeegee shall be used under and 6-inches above the goose neck at the service connection.

1. Squeegee shall conform to Trenching, Bedding and Backfill specifications, reference section 02225.

Water Distribution Bedding (Squeegee)	
Size	Percent Passing
1/2"	100
3/8"	85 - 100
#4	10 - 30
#8	0 - 10
#16	0 - 5

D. Service trenches shall be subject to compaction specifications.

1. Reference Section 02225 – Trenching, Bedding and Backfill.

E. All commercial service lines shall be protected by a backflow prevention assembly per the most recent Cross-Connection Control Manual adopted by City Council. This shall include domestic, fire and lawn irrigation service lines

3.04 CURB STOPS

A. The Contractor shall adjust the curb stop box to ½-inch above final grade prior to final inspection.

B. Curb stop box shall be screwed onto the curb stop.

C. Curb stop box shall be plumb, so that a shut-off key can be placed on the curb stop.

D. Major landscaping (shrubs, boulders, etc.) and structures (retaining walls, fences, buildings**,** etc.) shall not be placed within four (4) feet of the curb stop box.

1. Trees shall not be planted with ten feet (10') of the curb stop box.

E. If the grade of the ground surrounding the curb stop box is changed, after the curb stop box has been installed, the curb stop box cover shall be adjusted to ½-inch above final grade.

3.05 SERVICE AND TAP INSPECTION

A. The Contractor shall insure that the curb stop, corporation stop, and any couplings remain exposed until after the inspection and the approval for backfill is given by the Engineer/Utility.

B. All tap and service inspections shall be scheduled with the Engineer/Utility.

1. Without exception, a minimum of forty-eight (48) hour notice is required on all tap and service inspections.

END OF SECTION

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SECTION 02650

METERS AND APPURTENANCES

PART 1 GENERAL

1.01 DESCRIPTION

A. This section concerns materials and installation of meters, meter setters, meter pits and appurtenances.

1.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Products shall be handled, stored, and protected in a manner which will prevent damage to materials, coatings and finishes.

B. All material shall be kept clean and free from dirt.

1.03 MAINTENANCE AND CORRECTION

A. Contractor shall maintain and repair all meter pits, copperhorns, coppersetters and any associated appurtenances which leak, were installed incorrectly, or otherwise prove to be defective.

B. Developer shall provide a two-year (2) maintenance guarantee and a five-year (5) guarantee covering all errors and omissions in the design and/or construction of the improvements and which guarantees shall run concurrently and shall commence upon the date of completion of the improvements and acceptance thereof by the City.

1.04 METER SETTERS

A. Contractor shall furnish meter setters for 3/4-inch, 1-inch, 1 ½-inch, and 2-inch meters.

1. Single family and duplex residential buildings may utilize interior or exterior meter settings for ¾-inch meters only.

a. Single family and duplex residential buildings with fire lines shall use exterior meter settings. The fire line connection shall be downstream of the meter box.

b. No meters shall be installed in crawl spaces.

2. Multi-family residential buildings shall use exterior meter settings.

3. Commercial buildings shall have meters installed as follows:

a. 3/4-inch meters may use an exterior or interior meter setting, at the option of the Developer.

b. All 1-inch, 1 ½-inch and larger meters shall use an exterior setting.

4. Interior meter settings shall be installed in accordance with Standard Interior Setting for 3/4-inch Water Meters Detail Drawing.

5. Exterior meter settings for 3/4-inch and 1-inch meters shall be installed in accordance with Standard Exterior Setting For ¾" and 1" Water Meters Detail Drawing.

6. Exterior meter settings for 1½-inch and 2-inch meters shall be installed in accordance with Standard Setting For 1½" and 2" Water Meters Detail Drawings.

1.05 METER BOXES (3/4 AND 1 INCH METERS)

A. Contractor shall install 3/4-inch and 1-inch meter boxes.

1. Meter boxes shall be a minimum of 20-inches in diameter, a minimum of 48-inches in length.

2. Meter box covers shall be constructed of cast iron with cast iron recessed lids and rubber or plastic inner lids.

3. Meter boxes shall be installed in accordance with Standard Exterior Setting For ¾" and 1" Water Meters Detail Drawing.

1.06 METER PITS (1 ½ AND 2-INCH METERS)

A. Contractor shall install 1 ½-inch and 2-inch meters pits.

1. Meter pits shall be constructed from standard 48-inch inside diameter precast concrete manhole sections.

2. Meter pit covers shall be an aluminum manhole ring and cover with a 24-inch diameter opening.

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

b. All meter pit covers shall have the word "water" cast in the lid.

c. Meter pits shall be installed in accordance with Standard Setting for 1 ½" and 2" Water Meters Detail Drawings.

1.07 METER VAULTS (3" AND LARGER METERS)

A. Contractor shall install 3-inch and larger meters and meter vaults.

1. Meter pits and vaults shall be constructed from precast concrete box sections designed for HS-25 bridge loading.

a. Minimum interior vault dimensions for different size meters shall be as noted on Standard Setting For 3” and 4” Water Meters Detail Drawings.

2. Unless otherwise specified, meter vault covers shall be an aluminum manhole ring and cover with a 24 inch diameter opening.

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

b. All meter vault covers shall have the word “Water” cast in the lid.

c. All meter vaults shall be installed in accordance with Standard Setting For 3” and 4” Water Meters Detail Drawings.

PART 2 PRODUCTS

2.01 METERS AND STRAINERS

A. All meters and strainers shall be purchased from the Utility unless otherwise specified.

B. Acceptable meters and strainers are:

1. Reference Section 01000 – Approved Product Listing.

2.02 METER SETTERS

A. All multi-family buildings shall use exterior meter settings.

B. Acceptable 3/4-inch copperhorns (interior meter settings) are:

1. Reference Section 01000 – Approved Product Listing.

C. Acceptable 3/4-inch coppersetters (exterior meter settings) are:

1. Reference Section 01000 – Approved Product Listing.

D. Acceptable 1-inch copperhorns (interior meter settings) are:

1. Reference Section 01000 – Approved Product Listing.

E. Acceptable 1-inch coppersetters (exterior meter settings) are:

1. Reference Section 01000 – Approved Product Listing.

F. Acceptable 1 ½-inch and 2-inch meter setters are:

1. Reference Section 01000 – Approved Product Listing.

2.03 METER BOXES

A. Acceptable 3/4-inch and 1-inch meter boxes are:

1. Reference Section 01000 – Approved Product Listing.

B. Acceptable meter box covers and lids for 3/4-inch and 1-inch meter boxes are:

1. Reference Section 01000 – Approved Product Listing.

C. Acceptable 3-inch meter box extensions for 3/4-inch and 1-inch meters are:

1. Reference Section 01000 – Approved Product Listing.

2.04 METER PITS AND VAULTS

A. Acceptable meter pits and vaults for 1 ½-inch and larger meters are:

1. Reference Section 01000 – Approved Product Listing.

B. Acceptable meter pit and vault covers for 1 ½-inch and larger meters are:

1. Reference Section 01000 – Approved Product Listing.

PART 3 - EXECUTION

3.01 EXTERIOR METER SETTINGS

A. Exterior meter settings shall be installed by the Contractor according to the manufacturer's recommendations, and in accordance with Standard Exterior Setting For ¾" and 1" water meters, 1 ½" to 2", 3" and 4" Water Meters Detail Drawings.

1. 3/4-inch, 1-inch, 1 ½-inch, and 2-inch meters shall be installed by the Utility

upon inspection and acceptance of the meter setting.

2. 3-inch and larger meters are issued by the Utility to be installed by the Contractor prior to inspection and acceptance.

B. Meter pits and vaults shall not be installed in any street, alley, parking area, driveway, or sidewalk.

C. Major landscaping (shrubs, boulders, etc.) and structures (retaining walls, fences, buildings, etc.) shall not be placed within four (4) feet of any meter box, pit or vault.

D. Trees shall not be planted within ten feet (10') of any meter box, pit or vault.

E. The ground surrounding meter boxes, pits and vaults shall slope away from the lid at a minimum grade of 2% and a maximum of 10% for a minimum of three (3) feet around the meter box measured from the center of the lid.

F. No plumbing connections will be allowed inside the meter box, pit or vault.

G. All tees, connections, and couplings shall be a minimum of three (3) feet downstream from the meter box, pit, or vault wall on the outlet side. Sprinkler System Detail.

1. Tees and connections shall not be installed between the curb stop and the meter setter or copper horn.

2. Buried stop & waste valves shall not be installed between the meter boxes, pits, or vaults and the backflow prevention assembly. If blowout needed see Sprinkler System Detail.

H. If the grade of the ground surrounding the meter box, pit or vault changes after the installation, the cover shall be adjusted to ½ inch above the final grade by the property owner.

I. Meter boxes, pits, or vaults shall not be covered or enclosed as to inhibit meter reading or meter maintenance.

3.02 INTERIOR METER SETTINGS

A. Interior meter settings shall be installed (residential only) by the Contractor in accordance with Standard Interior Setting For ¾" Water Meters Detail Drawing.

1. The meter, readout wire and readout shall be installed by the Utility upon inspection and acceptance of the meter setting.

B. If the water service enters the house through the floor, a minimum of 4 inches of concrete or 24 inches of soil shall cover the water service from the edge of the

foundation to the vertical riser.

1. The meter setter shall be installed in a heated portion of the building.

2. Services shall be insulated from direct contact with concrete or other abrasive surfaces.

C. Copper horns shall not be placed in a crawl space.

D. All copper horns shall be installed so that the meter is in a horizontal position.

1. The copper horn shall not be installed above a hot water heater.

E. A clear and unobstructed access of not less than 24 inches by 24 inches shall be provided so that the copper horn can easily be reached.

F. There shall be no tees or connections made between the water main and the meter.

G. A ½-inch, or larger, conduit shall be installed from the meter setter to the remote reading point.

1. The conduit shall be EMT only.

2. There shall be no more than 75 feet of conduit between pull boxes.

a. There shall be no more than 4 (four) 90-degree bends between pull boxes.

b. All pull boxes must be installed no more than 48 to 66 inches above the floor.

c. Pull boxes shall not be installed in attics or crawl spaces.

3. The remote reading point shall be a two (2) inch deep recessed electrical box with a blank metal cover.

a. The recessed electrical box shall be mounted on the outside wall of the building, 48 to 66 inches above the ground, conduit will be connected to the recessed electrical box mounted within one foot of the front corner of the structure on the same side as the electrical meter and terminated within six (6) inches of the copperhorn.

b. The remote reading point shall not be covered or enclosed as to inhibit meter reading or meter maintenance.

c. Single family attached homes that are individually metered shall be placed on the nearest exterior wall of that unit.

3.03 METER INSPECTIONS

A. All water fees shall be paid prior to inspection.

B. A minimum of 48 hour notice is required on all meter inspections.

C. All water meter inspections shall be scheduled through the Utilities Water Meter Shop.

1. The Developer shall be billed for re-inspections.

D. Inspection of 3-inch and larger meters shall be made within 30 days of the issuance of the meter to the Contractor.

END OF SECTION

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SECTION 02675

DISINFECTION OF WATER SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION

This section covers disinfection of potable water systems. The Contractor is responsible for disinfection.

1.02 SUBMITTALS

Certification: Label on container shall have proper precautionary information that material is a strong oxidizing agent and that contact with heat, acids, organics or combustible materials could cause fire.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage shall be in a cold, dark, dry and secure area. Extreme care shall be exercise in handling of hypochlorites.

B. Standard: Foreword to both AWWA B-300 and AWWA C-651.

PART 2 - MATERIALS

2.01 MATERIALS

A. Hypochlorites: References AWWA B-300.

1. Hypochlorites for use in swimming pools shall not be allowed.

PART 3 - EXECUTION

3.01 GENERAL

A. The Contractor shall properly disinfect all new waterlines and system components prior to placing them in service, in accordance with AWWA C-651.

B. All newly constructed pipelines must be flushed, chlorinated and dechlorinated. Bacteriological testing must be performed and results must pass before pressure testing and placing pipeline in service.

C. Valves which tie the new main to the existing waterlines and existing water valves in the City's system shall be operated by approved City personnel only.

D. The Contractor shall take appropriate measures during the construction of the work so as to prevent contamination of all pipelines and system components at all times. If in the opinion of the Engineer/Utility, contamination has occurred, all systems shall be flushed before disinfecting.

E. If in the opinion of the Engineer/Utility dirt or debris has entered the system that 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 percent hypochlorite disinfection solution. Cleaning with the use of a pig, swab, or "go-devil" should be undertaken only when such operation will not force mud or debris into pipe joint spaces.

F. Care shall be taken to prevent the disinfectant solution from flowing back into existing pipelines in service. The City shall operate existing valves and shall limit velocities to 2.5 fps.

G. 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.

H. 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 24-hour holding period will 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.

I. If permanent air vents are not available, the contractor shall install corporation stops at high points in the waterline, in order to evacuate air. After the water main is filled, all corporation stops which were installed to facilitate evacuation of air from the water main shall be removed and plugged with a brass plug.

3.02 PRELIMINARY FILLING/FLUSHING

A. Disposing of chlorinated water during flushing activities.

1. A reducing agent shall be applied to the water to be disposed to thoroughly neutralize the chlorine residual remaining in the water. Where necessary, federal, state, and local regulatory agencies should be contacted to determine special provisions for the disposal of chlorinated water.

2. Chlorine residual of water being disposed shall be reduced to a concentration of less than 0.1 mg/l.

3. The treated water to be disposed shall have a pH of between 6.5 and 9 Standard Units (S.U.).

4. Chlorine residual of water being disposed shall be neutralized by treating with one of the chemicals specified in Paragraph 3.04.B.4.

B. Fill/flush water main in a manner to avoid surge conditions in the pipeline.

C. After initial filling, flush main with a minimum flushing velocity of 2.5 feet/second. In some cases, depending on the diameter of the main, this may not be practical. In these situations, a lower flushing velocity may be used with the approval of the Engineer/Utility.

D. Procedures:

1. Inform the Engineer/Utility of the filling/flushing plan.

2. Check all valves, air release valves, etc. on the new main for proper orientation.

3. Inspect facilities for wasting the flushed water.

4. Notify Engineer/Utility Inspector or the Water Distribution Superintendent at (970) 212-2900 to inform that filling/flushing is about to begin.

5. Approved City personnel shall operate valve to begin filling. Open only one valve to existing system at a time during filling/flushing.

6. Check air release valves and other facilities for wasting filling/flushing water for proper operation.

7. When filling/flushing is complete, close line valve to existing system, then close valve at the point of discharge (i.e. fire hydrant or blow-off connection).

3.03 METHODS

A. In general, apply chlorine using continuous feed or granular methods.

1. The tablet method may NOT be used.

B. Continuous Feed Method

1. The continuous feed method consist of injecting a chlorine solution in water after construction and filling the main with potable chlorinated water so that after a 24-hour holding period in the main there will be a free chlorine residual of not less than 10 mg/l.

2. Prior to being chlorinated, the main shall be filled to eliminate air pockets and, if practical, shall be flushed to remove particulates.

3. Chlorinating The Main:

a. Water from the existing distribution system or other approved source

of supply shall be made to flow at a constant, measured rate into the newly laid water main.

b. At a point prior to the potable water connection to 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. To assure that the proper concentration is provided, the injected chlorine solution shall be metered and tested in accordance with the procedures described in the current edition of Standard Methods or AWWA M-12, Simplified Procedures for water examination, or using appropriate chlorine test kits.

4. During the application of chlorine, valves shall be positioned so that the strong chlorine solution in the main being treated will not flow into water mains in active service. Chlorine application shall not cease until the entire main is filled with heavily chlorinated water. The chlorinated water shall be retained in the main for at least 24 hours, during which time all new valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances. At the end of this 24-hour period, the treated water in all portions of the main shall have a residual of not less than 10 mg/l free chlorine.

5. The preferred equipment for applying liquid chlorine is a solution feed vacuum operated chlorinator to mix the chlorine gas in solution water, in combination with a booster pump for injecting the chlorine gas solution water into the main to be disinfected. It is recommended that direct feed chlorinators not be used. (A direct feed chlorinator is one which operates solely from the pressure in the chlorine cylinder.) Hypochlorite solutions may be applied to the water main with a gasoline or electrically powered chemical feed pump designed for feeding chlorine solutions. Feed lines shall be of such material and strength as to withstand safely the corrosion caused by the concentrated chlorine solutions and the maximum pressure that may be created by the pumps. All connections shall be checked for tightness before the solution is applied to the main.

6. Procedure:

a. Inform Engineer/Utility of proposed disinfection plan.

b. Check all line valves, air release valves, etc. for proper orientation.

c. Inspect facilities for wasting the displaced water which are to include a meter for measuring the wasted water.

d. Inspect facilities for injecting chlorine into pipeline.

e. Call Engineer/Utility Inspector or the Water Distribution Superintendent at (970) 221-2900 to inform Utility disinfection is about to begin.

f. Operate valve to begin disinfection procedure. Open only one valve to

existing system at a time during disinfection procedure. Only qualified City personnel shall operate existing valves.

g. Check facilities for wasting water for proper operation.

h. Check first available sampling station for proper chlorine concentration.

i. Adjust rate of chlorine if not acceptable.

j. Continue injecting chlorine until pipeline is completely full of heavily chlorinated water.

k. Close valve to existing system.

l. Close valve to facility where water is being wasted.

m. If more than one chlorination set-up is required on a segment of pipeline, repeat Steps c through m for each set-up.

n. After chlorination process is complete and all valves are closed, test each sampling station (access manhole, fire hydrant, air valve, blow-off, etc. for initial chlorine concentration of at least 25 mg/l.

o. After 24 hours, re-test each sampling station for residual free chlorine concentration of at least 10 mg/l.

C. Granule Method

1. Consists of placing calcium hypochlorite granules in water main during construction and filling main with potable water when installation is completed.

a. Granule method shall not be used if trench water or foreign material has entered the water line, if the water main extensions are over 1000 feet in length, if the water main is larger than 12-inches in diameter, or if the water temperature is below forty-one degrees Fahrenheit (5^{o} C).

b. Calcium hypochlorite granules shall be placed at the upstream end of the first section of pipe and at the upstream end of each branch main.

TABLE 1 – AWWA C651-99

Pipe Diameter (inches)	Calcium Hypochlorite Granules ounces (oz)

4	1.7
6	3.8
8	6.7
10	10.5
12	15.1
14 and larger	D^2 x 15.1

Where “D” is the inside pipe diameter in feet.

c. Granules shall be placed in each section of pipe, hydrant, hydrant lateral and other appurtenances.

d. Granules shall be placed in sufficient number and amount to produce a minimum chlorine concentration in the treated water of 50 mg/l.

e. Contractor shall introduce water into the pipes at a velocity of less than 1 feet per second.

f. Chlorinated water shall be retained in the lines for a minimum of 24 hours, at which time the treated water must contain no less than 25 milligrams per liter of chlorine throughout the entire length of the water main.

3.04 FINAL FLUSHING

A. Clearing the Main of Heavily Chlorinated Water

After the applicable retention period, the heavily chlorinated water shall be flushed from the main until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the system, less than 0.55 mg/l.

B. Disposing of Heavily Chlorinated Water

1. A reducing agent shall be applied to the water to be disposed to thoroughly neutralize the chlorine residual remaining in the water. Where necessary, federal, state, and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

2. Chlorine residual of water being disposed shall be reduced to a concentration of less than 0.1 mg/l.

3. The treated water to be disposed shall have a pH of between 6.5 and 9 (S.U.).

4. Chlorine residual of water being disposed shall be neutralized by treating with one of the following chemicals.

Pounds of chemicals required to neutralize various residual chlorine concentrations in

100,000 gallons of water.

RESIDUAL CHLORINE CONCENTRATION mg/l	SULFUR DIOXIDE SO2	SODIUM BISULFATE NaHSO3	SODIUM SULFITE Na2S03	SODIUM THIOSULFATE Na2S203 5H20
1	0.8	1.2	1.4	1.2
2	1.7	2.5	2.9	2.4
10	8.3	12.5	14.6	12.0
50	41.7	62.6	73.0	60.0

C. Procedures:

1. Check that all potentially affected people, businesses, etc. have been notified.

2. The Water Quality Lab shall be contacted at least 24 hours before flushing to schedule sampling and bacteriological testing.

3. Check all valves, blow-offs and air release valves for proper orientation.

4. Inspect facilities for detaining and wasting the flushed/dechlorinated water.

5. Call Engineer/Utility Inspector or the Water Distribution Superintendent at (970) 212-2900 to inform that flushing/dechlorination is about to begin.

6. City approved personnel shall operate valve to begin flushing/dechlorination. Only one valve shall be opened to the existing system at a time during the flushing/dechlorination.

7. Check all blow-offs, air release valves and facilities for flushing/dechlorination for proper operation.

8. Perform chlorine concentration testing on flushed and dechlorinated water for compliance. Any chlorine residual in the dechlorinated water is unacceptable. Continue periodic chlorine testing until flushing/dechlorination procedure is completed.

9. When residual chlorine concentration in the entire pipeline is no greater than 0.55 mg/l or no greater than is generally prevailing in the system, close line valve to existing system, then close valve to the flushing facility.

3.05 BACTERIOLOGICAL TESTS

A. The Utility's Water Quality Lab shall collect samples from the pipeline after final flushing, and prior to pressure testing and placing waterlines in service, to test for bacteriological quality to show the absence of coliform organisms.

Prior to collecting samples the Water Quality Lab shall be given a minimum of 24 hours advance notice.

B. The number and frequency of samples shall be determined by the Engineer/Utility's Water Quality Lab based upon AWWA C-651.

C. Procedures:

1. Collect samples at each sampling point designated by the Engineer/Utility and/or Water Quality Lab. Sample sites and number shall generally follow AWWA guidelines.

2. If sampling is performed without Water Quality Lab personnel present, the required sterile sample containers can be obtained and returned to the Water Quality Lab at the City Water Treatment Facility for bacteriological testing.

3. Label sample containers with sample date, time, location, free chlorine concentration, and the initials of the person who collected the sample. Sample containers shall be transported in a cooler (with frozen ice packs if weather is warm).

4. Results of bacteriological testing should be available 48 hours after testing begins.

5. All water samples shall meet the following criteria:

   a. Coliform bacteria - 0 per 100 ml

   b. pH - distribution system average ± 0.5 units

   c. Alkalinity - distribution system average ± 5 mg/l

   d. Any other parameters which clearly do not meet the criteria of the Colorado Primary Drinking Water Regulations (Example - turbidity).

6. If any water sample fails the bacteriological testing, the entire segment of water line which contained the failed sample shall be flushed again and the sites re-sampled.

7. If any water re-sample fails the bacteriological testing, the entire segment of water line which contained the failed sample shall be re-chlorinated,

flushed/dechlorinated and retested.

8. If any water sample fails the water chemistry or other testing (taste, odor, pH, etc.), continue flushing until acceptable testing results are achieved.

3.06 REPETITION OF PROCEDURES

A. If the initial chlorine concentration at any testing location is less than 25 milligrams per liter the entire segment of waterline being chlorinated will be rechlorinated using the continuous feed method.

B. If, after the 24 hour retention period, the residual chlorine concentration at any testing location is less than 10 milligrams per liter the entire segment of waterline being chlorinated shall be rechlorinated by the continuous feed method of chlorination and retested.

C. If the initial disinfection, or subsequent disinfections, fail to produce satisfactory bacteriological samples, the main shall be reflushed and resampled. If the samples are still not satisfactory, the main shall be rechlorinated by the continuous feed or the slug method of chlorination until satisfactory results are obtained.

END OF SECTION

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SECTION 02676

DOMESTIC WATER SYSTEM HYDROSTATIC TESTING

PART 1 GENERAL

1.01 DESCRIPTION

This section covers hydrostatic testing of domestic water system and electronic leak detection testing. Electronic leak detection testing will be performed at the discretion of the Engineer/Utility. The Contractor is responsible for hydrostatic testing and shall provide all equipment and personnel to perform the hydrostatic test.

1.02 Once the pipeline has been filled, disinfected, flushed, and backfilling has been completed and approved, a pressure test shall be conducted.

1.03 Testing equipment shall be able to maintain a continuous internal pipe pressure of 150 psi and accurately measure leakage over a two (2) hour minimum test period.

PART 2 PRODUCTS *(Not Applicable)*

PART 3 EXECUTION

3.01 GENERAL

A. After the pipeline has been disinfected and all chlorinated water has been purged, dechlorinated, and all bacteriological testing completed and accepted, all pipe shall be field pressure tested to 150 psi unless otherwise noted.

B. The Engineer/Utility shall be notified 24 hours in advance of testing. All testing shall be made in the presence of the Engineer/Utility.

C. The Contractor will furnish the calibrated meter and the pump for testing. The pipeline shall be in a state of readiness for testing; all bulkheads, pumps, taps and appurtenances necessary to fill the pipeline and maintain the required pressure shall be in place. The pipeline shall be filled with potable water and the test pressure of 150 psi applied to the pipeline by means of a pump, equipped with a suitable pressure regulator. When filling the pipeline, it shall be filled at a rate which will not cause any surge nor will it exceed the rate at which the air can be released.

D. Contractor shall furnish to the Engineer/Utility written documentation of the testing results which are signed by both the contractor's representative and the Utility Inspector.

E. All air in the line shall be properly purged. Where blow-offs or hydrants are not available or effective in purging air from the line, the Engineer/Utility shall require a tap to purge the line. Following completion of the tests, Contractor shall properly

extract corporation(s) and install plug(s).

F. Water services shall be pressure tested with the main to the Curb Stop.

G. Testing through fire hydrants is not permitted.

H. The City is not responsible for water tightness of its valves on existing facilities. If existing valves leak, the City will assist in reducing the influx of water, but the Contractor must use methods at his/her own disposal to work with the resulting leakage, including temporary plugging and blocking of the new water line for hydrostatic testing.

I. Test shall be performed on isolated water main sections not to exceed 1,000 feet in length, unless approved by Engineer/Utility.

3.02 LEAKAGE

A. While the test pressure is maintained, an examination shall be made of the pipeline in general, and any leaks shall be repaired. Any pipe or fitting found to be cracked shall be removed and replaced. Cutting and replacing of pavement, excavating and backfilling are a necessary part of locating and repairing leaks discovered by pressure testing of pipe.

B. Any exposed pipe, fittings, valves, hydrants, and joints shall be examined carefully during the test. Any damaged or defective pipe, fittings, valves, hydrants, or joints that are discovered following the pressure test shall be repaired or replaced with reliable material, and the test shall be repeated until satisfactory results are obtained.

C. After all visible leaks have been stopped the full test pressure shall be maintained for a minimum of 2 hours. The amount of leakage for each test section of the pipeline shall be determined by the following formula for all types of pipe.

$$L = \frac{SD(P)^{1/2}}{133{,}200}$$

where:
- L = maximum allowable leakage in gallons per hour
- S = pipeline length to be tested in feet
- D = nominal pipeline diameter in inches
- P = average test pressure during the leakage test in psi (gauge)

1. Reference AWWA C600.

D. Leakage shall be defined as the quantity of water that must be supplied into the pipeline test section to maintain pressure within 5 psi of 150 psi after the air in the pipeline has been expelled and the pipe has been filled with water. Leakage shall not be measured by a drop in pressure in a test section over a period of time.

E. If pressure test fails, Contractor shall repair defects and retest until leakage is less than minimum allowed.

F. All visible leaks shall be repaired regardless of maximum allowable leakage.

3.03 ELECTRONIC LEAK DETECTION

A. When applicable, the Engineer/Utility will conduct electronic leak detection before paving operations and/or prior to end of warranty period.

B. Contractor shall repair all identified leaks prior to acceptance of the water mains.

END OF SECTION

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SECTION 02713

WATER DISTRIBUTION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section concerns the installation of water distribution mains, and includes the acceptable products, materials, and construction practices which may be used in the installation of water distribution mains.

1.02 QUALITY ASSURANCE

A. Water system installations shall conform to the regulations of the Colorado Department of Public Health and Environment, and the Water Quality Control Commission.

B. Construction staking.

1. Reference Section 01720 – Field Engineering and Surveying.

C. Horizontal alignment shall not be deviated from by more than six (6) inches.

D. Vertical alignment shall not be deviated from by more than three (3) inches, as measured from the pipe invert.

E. The minimum effective area of thrust blocks, shall be as specified in the Thrust Blocks Detail Drawing.

1.03 JOB CONDITIONS

A. Foreign material, including trench water, shall not be permitted in the pipe.

B. Debris, tools, clothing, or other material shall not be permitted in the pipe.

C. Pipe shall be delivered to the site and stored with plastic end plugs to ensure it is kept free from dirt, debris, animals, etc.

D. In order to prevent water, debris, and animals from entering the pipe, the open ends of the pipe shall be plugged with a restrained watertight plug when pipe laying is not in progress.

E. Effective measures shall be used to prevent uplifting or floating of the pipeline prior to completion of the backfilling operations.

F. Pipe, or taps, shall not be installed under the following conditions:

1. When the trench contains water.

2. When weather conditions are unsuitable.

a. Temperature is less than 10^{o}F. Written approval is required when the temperature is 32^{o} F or less.

b. Snowing heavily.

c. Raining heavily.

d. High winds.

3. When the trench bottom is unstable.

G. Pipe and appurtenances shall be protected against dropping and damage.

1. Pipe and appurtenances shall not be used if they are damaged.

PART 2 PRODUCTS

2.01 PIPE

A. The same type of pipe material shall be used for each size pipe.

1. Pipe material shall not be interchanged, except where another type of pipe material is specifically indicated.

2. Manufacturer of pipe material shall not be interchanged without permission of the Engineer/Utility.

B. Reference Sections 02615 – Ductile Iron Pipe and Fittings and 02621 - Plastic Pressure Pipe.

2.02 VALVES

A. Reference Section 02640 - Valves.

2.03 HYDRANTS

A. Reference Section 02645 - Hydrants.

2.04 SERVICE LINES, METERS, APPURTENANCES

A. Reference Section 02646 – Water Service Lines and Appurtenances and 02650 – Meters and Appurtenances.

PART 3 EXECUTION

3.01 INSPECTION

A. Pipe barrel, fittings, and valve boxes 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. Pipe and fittings with damaged linings or coatings shall be rejected.

1. Defective pipe shall be marked and removed from the site.

3.02 PREPARATION

A. Trenching, backfilling and compaction.

1. Reference Section 02225 – Trenching, Bedding, and Backfill.

B. Connections.

1. The location and elevation of the existing pipe shall be verified prior to construction.

C. Cutting the pipe.

1. The pipe shall be cut smooth, straight, and at right angles to the pipe axis, with saws or pipe cutters which are designed specifically for the material.

2. The cut end of the pipe shall be beveled in accordance with the manufacturer's recommendations.

3. Burrs shall be removed and all dust shall be wiped off of the jointing surface.

D. Joints.

1. Dirt, oil, grit, and other foreign matter shall be removed from the inside of the bell and outside of the spigot.

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

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

4. The pipe shall have a depth mark prior to the assembly to insure that the spigot end is inserted the full depth of the joint.

5. Stabbing of the pipe shall not be allowed.

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

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

8. After the initial acceptance of the water main, the Contractor shall be responsible for the repair of any leak, resulting from improper workmanship or materials, which is discovered within a two (2) year period.

3.03 PIPE INSTALLATION

A. Pipe shall be installed with the bells pointing in the direction that the work is progressing.

B. The Contractor shall prevent the opening of joints during bedding and backfilling operations.

1. Bedding Zone Material shall not be dropped onto unsupported pipe, which has been set to alignment and grade.

C. The joint shall be completed in accordance with the pipe material specification, and the pipe shall be adjusted to the correct line and grade as each length of pipe is placed in the trench.

1. Pipe shall be laid to and maintained at required lines and grades as specified in the approved Construction Drawings.

D. Ductile iron pipe shall be installed with polyethylene encasement.

E. Plastic pressure pipe shall not be installed without the use of a tracing wire.

1. Reference Section 02621 – Plastic Pressure Pipe.

2. A continuity test will be required on the tracing wire after backfilling.

F. The pipe shall be secured in place with the specified Bedding Zone Material

consolidated under and around the pipe.

G. The pipeline shall be installed so that a uniform positive or negative grade is maintained between the designed high and low points.

H. The minimum depth of cover shall be 4 ½ feet from the finished grade to the top of the pipe, except as otherwise indicated on the Construction Drawings.

I. The maximum depth of cover shall be 5 ½ feet from the finished grade to the top of the pipe, except as otherwise indicated on the Construction Drawings.

J. Concrete encasement shall be provided where indicated on the Construction Drawings or required by these specifications.

K. A Minimum of 18" vertical clearance shall be maintained when crossing all other utilities.

L. A Minimum horizontal clearance of 10' shall be maintained from all other utilities unless approved by the Engineer/Utility.

1. Cast-in-Place Concrete.

a. Reference Division 3.

2. Where water lines cross sewer mains, and the sewer is above the water main or less than 18 inches clear distance vertically below the water main, construct the crossing using one length of pipe at least 14 feet long centered over or under the water main. Encase all sewer line joints with concrete that exist within 10 feet either side of the waterline.

3. In lieu of the above, Contractor may, upon approval of the Engineer/Utility, wrap the joints of the joints of the sewer pipe with Butyl adhesive tape.

a. Tape shall be 12" wide at all locations within 10 feet either side of the water line.

b. Comply with ASTM C 877 (Type III) and manufacturer's instructions for installation of the material.

c. Suitable backfill or other structural protection shall be provided to prevent settling or failure or the higher pipe.

d. The center of the sewer line pipe shall be centered under or over the waterline unless approved by the Engineer/Utility.

M. If an existing water main is taken out of service or shut down than the Contractor

shall provide to the Engineer/Utility a written plan on how the main will be put back in service (recharged). This plan should include flushing points, de-chlorination, and valves that will need to be operated.

3.04 THRUST RESTRAINT (THRUST BLOCKS)

A. Anchorage and blocking.

1. General: Thrust blocks can be constructed at all horizontal bends, tees, wyes, offsets, dead ends and reducers in lieu of Mechanically Restrained Bell Restraint Devices (except for fire hydrant leads). A bond breaker shall be placed between the pipe and the thrust block to aid in ease of future removal. For the same reason if a large thrust block is to be poured, it shall be separated by a suitable material into sections. The Construction Drawings show sizes and shapes of thrust blocks. The bearing surface areas are the minimum areas to bear against the undisturbed trench wall. If, in the opinion of the Design Engineer or the Engineer/Utility, the soil bearing capacity is not sufficient to provide adequate restraint based on the minimum bearing areas shown on the Construction Drawings, then the minimum bearing area shall be increased to the size that will ensure adequate restraint. In every instance the thrust block shall bear against undisturbed earth. When it is impossible, through over excavation or other causes, to pour a thrust block against undisturbed earth, approved restraining systems shall be required to anchor the fittings to the main. Before placing concrete, all equipment for mixing and transporting the concrete shall be clean. All debris, water or ice shall be removed from the place to be occupied by the concrete. Concrete shall not be placed in frozen subgrade. Concrete shall be placed only in the presence of the Engineer/Utility unless inspection has been waived prior to the placement.

B. Form Work for Thrust Blocks

1. All forming for concrete thrust blocks and anchors will be done by bulkheading around the shape of the thrust block or anchor with burlap or reinforced paper sacks which have been filled with sand or earth. Sacks shall be of a size easily handled by the workmen when the sacks are full. Filled sacks used to form concrete blocks shall be left in place in the trench.

2. If the main must be placed immediately into service, plastic wood composite or concrete blocks may be used to form up the thrust block. The plastic wood composite or concrete blocks shall be of such design as to support the thrust until the concrete has set.

3. No horizontal struts or braces required for trench shoring shall remain in the concrete thrust blocks. Prior to placing concrete, the forms and ditch bank

shall be inspected and approved by the Engineer/Utility.

C. Minimum Curing Time

1. Newly placed concrete shall be allowed to set, undisturbed for a minimum curing time of 24 hours prior to pressurizing the pipeline.

D. Compaction of Fill Over the Thrust Block

1. Backfill may be placed over the thrust block once the surface has set sufficiently to resist the weight of the backfill.

E. Reference Standard Concrete Thrust Blocks & Water Main Lowering Detail Drawings.

F. Concrete thrust blocks and anchors for preventing pipe movement shall be provided at all mechanical joint plugs, wyes, tees, crosses, bends which deflect 11-1/4 degrees or more.

G. Minimum size of concrete thrust blocks and anchors shall be determined from the table in Standard Concrete Thrust Blocks & Water Main Lowering Detail Drawings.

H. Concrete thrust block bottom shall be flat, and sides shall be vertical.

I. If soil is disturbed, making a concrete thrust block or thrust anchor unusable, alternate restraining systems must be approved by the Engineer/Utility prior to pipeline installation.

J. The concrete thrust block shall be formed to provide access to fittings, valves and hydrants.

K. Concrete thrust blocks shall be constructed so that joints and drain holes are clear and accessible.

L. The Engineer/Utility shall be notified 24 hours before concrete is placed.

3.05 THRUST RESTRAINT (MECHANICALLY RESTRAINED DEVICES)

A. Restraining devices.

1. Mechanically restrained devices can be used in lieu of Thrust Blocks for restraining push-on and mechanical joints at bends, tees, wyes, offsets, reducers and dead ends.

a. The Design Engineer shall determine the amount of pipe which

needs to be restrained for each individual situation where a mechanical restraining device is needed.

b. The Engineer/Utility may request that the Design Engineer furnish joint restraint calculations including all design considerations and assumptions prior to and/or during installation in order to accommodate specific site conditions.

2. All nuts and bolts shall be high-strength, low alloy 304 Stainless Steel, manufactured in accordance ANSI A21.11 (AWWA C111).

3. Reference Sections: 02615 – Ductile Iron Pipe and Fittings and 02621 – Plastic Pressure Pipe.

3.06 INSTALLATION OF PIPELINE APPURTENANCES

A. Valves, meters, hydrants and other appurtenances to the water distribution lines shall be installed at the location and to the elevation shown on the Construction Drawings, or as approved by the Engineer/Utility to accommodate field conditions.

1. Measurements of the actual location of appurtenances shall be made prior to backfilling for recording in the Record Drawings, by the Developer.

2. Taps shall not be made within five feet (5') of any joint, fitting, or other taps greater than 2 inches.

3. No taps shall be made when the temperature is 32^0 Fahrenheit, or less, without permission from the Engineer/Utility.

B. All dead-end water mains shall be plugged and have a thrust block poured against the plug or be mechanically restrained.

C. Blow-offs shall not be permanently installed on dead-end mains.

1. Dead-end water mains with services, shall have a fire hydrant at the end of the water main to facilitate the discharge of air and water from the water main.

a. If the water main is to be extended in the future, the fire hydrant may be installed temporarily, until the extension occurs.

b. Reference Section 02645.

D. Blow-offs which are installed by the Contractor during construction shall be abandoned at the main and removed prior to acceptance of the water main.

3.07 PROTECTION OF METAL SURFACES

A. If the supplied material has not been factory coated it shall not be accepted and shall be removed from the site. If the coating has been damaged by installation, the material shall be protected by one of the following methods:

1. Two coats of coal tar paint shall be applied to ferrous metal rods, rebars, clamps, bolts, nuts and other accessories which are subject to submergence or contact with earth or fill material, and are not encased in concrete.

    a. The first coat of coal tar paint shall be applied to a dry, clean surface.

    b. The first coat of coal tar paint shall be allowed to dry before the second coat is applied.

2. If the factory coated epoxy coating has been damaged or chipped it shall be repaired with an epoxy repair kit at the discretion of the Engineer/Utility.

END OF SECTION

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SECTION 02722

WASTEWATER COLLECTION SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. This section covers the installation and testing of sanitary sewer lines plus the furnishing and installation of manhole materials, and other appurtenances.

1.02 QUALITY ASSURANCE

A. Lay pipe and set manhole inverts true to line and grade shown on Construction Drawings. Under no circumstances shall pipe be laid which results in a level invert, reverse sloping invert, or a grade flatter than shown on the Construction Drawings.

1.03 JOB CONDITIONS

A. Use effective measures to prevent foreign material from entering the pipe.

B. Do not place debris, tools, clothing, or other materials in the pipe.

C. Close the open end of any pipe with a plug, or cap, to prevent the entry of foreign material or water into the pipe.

D. Use effective measures to prevent the uplift or floating of the line prior to completion of the backfilling operation.

PART 2 PRODUCTS

2.01 PIPE MATERIALS

A. Type.

1. Plastic Non-Pressure Pipe: Reference Section 02622.

B. Stubouts.

1. All stubouts shall meet the requirements of Section 02622.

2.02 MANHOLE MATERIALS

A. Reference Section 02605

B. Plugs and Caps

1. Plugs or stoppers consisting of a PVC plugs or stoppers shall be furnished for all temporary or permanent stub-outs and all unused branch pipes. The size of the stopper shall be determined by the size of the pipe in which it is installed.

PART 3 EXECUTION

3.01 PREPARATION

A. Perform excavation in accordance with Section 02225, Trenching, Bedding And Backfill.

3.02 PIPE INSTALLATION

A. Pipe Laying

1. Begin pipe laying at the lowest point, unless otherwise approved by Engineer/Utility, and install the pipe with the spigot ends pointing in the direction of flow.

2. Lay pipe true to line and grade.

3. As each length of pipe is placed in the trench, complete the joint in accordance with the applicable pipe material specification and adjust the pipe to the correct line and grade. Make adjustments by scraping away or filling pipe bedding under the body of the pipe, and not by wedging or blocking up the bells.

4. Secure the pipe in place with the specified bedding tamped under and around the pipe except at the joints. Do not use mechanical compacting equipment in the zone above the horizontal centerline of the pipe and below a plane 1 foot above the top of the pipe. Do not walk on small diameter pipe or otherwise disturb pipe after the jointing has been completed.

B. Contractor shall arrange delivery of pipe and bedding material so as to only save enough on the roads to complete the work. Large stockpiles of equipment and material will not be permitted on the road right-of-ways.

C. Where shown on the Construction Drawings a piece of pipe of the proper size shall be built into the manhole where future laterals may be connected. This pipe shall be sealed with a plug at its outer end and an invert shall be built into each manhole for such lateral connections.

D. The physical connection to the existing sewer system shall be plugged until the

sewer has been completed to the satisfaction of the Engineer/Utility.

3.03 WATER LINE CROSSINGS

A. Where sewer lines cross water mains, and the sewer is above the water main or less than 18 inches clear distance vertically below the water main, construct the crossing using one length of pipe at least 14 feet long centered over or under the water main. Encase all sewer line joints with concrete that exist within 10 feet either side of the waterline.

B. In lieu of the above, Contractor may, upon approval of the Engineer/Utility, wrap the joints of the joints of the sewer pipe with Butyl adhesive tape.

1. Tape shall be 12” wide at all locations within 10 feet either side of the water line.

2. Comply with ASTM C 877 (Type III) and manufacturer’s instructions for installation of the material.

C. Provide suitable backfill or other structural protection to preclude settling or failure of the higher pipe.

D. The center of the sewer line pipe shall be centered under or over the waterline.

3.04 FIELD QUALITY CONTROL

A. Sewer shall meet the requirements of the following tests. Furnish all equipment, labor and incidentals necessary and conduct tests in the presence of Engineer.

1. Air tests of individual pipe joints and alignment tests shall be used to test the sanitary sewer pipeline.

2. Vacuum tests and leakage tests shall be used to test the sanitary sewer manholes.

B. Alignment Tests

1. The contractor may choose to lamp each section of sewer between manholes to determine whether any displacement of the pipe has occurred. The Engineer/Utility will verify proper alignment by performing TV Camera Inspection after completion of construction.

2. Repair poor alignment, displaced pipe, or other defects discovered.

C. Air Tests

1. Where no service line connections exist between manholes, use the following procedure.

a. The Contractor shall perform these tests with suitable equipment specifically designed for air testing sewers. A suitable gauge shall be used for readings not to exceed 15-pounds/square inch (PSI) maximum reading. The gauge shall be located at the surface. Flush and clean the sewer line prior to testing in order to wet the pipe surfaces and produce more consistent results. Plug and brace all openings in the main 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 procedure over again.

b. Contractor shall furnish to the Engineer/Utility written documentation of the testing results which are signed by both the contractor's representative and the utility inspector.

c. The line shall be plugged at each manhole with pneumatic plugs. Low pressure air shall be introduced into the plugged line until the internal pressure reaches four (4.0) p.s.i.g. greater than the average back pressure of any ground water pressure that may submerge the pipe. At least two (2) minutes shall be allowed for the air temperature to stabilize before readings are taken and the time is started.

d. If the time shown in Table 1 for the designed pipe size and length elapses before the air pressure drops 0.5 PSIG; section undergoing test shall be presumed to be free of defects. The test may be discontinued once the prescribed time has elapsed even through the 0.6 PSIG drop has not occurred.

e. Brace all plugs sufficiently to prevent blowouts and vent the pipeline completely before attempting to remove the plugs.

f. Provide pressurizing equipment with a relief valve set at 5 psi to avoid over pressurizing and damaging an otherwise acceptable line.

g. All pipelines shall be tested for compliance with the specifications. If leaks are discovered, they shall be repaired by the Contractor as part of the work of laying this pipe and appurtenances and approved by the Engineer/Utility.

h. All equipment and appurtenances shall be repaired or replaced and the tests repeated at the Contractor's expense until the pipe, appurtenances and equipment are in satisfactory compliance with these specifications in the judgment of the Engineer/Utility.

Table 1

Pipe Dia. (in)	100'	150'	200'	250'	300'	350'	400'	450'	500'	>500'
8	3:47	3:47	3:47	3:47	3:48	4:26	5:04	5:42	6:20	0.760 L
12	5:40	5:40	5:42	7:08	8:33	9:58	11:24	12:50	14:15	1.709 L
15	7:05	7:05	8:54	11:08	13:21	15:35	17:48	20:02	22:16	2.671 L
18	8:30	9:37	12:49	16:01	19:14	22:26	25:38	28:51	32:03	3.846 L
21	9:55	13:05	17:27	21:49	26:11	30:32	34:54	39:16	43:38	5.235 L
24	11:24	17:57	22:48	28:30	34:11	39:53	45:35	51:17	56:59	6.837 L
27	14:25	21:38	28:51	36:04	43:16	50:30	57:42	64:54	72:07	8.653 L

2. Where service line connections exist between manholes, only testing of individual pipe joints is required.

   a. Low pressure air shall be slowly introduced at each joint. Introduce air until the internal pressure reaches 4.0 PSIG greater than the average back pressure of any groundwater above the pipe, as shown in the soils report covering the area; but not greater than 9.0 PSIG.

   b. Duration of test per joint shall be 5 minutes. Duration of test shall be the same for all pipe sizes.

   c. If air pressure drop is less than 0.5 PSIG, joint undergoing test shall be presumed to be free of defects.

D. Vacuum Testing

1. Manholes shall be vacuum tested after assembly and prior to backfilling.
   a. Care shall be taken to affect a seal between the vacuum base and the manhole rim. Pipe plugs shall be secured to prevent movement while the vacuum is drawn.

   b. Contractor shall furnish to the Engineer/Utility written documentation of the testing results which are signed by both the contractor's representative and the Utility inspector.

   c. A vacuum of 10 inches of mercury shall be drawn. The time for the vacuum to drop to 9 inches of mercury shall be recorded.

   d. Acceptance shall be defined as when the time to drop to 9 inches

meets or exceeds the following:

Diameter	Time to Drop 1" Hg
4 ft.	60 seconds
5 ft.	75 seconds
6 ft.	90 seconds
8 ft.	120 seconds

e. If the manhole fails the test, make necessary repairs. Repairs and repair procedures must be acceptable to Engineer/Utility.

f. If preformed plastic gaskets are pulled out during the vacuum test, the manhole shall be disassembled and the gaskets shall be replaced.

E. Manholes and pipelines shall not have any visible leaks or damp spots.

F. Repair and retest lines and manholes that fail tests until satisfactory results are obtained.

G. Camera inspection will be done by the City on all sewers. Sewers must pass camera inspection prior to acceptance.

3.05 TV CAMERA INSPECTION

A. City may, at its own expense, inspect the new sewer lines using a TV camera.

B. Displaced joints of pipe or other defects resulting in poor workmanship shall be corrected by the Contractor. TV inspection will be scheduled again after such repairs have been made.

C. TV inspection will occur twice: once upon completion and again prior to the end of the warranty period.

3.06 CLEANING

A. Prior to completion of the Work, remove all accumulated construction debris, rocks, gravel, sand, silt and other foreign material from the sewer system. This shall be accomplished with a sewer jet rodding rig. No mechanical rodding or bucketing equipment will be permitted.

B. Upon final inspection if any foreign matter is present in the system, flush and clean the sections of the line as required.

END OF SECTION

SECTION 02740

GREASE AND SAND & OIL INTERCEPTORS

PART 1 GENERAL

1.01 DESCRIPTION

A. This Section concerns the selection and installation of grease interceptors and combination sand & oil interceptors.

1.02 PRODUCT DELIVERY, STORAGE AND HANDLING

A. All products shall be handled, stored, and protected in a manner which will prevent damage to materials.

PART 2 PRODUCTS

2.01 PRECAST CONCRET PRODUCTS

A. All precast concrete products shall conform to ASTM C478 and shall be made with Type I/II cement.

B. Reference Section 03310.

2.02 CAST-IN-PLACE CONCRETE

A. All cast-in-place concrete shall be made with Type I/II Portland Cement conforming to ASTM C150.

B. Reference Section 03310.

2.03 MORTAR

A. Mortar shall be sand-cement grout, using the following ratio of ingredients:

1. One part Portland Cement; conforming to ASTM C150, Type I/II.

2. Two parts sand; conforming to ASTM C144.

3. ½ part hydrated lime; conforming to ASTM C207, Type S.

2.04 GROUT

A. Grout shall be one of the following:

1. Pre-mixed non-shrinking group; the acceptable types and manufacturers

of which are listed below:

a. Reference section 01000 – Approved Product Listing.

b. Or an approved equal.

2. Job mixed grout, using the following ratio of ingredients:

a. One part Portland Cement; conforming to ASTM C207, Type I/II.

b. One part sand; conforming to ASTM C144.

c. One part shrinkage correcting aggregate; the acceptable types and manufacturers of which are listed below:

i. Master Builders; “Embeco Aggregate”.

ii. Sonneborn; “Ferreloith G-D-S”.

iii. Or an approved equal.

2.05 RING AND COVER

A. Acceptable ring and covers are:

1. Neenah, R-1706. Reference section 01000 – Approved Product Listing.

2. Or an approved equal.

2.06 STEPS

A. All steps shall be made of one of the following materials:

1. Copolymer polypropylene plastic, conforming to ASTM C478 and ASTM C497.

B. Acceptable steps and their manufacturers are:

1. Reference section 01000 – Approved Product Listing.

2. Or an approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. Unless written approval is given by the Utility, all food serving, food preparing,

food catering, meat cutting establishments; fish, fowl, animal slaughter houses, soap factory, tallow rendering, fat rendering, hide curing establishments; and others capable of discharging large amounts of grease into the sanitary sewer system, shall be required to install a grease interceptor.

B. Grease interceptors shall not be required for private residences or dwellings.

C. Owners of businesses that may require grease interceptors shall submit plans to the Utility for review and approval.

3.02 LOCATION OF GREASE INTERCEPTORS

A. Unless prior permission is given by the Utility, all grease interceptors shall be located outside, on private property, within thirty (30) feet of the facility served, and shall be easily accessible at all times for maintenance and examination.

B. All grease interceptors shall be Type A.

1. Reference Standard Detail Drawing.

C. All grease interceptors shall have two compartments, the smallest of which shall have at least one-third the capacity of the entire interceptor.

3.03 SIZE OF GREASE INTERCEPTORS

A. The size of grease interceptors shall be determined by the Utility.

1. If the seating capacity of the restaurant can be determined, the following method of sizing shall be used.

a. Number of seats times a full capacity factor of 0.9 times a turnover rate of 2.2 per meal period equals the number of meals served per meal period.

b. Number of meals per meal period times 2.5 gallons per meal equals the required volume of the grease interceptor.

c. i.e., 214 seats x 0.9 = 192.6 estimated full capacity
192.6 x 2.2 = 423.7 estimated meals per period.
423.7 x 2.5 = 1059.3 gallons

2. If food is prepared but not consumed on the premises, or if the seating capacity cannot be determined, the following method of sizing shall be used.

a. A fixture unit count for the various pieces of kitchen equipment shall be determined following the methods outlined in the Uniform

Plumbing Code.

b. The total number of fixture units times 7.5 gallons per minute equals the maximum flow rate.

c. The maximum flow rate times 8.0 equals the required volume of the grease interceptor.

d. For example:

1 dishwasher	= 3 fixture units (f.u.)
2 3-compartment sink	= 6 f.u.
1 mop sink	= 3 f.u.
1 floor drain	= 2 f.u.
	14 f.u.

11 f/u x 7.5 gpm x 8 minute retention = 840 gallons.

e. If the required volume is within 10% of a smaller approved precast grease interceptor, the smaller unit will be acceptable.

PART 4 COMBINATION SAND & OIL INTERCEPTORS

4.01. GENERAL

A. Unless written permission is obtained from the Utility or the City's Building Inspection Department, all service stations, truck or car wash facilities, vehicle maintenance facilities, machine shops and others where significant amounts of sand, oil and/or flammable wastes could enter the sanitary sewer system, shall be required to install a combination sand & oil interceptor.

B. Owners of businesses that may require sand & oil interceptors shall submit plans to the Utility for review and approval.

4.02 LOCATION OF COMBINATION SAND & OIL INTERCEPTORS

A. All combination sand & oil interceptors shall be located outside, on private property, within thirty (30) feet, and not less than five (5) feet, of the facility served, and shall be accessible at all times for maintenance and examination.

B. All sand & oil interceptors shall be either Type A, or B.

1. Reference Standard Detail Drawings.

C. All combination sand & oil interceptors shall have two compartments, the smallest of which shall have at least one-third the capacity of the entire interceptor.

4.03 SIZE OF COMBINATION SAND & OIL INTERCEPTORS

A. The size of combination sand & oil interceptors shall be determined by the Utility.

1. A fixture unit count for the various drains shall be determined following the values listed below:

a. Three (3) inch diameter floor drains shall be rated at six (6) fixture units.

b. Four (4) inch diameter floor drains shall be rated at eight (8) fixture units.

c. If trough drains are used, each bay, or compartment, or area equaling the square foot surface of a standard service station bay which is served by the trough drain shall be rated at six (6) fixture units per bay.

d. Vehicle wash drains shall be rated at eight (8) fixture units, regardless of the size.

2. The total number of fixture units times 7.5 gallons per minute equals the maximum flow rate.

3. The maximum flow rate times a 5 minute retention time equals the required volume of the sand & oil interceptor.

4. For example:

4 4-inch floor drains = 32 fixture units
32 f.u. x 7.5 gpm x 5.0 minute retention = 1,200 gallons.

B. Commination sand & oil interceptors small than 750 gallons will not be allowed.

END OF SECTION

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DIVISION 3

CONCRETE

03110	STRUCTURAL CAST-IN-PLACE CONCRETE FORMS	03110-1 – 03110-10
03210	REINFORCING STEEL	03210-1 – 03210-6
03220	WELDED WIRE FABRIC	03220-1 – 03220-2
03310	STRUCTURAL CONCRETE	03310-1 – 03310-10
03320	CONSTRUCTION JOINTS	03320-1 – 03320-2
03350	CONCRETE FINISHING	03350-1 – 03350-10
03390	CONCRETE CURING	03390-1 – 03390-4
03615	GROUT	03615-1 – 03615-4

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SECTION 03110

STRUCTURAL CAST-IN-PLACE CONCRETE FORMS

PART 1 GENERAL

1.01 SECTION INCLUDES

The Contractor shall supply all labor, tools, equipment and materials to set forms for the proper placement of concrete for structures. It is the Contractor's responsibility to design and build adequate forms and to leave them in-place until the forms can be safely removed. The Contractor is responsible for damage and injury caused by removing forms carelessly or before the concrete has gained sufficient strength. Means and methods of repair shall be reviewed by the Engineer prior to performing the work.

1.02 RELATED SECTIONS

A. Section 03310 – Structural Concrete

B. Section 03320 – Construction Joints

C. Section 03350 - Concrete Finishing

D. Section 03615 - Grout

1.03 QUALITY STANDARDS

A. American Concrete Institute

1. ACI 318 - Building Code Requirements for Structural Concrete

2. ACI SP-4 - Formwork for Concrete

B. American Plywood Association

1. PS 1 - US Product Standard for Construction and Industrial Plywood

2. J20 - Grades and Specifications

3. V345 - Concrete Forming

1.04 QUALITY ASSURANCE

Formwork, and if required shoring and reshoring, shall be designed by a Professional Engineer licensed to practice in the state where the project is located and having a minimum of five years' experience in the design of concrete formwork or form systems.

PART 2 PRODUCTS

2.01 GENERAL

For the purposes of this specification exposure shall be defined as a surface, interior or exterior, of a structure that will be exposed to view during its use. For example, the interior wall of a structure is a surface exposed to view.

2.02 FORMS FOR SURFACES EXPOSED TO VIEW

A. Walls

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.

2. Symons hand set steel-ply forms, or equal.

B. Beams

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.

2. Symons hand set steel-ply forms, or equal.

C. Sides of Column Footings

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.

2. Symons hand set steel-ply forms, or equal.

3. Steel of sufficient thickness that the form will remain true to shape after numerous repetitive uses.

D. Sides of Curved or Straight Continuous Wall Footings

1. APA High Density Overlay Plyform Class I Exterior.

2. APA B-B Plyform Class I, Exterior, PS-1-83.

For curved surfaces, plywood of sufficient thickness, free from knots and other imperfections, which can be cut and bent and held in place accurately to the required curvature without splintering or splitting shall be used.

E. Floor and Roof Slabs

1. APA B-B Plyform Class I, Exterior, PS-1-83. The plywood shall be mill oiled and edge sealed.

F. Columns

Regardless of materials of construction the forms shall be such to permit bracing in two directions at half-height and full height at a minimum. Two braces at 90° are required at half and full height.

1. Steel of sufficient thickness that the form will remain true to shape after numerous repetitive uses.

2. Fiberglass of sufficient thickness that the form will remain true to shape.

G. Column Capitals

1. Steel, 16 gage or thicker, so that the form will remain true to shape after numerous repetitive uses.

2.03 FORMS FOR SURFACES NOT EXPOSED TO VIEW

Wood or steel sufficiently tight to prevent mortar leakage.

2.04 ANCHORAGE IN SLABS FOR BRACES FOR WALL AND COLUMN FORMS

Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column alignment under all load conditions including wind.

Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of wall or column braces in water retaining structures. Wedge anchors or nails may be used in other structures when in the opinion of the Engineer/Utility the resulting concrete finish patch will be acceptable. The Contractor shall make a submittal including information about the type of wedge anchor or nail and the means of patching the surface for review and acceptance by the Engineer.

2.05 ANCHORAGE IN SLABS FOR UPTURNED COLUMN FOOTING FORMS

Braces shall be anchored to deadmen of sufficient size and weight to maintain the proper wall/column configuration and diameter. Wedge anchors of any type, inserts or concrete nails are specifically not permitted for anchorage of column footing forms.

2.06 FORM TIES

A. Water Retaining Structures and Below Grade Structures:

Symons, S-Panel Ties, or equal, with water seal and one-inch break back cones on both tie ends, shall be used on all wall forms.

B. Structures without formliners:

Symons, S-Panel Ties, or equal, with one-inch break back cones on both tie ends unless otherwise called out or shown in the Drawings or approved by the ENGINEER, shall be used on all wall forms.

C. Structures with formliners:

Ellis Construction supplied heavy duty loop panel ties with 1" extension, 2" break back minimum unless otherwise called out or shown in the Drawings or approved by the ENGINEER, shall be used on all wall forms where formliner will be used.

D. Twisted Wire Ties:

Twisted wire ties with loops to hold forms in position are not permitted.

2.07 CHAMFER STRIP

Chamfer strips (3/4 inch) shall be placed in the corners of forms and at the tops of walls or up-turned footings, to produce beveled edges on permanently exposed concrete surfaces. Interior angles of intersecting concrete surfaces and edges of construction joints shall not be beveled unless otherwise indicated in the Construction Drawings. The chamfer strip may be made of wood or polyvinyl chloride (PVC).

2.08 STIFFBACKS

Stiffbacks for wall forms shall be constructed of lumber or Glulams, uniform in width and thickness, free from knots and other surface defects. Only one joint is permitted in the board of a stiffback and joints shall be offset so as to not occur at the same point. Stiffbacks shall extend to a point not less than six inches above the top of forms.

2.09 GANG WHALER PLATES FOR THE TOP OF CURVED WALLS

Gang whaler plates shall be constructed of plywood as described below cut to the radius of the wall curve. The gang whaler plate shall be of sufficient depth to permit notching for stiffbacks.

A. APA High Density Overlay Plyform Class I Exterior.

B. APA B-B Plyform Class I, Exterior, PS-1-83.

2.10 WEDGE INSERTS

When permitted by the Design Engineer at the tops of walls or columns, wedge inserts may be used to support future formwork or catwalks. The inserts shall be Richmond Screw Anchor, or equal.

2.11 FORM RELEASE AGENT

Magic Kote by Symons Corp. or equal.

PART 3 EXECUTION

3.01 GENERAL

Forms shall be used, wherever necessary, to confine the concrete and shape it to the specified lines and grades as shown on the Construction Drawings. The Contractor shall set and maintain concrete forms so as to ensure completed work is within all applicable tolerance limits. If a type of form does not, in the opinion of the Design Engineer and Engineer/Utility, consistently perform in an acceptable manner, the type of form shall be changed and the method of erection shall be modified by the Contractor, subject to the review of the Design Engineer and Engineer/Utility.

Forms shall have sufficient strength to withstand the pressure resulting from placement and vibration of concrete, and shall be maintained rigidly in position. The design of formwork and placing rate of concrete with medium and high-range water reducing agents shall be adjusted to compensate for the greater hydraulic pressures exerted on the forms by concrete of high fluidity.

Forms shall be clean and free from mortar and other foreign material from previous use prior to being placed.

The Contractor shall demonstrate that forms are vertical, proper alignment, grade or radius when requested by the Engineer/Utility.

3.02 FORM SURFACE TREATMENT

A. General

Prior to placing reinforcing steel coat the forms with a non-staining release agent that will effectively prevent the absorption of moisture and prevent bond of the concrete to the form. Contact with hardened concrete against which fresh concrete is to be placed is prohibited. All bond breaking materials or processes shall be used only after acceptance by the Design Engineer. Care shall be taken in applying form oil to avoid contact with reinforcement steel. Embedded material which becomes coated with form oil shall be thoroughly cleaned or replaced.

B. For Potable Water Facilities

Form release agents for potable water facilities, such as treated water storage reservoirs or water treatment plants, shall be non-toxic 30 days after application.

3.03 TOLERANCES

Tolerances are defined as allowable variations from specified alignments, grades and dimensions. Allowable variations from specified alignments, grades and dimensions are prescribed in the following sub-section. Descriptions of these criteria can be found in Part 2 of the ACI Manual of Concrete Practice 1995, Commentary of Standard Specifications for Tolerances for Concrete Construction and Materials (ACI 117-90).

A. Footings and Foundations

1. Drilled Piers

Vertical alignment ≤ 2 % of the shaft length

Lateral alignment ≤ 1/24 of shaft diameter, 3 inch maximum

Level alignment to cut-off elevation: +1 inch, -3 inch

2. Continuous Wall Footings (Circular and Non-circular)

Lateral alignment: ≤ 2% of the footing width, 2 inches maximum

Relative alignment: Variation ≤ 1 inch in 10 feet (variation between specified plane and as built surface)

Cross-sectional dimension:

Horizontal dimension: Variation +2 inch, -1/2 inch

Vertical dimension (thickness): Variation ± 1/2 inch

Circular Wall Footing Only

Variation in Radius in any 20 feet of wall length: ≤ 1/2 inch

Variation in Radius in entire wall length: ≤ 1 inch

3. Column footings

Lateral alignment: Variation ≤ 2 inch

Level alignment: Variation from specified elevation +1/2 inch, - 2 inch

Relative alignment: Variation ≤ 1 inch in 10 feet (variation between specified plane and as built surface)

Cross-sectional dimension:

Horizontal dimension: Variation +2 inch, -1/2 inch

Vertical dimension (thickness): Variation ± 1/2 inch

B. Cast-in-Place Concrete for Buildings and other Structures

1. Member (such as a beam, column, wall, slab, or pier)

Vertical alignment:

Variation from specified plumb ≤ 3/8 inch (full height)
1/4 inch (one form section)

Lateral alignment:

Maximum in any bay: Variation ≤ 1/2 inch

Maximum in any 20 feet of length: Variation ≤ 1/2 inch

Maximum for entire wall length: Variation ≤ 1 inch

Floor and wall opening locations: Variation ≤ 1/2 inch

Sawcuts and joints: Variation ≤ 3/4 inch

Level alignment:

Top elevation of slabs: Variation ≤ 3/4 inch

Lintels, other lines exposed to view: Variation ≤ 3/4 inch

Cross sectional dimensions:

Walls and slabs (thickness): Variation ±1/4 inch

Columns and Beams: Variation +1/2 inch, -1/4 inch

Size of wall and floor openings: Variation ± 1/4 inch

Relative alignment:

Offset between adjacent formwork: Variation ±1/4 inch

Variation in Specified Grade:

For any distance less than 10 feet: Variation ≤ 1/4 inch

For entire structure: Variation ± 1/2 inch

For manholes and outlet structures: Variation ≤ 1 inch

2. Stairways

Relative alignment:

Difference in height between adjacent risers: 1/8 inch

Difference in width between adjacent treads: 1/4 inch

3.04 PLUMB AND STRING LINES

Plumb and string lines shall be installed on wall and column forms before, and maintained, during concrete placement. There shall be sufficient number of plumb or string lines in walls, for example at every other stiffback, properly installed to permit continuous monitoring. During concrete placement, the Contractor shall continually monitor plumb and string line positions and immediately correct deficiencies. The plumb and string lines shall extend to a point at least six inches above the top of wall or column.

3.05 FORMWORK CAMBER

In order to maintain specified tolerances of joists, beams or slabs subject to dead load deflection, the Contractor shall camber formwork to compensate for dead load deflection prior to hardening of the concrete.

3.06 GANG WHALER PLATES FOR CIRCULAR WALLS

The Contractor shall place a gang whaler plate cut to the curvature of the wall, such as a circular reservoir wall, at the top of the wall forms. The gang whaler plate shall be attached to the forms with a gang whaler rod at appropriately designed intervals. The gang whaler plate may be notched to permit the stiffback to extend above the top of the wall forms. The gang whaler plate shall be sufficiently stiff to maintain the required curvature.

3.07 HAND SET MODULAR FORMS

Hand set modular forms, such as Symons hand set steel-ply forms, shall be placed with no more than two intersecting joints occur at one level in the formwork above the bottom modular form level. The following figure illustrates the required form pattern.

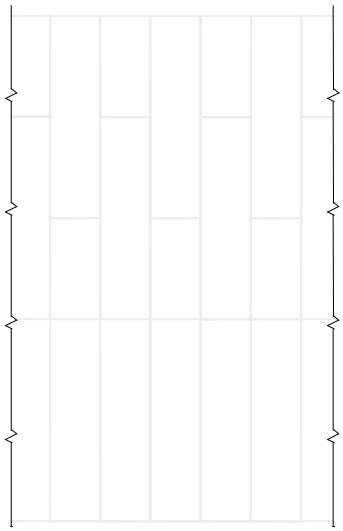


Figure 1

The above form configuration is one way recommended by Simons Corp. to eliminate vertical, in plane, bending of the forming system. The Contractor may develop alternate means of maintaining vertical alignment. Alternate form system configurations require preparation by a licensed Professional Engineer in Colorado.

3.08 FORMWORK CLOSURE

Forms which will prohibit visual review of items such as reinforcing steel, waterstops and bearing pads by the Engineer/Utility, shall not be placed until the Engineer/Utility has performed a final review of the reinforcing steel.

The Contractor shall use compressed air from an air-compressor to blow-out construction debris and dirt at the bottom of sections or members to be placed such as walls, slabs, beams and columns, prior to placing forms or concrete. The Contractor shall demonstrate to the Engineer/Utility that all debris, such as loose concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

3.09 HOT OR COLD WEATHER PLACEMENT AND STEEL FORMS

Prior to placing concrete when steel forms are used, the forms shall be heated when the surface temperature of the form is below 40° F or cooled when the surface temperature of the form is above 90° F. If water is used to cool forms where ponding of water may occur, i.e., at the bottom of a column, the water shall be permitted to drain prior to placing concrete.

3.10 REMOVAL OF FORMS

The forms for any portion of a structure shall not be removed until the concrete has reach sufficient strength with a factor of safety of 2.0, to withstand applied loads such as self weight and wind loads or withstand damage when the forms are removed.

For post-tensioned concrete slabs and beams, formwork shall not be removed until the entire slab or member has been stressed and stressing records accepted.

END OF SECTION

SECTION 03210

REINFORCING STEEL

PART 1 GENERAL

1.01 SECTION INCLUDES

This work shall consist of furnishing and placing reinforcing steel in accordance with these specifications and in conformity with the Construction Drawings.

1.02 RELATED SECTIONS

A. Section 03310 – Structural Concrete

1.03 QUALITY STANDARDS

A. American Concrete Institute

1. ACI 318 - Building Code Requirements for Reinforced Concrete

2. ACI Detailing Manual - (SP-66)

3. ACI 117 - Standard Tolerance for Concrete Construction and Materials

B. American Society for Testing and Materials

1. ASTM A 615, A 616 including supplementary requirement S1, A 617, A 706

2. ASTM A 767, Zinc-coated (galvanized) reinforcing bars

3. ASTM A 775 Epoxy-coated reinforcing bars

C. Concrete Reinforcing Steel Institute (CRSI)

1. Manual of Standard Practice

2. Placing Reinforcing Bars

D. American Welding Society (AWS)

1. AWS D1.4 - Structural Welding Code - Reinforcing Steel

PART 2 PRODUCTS

2.01 REINFORCING STEEL

A. Deformed Bars:
All bar steel reinforcement shall be of the deformed type, ASTM A 615, (AASHTO M31) and grade (40 or 60) as specified in the Construction Drawings.

B. Spirals:

Spirals, hot-rolled plain or deformed bars per ASTM A 615, Grade 60 or cold drawn wire per ASTM A 82 as specified in the Construction Drawings.

Spirals for columns shall have two “spacers” with a section modulus > $0.008in^3$ in order to maintain the proper pitch and spacing.

C. Epoxy-Coated Reinforcing Bars:

Epoxy-coated reinforcing bars shall conform to ASTM A 775. When required, damaged epoxy coating shall be repaired with patching material conforming to ASTM A 775 in accordance with the material manufacturer's recommendations.

D. Zinc-coated (Galvanized Reinforcing Bars):

Zinc-coated reinforcing bars shall conform to ASTM A 767. When required, damaged zinc coating shall be repaired with a zinc-rich formulation conforming to ASTM A 767.

2.02 TIE WIRE

16 gauge wire ties, manufactured by American Wire Tie, Inc., or equal. When epoxy coated reinforcing steel is shown in the Drawings, PVC coated wire ties shall be used. The minimum PVC coating is 0.7 mils.

2.03 IDENTIFICATION

Bundles of reinforcing bars and wire spirals shall be tagged, with a metal tag, showing specification, grade, size, quantity and suitable identification to permit checking, sorting and placing. When bar marks are used to identify reinforcing bars in the Drawings, the bar mark shall be shown on the tag. Tags shall be removed prior to concrete placement.

Bundles of flat sheets and rolls of welded wire fabric shall be tagged similar to reinforcing bars.

2.04 STORAGE AND PROTECTION

Reinforcing steel shall be stored off of the ground and protected from oil or other materials detrimental to the steel or bonding capability of the reinforcing bar. Epoxy-coated reinforcing bars shall be stored on protective cribbing.

Rust, seams, surface irregularities, or mill scale, shall not be cause for rejection provided that the weight and height of deformations of a hand-wire-brushed test specimen are not less than the applicable ASTM Specification.

When placed in the work, the reinforcing bars shall be free from dirt, loose mill scale, paint, oil, loose rust or other foreign substance.

2.05 BAR SUPPORTS

A. General:

Bar supports and spacing shall be in accordance with the CRSI Manual of Standard Practice, Chapter 3, a maximum of four feet or as required by the Drawings.

B. Floor Slabs:

Uncoated steel or non-metallic composite chairs shall be used unless otherwise shown in the Drawings. If required by the ENGINEER, the chair shall be stapled on a bearing pad to prevent chair displacement. The bearing pad shall be made of exterior grade plywood and be approximately five inches square.

C. Soffits:

Steel wire bar supports in concrete areas where soffits are exposed to view or are painted shall be Class 1 or Class 2, Types A or B: Class 3 is acceptable in other areas.

D. Water and Wastewater Vaults, Tank and Basin Walls, and Roof Slabs:

Only plastic clip, non-metallic composite or 100% epoxy coated steel chair bar and bolster supports are acceptable for use in walls and roof slabs. Supports shall be securely stapled to formwork.

E. Columns:

Plastic "space wheels" manufactured by Aztec (Model DO 12/40), or equal, are required.

F. Epoxy-Coated and Zinc-Coated Bar Supports:

Epoxy-coated reinforcing bars supported from formwork shall rest on coated wire bar supports made of dielectric or other acceptable materials. Wire supports

shall be fully coated with dielectric material, compatible with concrete. Reinforcing bars used as support bars shall be epoxy-coated. In walls reinforced with epoxy-coated bars, spreader bars shall be epoxy coated. Proprietary combination bar clips and spreaders used in walls with epoxy-coated reinforcing shall be made of corrosion-resistant material or coated with dielectric material.

PART 3 EXECUTION

3.01 GENERAL

The Contractor shall be responsible for furnishing and placing all reinforcing steel in accordance with fabrication details and/or as shown on the Construction Drawings.

3.02 FABRICATION

Fabrication tolerances for straight and bent bars shall be in accordance with the requirements of Subsection 4.3, Tolerance, of the American Concrete Institute Standard 315 and the CRSI Manual of Standard Practice.

3.03 BENDING

All reinforcing bars shall be bent cold. Bars partially embedded in concrete shall not be field bent except as shown on the Construction Drawings or as permitted by the Engineer/Utility. Bars shall not be bent or straightened in a manner that will injure the material.

3.04 SPIRALS

One and one-half finishing bends are required at the top and bottom of the spiral. Spacers shall be provided in accordance with Chapter 5, Section 9 of the CRSI Manual of Standard Practice. Welding as an aid to fabrication and/or installation is not permitted.

3.05 PLACING AND FASTENING

The placing, fastening, splicing and supporting of reinforcing steel and wire mesh or bar mat reinforcement shall be in accordance with the Construction Drawings and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars". In case of discrepancy between the Construction Drawings and the CRSI publication stated above, the Construction Drawings shall govern. Reinforcement shall be placed within the tolerances provided in ACI 117.

Steel reinforcement shall be accurately placed in the positions shown on the Construction Drawings and firmly held during the placing and setting of concrete by means of spacer strips, stays, metal chairs or other approved devices or supports. Chair and bolster supports for slabs and walls shall be spaced at a maximum of four foot centers unless otherwise shown in the Construction Drawings. Staples used to attach bar supports to wall and roof forms shall have the staple "tails" clipped after form removal. For Columns, three wheels, spaced 120 degree apart, shall be placed every four feet of column

height. The Contractor may increase the column spiral pitch if a conflict occurs with the wheel. Pre-tied column reinforcing steel lowered into column forms shall be lowered vertically to prevent damage to the space wheels.

Bars shall be securely tied at 50% of all intersections except where spacing is less than one foot in each direction, when alternate intersections shall be tied unless otherwise called out in the Construction Drawings or in applicable specifications. Tying of steel by spot welding will not be permitted unless specifically authorized by the Design Engineer and Engineer/Utility. The placing and securing of the reinforcement in any unit or section shall be accepted by the Engineer/Utility before any concrete is placed in any such unit or section.

Bundle bars shall be tied together at not more than 6-foot centers.

Unless specified on the Construction Drawings, the minimum protective cover for reinforcement shall be as listed, below.

CONCRETE PROTECTION FOR REINFORCEMENT

		Minimum Cover, inches
A.	CAST-IN-PLACE CONCRETE	
1.	Concrete cast against and permanently exposed to earth	3
2.	Concrete exposed to earth or weather:	
	#6 and larger	2
	#5 bar, W31 or D31 wire, and smaller	½
3.	Concrete not exposed to weather or in contact with ground:	
	Slabs, walls, joists:	
	#14 and larger	1-1/2
	#11 bar and smaller	3/4
	Beams, columns:	
	Primary reinforcement, ties, stirrups, spirals	1-1/2
B.	PRECAST CONCRETE (manufactured under plant control conditions)	
1.	Concrete exposed to earth and weather:	
	Wall panels:	
	#14 and larger	1-1/2
	#11 bar and smaller	3/4
	Other members:	
	#14 and larger	2
	#6 through #11 bars	1-1/2
	#5 bar, W31 or D31 wire, and smaller	1-1/4
	Concrete not exposed to weather or in contact with ground:	
	Slabs, walls, joists:	
	#14 and larger	1-1/4
	#11 bar and smaller	5/8

Beams, columns:		
	Primary reinforcement	d_b but not less than 5/8 and need not exceed 1-1/2
	Ties, stirrups, spirals	3/8

3.06 SPLICING

Bar steel reinforcement shall be furnished in the full lengths indicated on the Construction Drawings. Splicing of bars, except where shown on the Construction Drawings, will not be permitted without the written acceptance of the Design Engineer. Splices shall be staggered. In cases where permission is granted to splice bars, other than those shown on the Construction Drawings, the additional material required for the lap shall be furnished by the Contractor. The minimum distance between staggered splices for reinforcing bars shall be the length required for a lapped splice in the bar. All splices shall be full contact splices.

Splices will not be permitted at points where the section is not sufficient to provide a minimum distance of two inches between the splice and the nearest adjacent bar or the surface of the concrete.

Welding of reinforcement shall be done only if detailed on the Construction Drawings or if authorized by the Design Engineer and Engineer/Utility. Welding shall be done by a certified welder. The welding shall conform to AWS D 12.1, Recommended Practices for Welding Reinforcing Steel, Metal Inserts and Connections in Reinforced Concrete Construction, with the modifications and additions specified hereinafter. Where AWS D 2.0 Specifications for Welded Highway and Railway Bridges is referenced, the reference shall be construed to be for AWS D 1.1. Where the term AWS D1.1 is used it shall mean the American Welding Society Structural Welding Code, D 1.1 as modified and amended by the AASHTO Standard Specifications for Welding of Structural Steel Highway Bridges. After completion of welding, coating damage to coated reinforcing steel bars shall be repaired.

When required or permitted, a mechanical connection may be used to splice reinforcing steel bars or as substitution for dowel bars. The mechanical connection shall be capable of developing a minimum of 125% of the yield strength of the reinforcing bar in both tension and compression. All parts of mechanical connections used on coated bars, including steel splice sleeves, bolts, and nuts shall be coated with the same material used for repair of coating damage.

3.07 CUTTING

When coated reinforcing bars are cut in the field, the ends of the bars shall be coated with the same material used for repair of coating damage. All rebar cut in the field shall be cut with a cut-off saw, any other method must be approved by the Design Engineer.

END OF SECTION

SECTION 03220

WELDED WIRE FABRIC

PART 1 - GENERAL

1.01 WORK INCLUDED

This work shall consist of furnishing and placing welded wire fabric in accordance with these specifications and in conformity with the Construction Drawings.

1.02 RELATED WORK

A. Section 03210 - Reinforcing Steel

B. Section 03310 - Structural Concrete

PART 2 - MATERIALS

2.01 Materials used in the work shall meet the requirements for the class of material named.

A. Size: 6 x 6 / W10 X W10 wire or as shown on the Drawings.

B. Manhole bases may use 4 x 4 / W4 x W4 as a minimum.

2.02 Welded wire fabric shall conform to the requirements of the following specifications:

A. Welded Steel Wire Fabric for Concrete Reinforcement -- AASHTO M55 (ASTM A185).

B. Welded Deformed Steel Wire Fabric for Concrete Reinforcement -- AASHTO M221 (ASTM A497)

PART 3 - EXECUTION

3.01 STORING AND SURFACE CONDITION OF REINFORCEMENT

Welded wire fabric shall be stored above the surface of the ground upon platforms, skids, or other supports and shall be protected as far as practicable from mechanical injury and surface deterioration caused by exposure to conditions producing rust. When placed in the work, the wire fabric shall be free from dirt, detrimental rust, loose scale, paint, grease, oil, or other foreign materials. The welded wire fabric shall be free from injurious defects such as cracks and laminations. Rust, surface seams, surface irregularities or mill scale will not be cause for rejection, provided the minimum dimensions, cross section area and tensile properties of a hand wire brushed specimen meets the physical requirements for the size and grade of steel specified.

3.02 PLACING AND FASTENING

The placing, fastening, splicing and supporting of the wire mesh shall be in accordance with the plans and the latest edition of "CRSI Recommended Practice for Placing Reinforcing Bars". In case of discrepancy between the plans and the CRSI publication stated above, the plans shall govern.

The wire mesh shall be accurately placed in the positions shown on the Construction Drawings and firmly held during the placing and setting of concrete by means of spacer strips, stays, metal chairs or other approved devices or supports. When metal chairs are used, the part of the chair in contact with the form and at least 1 inch from the form shall be hot dip galvanized or plastic coated. Other coatings or treatments will be acceptable when specifically accepted by the Design Engineer and Engineer/Utility. Precast concrete bricks or other accepted bricks or blocking may be used in structures to support reinforcement in slabs placed on grade; however, the bricks or blocking shall not contact the reinforcement over a distance greater than the depth of a standard concrete brick. The placing and securing of the wire mesh in any unit or section shall be accepted by the Design Engineer and Engineer/Utility a minimum of 24 hours before any concrete is placed in any such unit or section.

At the time the concrete is placed, the wire fabric required shall be free from flaky rust, mud, oil or other coatings that will destroy or reduce the bond.

3.03 SPLICING

Sheets of welded wire fabric reinforcement shall overlap each other sufficiently to maintain a uniform strength and shall be securely fastened at the ends and edges. The edge lap shall not be less than 1 mesh in width or six inches (6”) minimum.

3.04 TIES, CHAIRS, SPACERS

The wire mesh shall be accurately placed and adequately supported by concrete, metal or other approved spacers or ties and secured against displacement within the tolerance permitted.

3.05 PLACEMENT

Unless otherwise specified by the Design Engineer, the wire fabric shall be placed in specified positions within the following tolerances:

A. In slabs, all wire mesh shall be placed within, plus or minus, one-quarter inch of specified location.

END OF SECTION

SECTION 03310

STRUCTURAL CONCRETE

PART 1 GENERAL

1.01 SECTION INCLUDES

The Contractor shall furnish all labor, tools and equipment for the construction of reinforced cast-in-place concrete for water, wastewater, and stormwater facilities, box culverts, inlets, headwalls, drop structures, concrete encasement of sanitary sewers, concrete cut-off walls, equipment pads, manhole bases, and thrust blocks as shown on the Construction Drawings and herein specified.

This section includes basic finishing and curing methods, accessory control, and expansion and contraction joint devices.

1.02 CONCRETE PRODUCER QUALIFICATIONS

The ready-mixed concrete supplier to the Contractor shall have the capability to produce and deliver concrete, meeting the requirements of the Construction Drawings and specifications. The supplier shall have a contingency plan for a back-up plant in the event of a mechanical malfunction of one of the primary plant(s).

1.03 RELATED SECTION

A. Section 03110 - Structural Cast-In-Place Concrete Forms

B. Section 03210 – Reinforcing Steel

C. Section 03320 - Construction Joints

D. Section 03350 - Concrete Finishing

E. Section 03390 - Concrete Curing

1.04 QUALITY STANDARDS

A. American Society for Testing Materials (ASTM)

1. ASTM C 33 - Concrete Aggregates

2. ASTM C 94 - Ready Mixed Concrete

3. ASTM C 150 - Portland Cement

4. ASTM C 260 - Air-entraining Admixtures for Concrete

5. ASTM C 494 - Chemical Admixtures for Concrete

6. ASTM C 618 - Fly Ash in Portland Cement Concrete

7. ASTM C 979 - Pigments for Colored Concrete

8. ANSI/ASTM D 994 - Preformed Expansion Joint Fillers

9. ASTM D 1751 - Preformed Non-Extruding and Resilient Expansion Joint Fillers

10. ASTM D 3575 - Test Methods for Flexible Cellular Materials made from Olefin Polymers

B. American Concrete Institute (ACI)

1. ACI 211 - Standard Practice for Selecting Proportions for Concrete

2. ACI 212 - Guide for Use of Concrete Admixtures

3. ACI 221 - Guide for Use of Normal Weight Aggregates

4. ACI 301 - Structural Concrete for Buildings

5. ACI 304 - Guide for Measuring, Mixing, Transporting and Placing Concrete

6. ACI 305 - Hot Weather Concreting

7. ACI 306 - Cold Weather Concreting

8. ACI 309 - Standard Practice for Consolidating Concrete

9. ACI 318 - Building Code Requirements for Structural Concrete

10. ACI 503 - Use of Epoxy Compounds

11. ACI 504 - Guide to Joint Sealants

1.05 QUALITY ASSURANCE

A. Acquire cement and aggregate from the same source for all work.

B. Conform to ACI 305 for hot weather concrete placement

C. Conform to ACI 306 for cold weather concrete placement

D. Conform to ACI 309 for concrete consolidation

1.06 CONTRACTOR ASSISTANCE

The Contractor shall assist the concrete testing consultant as requested during the performance of quality control testing. When concrete is placed using a concrete pumper, concrete for testing will be taken from the pumper discharge hose.

1.07 DELIVERY, STORAGE,AND HANDLING

A. Ready-Mixed Concrete Delivery Ticket:

The ready-mixed concrete truck driver shall provide the batch ticket to the Engineer/Utility at the time of concrete delivery. The ticket shall summarize the following information legibly in an easily discernible table:

1. Weight in pounds of all materials, excepting the water reducing and air-entraining agents which shall be in ounces.

2. Cubic yards batched

3. The ratio of water to cementitious (W / C) materials ratio

4. Temperature of the concrete at the time it was batched

5. Time of batching.

6. Free moisture in the fine and coarse aggregates in percent of weight of aggregate.

7. Gallons of water that may be added at the site without exceeding the permissible W / C ratio.

B. Delivery:

Delivery shall conform to the recommendations of ACI 304.

PART 2 PRODUCTS

2.01 CEMENT

Cement shall be Portland Cement Type II, unless otherwise indicated on the Construction Drawings or the specifications.

2.02 AGGREGATE

A. Fine Aggregate:

Fine aggregate shall consist of hard, strong, durable particles to the provisions of ASTM C 33.

B. Coarse Aggregate:

Coarse aggregate shall conform to the provisions of ASTM C 33 except that all aggregate shall be crushed aggregate. Screened aggregate is unacceptable.

2.03 WATER

Water shall be clean and free from injurious amounts of oils, acids, alkalis, salts, organic materials, or other substances that may be deleterious to concrete or steel. Mixing water for prestressed pretensioned and prestressed post-tensioned concrete or for concrete which will contain aluminum embedments, shall not contain deleterious amounts of chloride ion.

Unless otherwise permitted or specified in the Construction Drawings, the concrete shall be proportioned and produced to have a slump not to exceed four inches or less than two and one-half inches. Concrete not consolidated by internal vibration shall be proportioned to have a slump not to exceed five and one-half inches or less than four inches. The slump shall be determined by the "Test for Slump of Portland Cement" ASTM C 143.

2.04 ADMIXTURES

Admixtures to be used in concrete shall be subject to prior acceptance by the Engineer/Utility. The admixture shall maintain the same composition and performance throughout the work as the product used in the concrete proportions established in accordance with ACI 211. Admixtures containing chloride ions shall not be used.

A. Air Entrainment:

An air-entraining agent shall be used in all concrete. The agent used shall conform to ASTM C 260.

Unless otherwise shown in the Construction Drawings, the amount of air entraining agent used in each concrete mix shall be such as will effect the entrainment of the percentage of air shown in the following tabulation in the concrete as discharged from the mixer. This table is applicable for concrete strengths less than 5000 psi.

Table 1

Nominal max. aggregate size, in.	Average air content, percent	
	Severe exposure	Moderate exposure
3/8	7 1/2 ± 1 ½	6 ± 1 1/2
¾	6 ± 1 ½	5 ± 1 1/2
1 1/2	5 1/2 ± 1 ½	4 1/2 ± 1 1/2

The level of exposure will be determined by the Engineer/Utility.

B. Water Reducing, Set-Controlling Admixture:

The Contractor shall use a “mid-range” water reducing, set controlling admixture, Polyheed 997, or equal. The water-reducing admixture shall be used in all concrete, be compatible with the cement, and conform to ASTM C 494, specifically Types A, B, C, D and E.

C. Finely Divided Mineral Admixtures:

Mineral admixtures shall be limited to fly ash conforming to ASTM C 618, Class C.

Class C fly ash will not be permitted where sulfate resistant concrete is required.

2.05 BATCHING

Measuring and batching of materials shall be done at a batching plant.

A. Portland Cement:

Either sacked or bulk cement may be used. No fraction of a sack of cement shall be used in a batch of concrete unless the cement is weighed. Bulk cement shall be weighed on scales separate and distinct from the aggregate hopper or hoppers. Batching shall be such that the accuracy of batching shall be plus or minus one percent of the required weight.

B. Water:

Unless water is to be weighed, the water-measuring equipment shall include an auxiliary tank from which the measuring tank shall be filled. In lieu of the volume method, the Contractor will be permitted to use a water-metering device.

C. Aggregates:

Aggregates shall be handled from stockpiles or other sources to the batching plant in such a manner as to secure a uniform grading of the material. Aggregates that have become segregated, or mixed with earth or foreign material, shall not be used. Batching shall be so conducted as to result in the weights of material required for each type aggregate within a tolerance of two percent.

Free water contents of the coarse and fine aggregates shall be continuously tested and concrete mixture adjusted for moisture conditions of the aggregate in order to meet the designated water/cement ratio.

D. Fine Aggregate:

The proportion of fine aggregate shall be between 36 and 44 percent by volume of the total aggregates in the concrete.

2.06 MIXING

Ready-mixed concrete shall be either “central mixed” or “shrink mixed” concrete as defined in ASTM C 94. “Truck mixed” concrete as defined in ASTM C 94 shall not be permitted. Mixing time shall be measured from the time water is added to the mix, or cement contracts the aggregate. All concrete shall be homogeneous and thoroughly mixed, and there shall be no lumps or evidence of undispersed cement. Mixers and agitators, which have an accumulation of hard concrete or mortar, shall not be used. Ready-mixed concrete shall be mixed and transported in accordance with ASTM C 94.

The temperature of mixed concrete, immediately before placing shall not be less than 50°F or more than 80°F for slabs larger than 10,000 square feet and not be less than 50°F or more than 85°F for walls. Aggregates and water shall be heated or cooled as necessary to produce concrete within these temperature limits. Neither aggregates nor mixing water shall be heated to exceed 150°F.

The time elapsing from the time water is added to the mix (or the cement comes in contact with aggregate) until the concrete is deposited in place at the site of the work shall not exceed 45 minutes when the concrete is hauled in non-agitating trucks, nor more than 90 minutes when hauled in truck mixers or truck agitators.

The batch shall be so charged into the drum that a portion of the mixing water shall enter in advance of the cement and aggregates. The flow of water shall be uniform and all water shall be in the drum by the end of the first 1/4 of the specified mixing time.

Cement shall be charged into the mixer by means that will not result in loss of cement due to the effect of wind, or in accumulation of cement on surfaces of hoppers or in other conditions which reduce or vary the required quantity of cement in the concrete mixture.

2.07 TRANSPORTING MIXED CONCRETE - MIXED CONCRETE OR TRUCK MIXERS

Transporting of mixed concrete shall conform to ASTM C 94.

Truck agitators shall be loaded not to exceed the manufacturer's guaranteed capacity. They shall maintain the mixed concrete in a thoroughly mixed and uniform mass during hauling.

No additional mixing water shall be incorporated into the concrete during hauling or after arrival at the delivery point, unless approved. If additional water is to be incorporated into the concrete at the site, the drum shall be revolved not less than 30 revolutions at mixing speed after the water is added and before discharge is commenced. One addition of water at the site to adjust mix workability is permitted but the maximum water cement ratio shall not be exceeded.

The Contractor shall furnish a water-measuring device in good working condition, mounted on each transit mix truck, for measuring the water added to the mix on the site. All water tanks on transit mix trucks shall be filled prior to being batched and arrive at the construction site 100% full.

Each load of ready mixed concrete delivered at the job shall be accompanied by the ticket referencing design mix and showing volume of concrete, the weight of cement in pounds, percent of free water in coarse and dry aggregates, and the total weight of all ingredients in pounds. The ticket shall also show the time of day at which the materials were batched and the reading of the revolution counter at the time the truck mixer is charged. See Paragraph 1.08.

2.08 COMPRESSIVE STRENGTH

Concrete compressive strength requirements consist of a minimum strength that must be obtained before various loads of stresses are applied to the concrete and, for concrete designated by strength, a minimum strength at the age of 28 days. Unless otherwise shown on the Construction Drawings the 28-day compressive strength of structural concrete shall be a minimum of 4,500 psi. Portland cement concrete pavement shall have a 28-day compressive strength of structural concrete shall be a minimum of 3,750 psi and have a modulus of rupture of third point loading of 600 psi (CDOT Class P). Non-structural concrete such as manhole bases, kickblocks, cut-off walls, equipment pads, valve box collars, fence post foundations, pipe cradles, etc., shall have a minimum 28-day compressive strength of 3,000 psi.

The mix shall be designed for required strengths in accordance with ACI 301. The ratio of water to the sum of concrete + pozzolan shall not exceed 0.41 by weight for durable, watertight, concrete. The amount of fly ash in the mix shall be between 15 and 20 percent by weight of the total cementitious materials.

2.09 CONCRETE VIBRATORS

Concrete vibrators for consolidating concrete shall be 2 1/2 inch diameter "high cycle" vibrators with a frequency under load of 8,000 - 10,400 vibrations per minute (vpm). Concrete vibrators of lesser capacity are unacceptable for use in any part of the construction. The Contractor shall have at least one standby concrete vibrator ready for use for every two concrete vibrators in use during a concrete placement.

PART 3 EXECUTION

3.01 PRIOR TO PLACEMENT

Prior to placing concrete the Contractor shall remove all debris and thoroughly dampen the surfaces that will be in contact with the concrete to be placed.

The Contractor shall use compressed air from an air-compressor to blow-out construction debris and dirt at the bottom of members to be placed such as walls, beams and columns, prior to final placement of forms that will obscure any joint. The Contractor shall demonstrate to the Engineer/Utility that all debris, such as concrete particles, saw dust, loose tie wire, bar tags, tape, trash and dirt, have been thoroughly removed.

No concrete shall be placed when form surfaces that will be in contact with the concrete, reinforcement, embedded items or sub-base is less than 32°F. When the mean daily outdoor temperature is less than 40°F, the temperature of the concrete shall be maintained between 50°F and 70°F for the required curing period. When necessary, arrangements for heating, covering, insulating, or housing the concrete work shall be made in advance of placement and shall be adequate to maintain the required temperature without injury due to concentration of heat. Combustion heaters shall not be used during the first 24 hours unless precautions are taken to prevent exposure of the concrete to exhaust gases which contain carbon dioxide.

Concrete shall not be placed against forms exposed to heating by the unless the temperature of the forms is first cooled to $\leq$ 90°F.

3.02 PLACEMENT

Placement shall conform to ACI 301, Chapter 8 "Placing", ACI 304R, "Guide of Measuring, Mixing, Transporting and Placing Concrete," ACI 306 "Recommended Practice for Cold Weather Concreting", ACI 305 "Recommended Practice for Hot Weather Concreting" and ACI 309, "Standard Practice for Consolidation of Concrete". No concrete shall be placed until all formwork, reinforcement, installation of parts to be embedded, bracing of forms, and preparation of surfaces involved in the placing have been reviewed by the Engineer/Utility. No concrete shall be placed in water except with the written permission of the Engineer/Utility. All surfaces of forms and embedded materials that have become encrusted with dried mortar or grout from concrete previously placed shall be cleaned of all such mortar or grout before the surrounding or adjacent concrete is placed. Immediately before placing concrete, all surfaces upon or against which the concrete is to be placed shall be free from standing water, mud, debris or loose materials. The surfaces of absorptive materials against or upon which concrete is to be placed shall be moistened thoroughly so that moisture will not be drawn from the freshly placed concrete. The concrete shall be placed by equipment that will prevent segregation or loss of ingredients. The stream of concrete shall not be allowed to separate by permitting it to fall freely over rods, spacers or other embedded materials.

No wetting of concrete surfaces during slab finishing operations shall be permitted. Further, no concrete finishing operation shall be permitted while there is water on the surface of slabs and other flatwork.

Unless otherwise called out in these specifications or shown in the Construction Drawings, the placement lift depth of concrete in walls shall be limited to two feet or less to minimize surface defects such as air voids that can form on concrete surfaces. Lift depths will be limited to one foot if, in the opinion of the Engineer/Utility, the quality of the finish is unacceptable at the 2-foot lift depth.

3.03 CONSOLIDATION

All concrete shall be thoroughly consolidated with internal vibrators as recommended in ACI 309 immediately after deposition. The concrete shall be thoroughly worked around the reinforcing steel, around embedded items and into corners of forms. Vibration shall be supplemented by spading, rodding or forking to eliminate all honeycomb and voids around embedded items.

The vibrator shall be inserted vertically, allowing it to penetrate rapidly to the bottom of the lift and at least six inches into the previous lift. The vibrator shall be held at the bottom of lift for 5 to 15 seconds. The vibrator shall be pulled up at a rate of about three inches per second.

The vibrator shall be inserted so that the fields of action overlap. The field of action is approximately eight times the vibrator's head diameter. Thus for a 2 1/2 inch diameter vibrator, the spacing of each insertion will be approximately 20 inches.

Vibration shall be stopped when the concrete surface takes a sheen and large air bubbles no longer escape.

Do not use a vibrator to move concrete horizontally.

3.04 OPENINGS AND INSERTS

Pipe sleeves, inserts for pipe connections, anchors and forms for pipe holes must be accurately placed and securely fastened to the forms in such a manner that the placing of concrete will not alter their alignment or location. In the event that openings are inadvertently omitted or improperly placed, the Engineer/Utility may require the concrete to be cored at the proper location. Filling of improperly placed openings shall be done with expansive grout or dry pack or mortar applied with an accepted epoxy adhesive. The surfaces of the opening shall be roughened prior to filling.

3.05 EMBEDDED ITEMS

At the time of concrete placement, embedded items should be clean and free from mud, oil and other coatings that may adversely affect bonding capacity. Aluminum embedments shall be coated with a bituminous material to prevent electrolytic action between the embedded item and reinforcing steel that results in concrete deterioration. Embedment items shall be accurately placed and securely fastened to the forms in such a manner that the placing of concrete will not alter their alignment or location. Contact

between embedded items and reinforcing steel or tendon ducts is unacceptable and is not permitted.

3.06 CONSTRUCTION JOINTS

The location of all construction joints will be subject to the acceptance of the Design Engineer and Engineer/Utility. The surface of all construction joints shall be thoroughly cleaned and all laitance and standing water removed. Clean aggregate shall be exposed by abrasive blast cleaning. Wire brushing and air water jets may be used while concrete is fresh provided results are equal to abrasive blast cleaning. Construction joints shall be keyed at right angle to the direction of shear. Except where otherwise shown on the Construction Drawings, keyways shall be at least 1-1/2" in depth over at least 25% of the area of the section.

3.07 EVAPORATIVE RETARDANT

The use of an evaporative retardant is required to assist in proper placement of concrete. See Section 03390. When an evaporative retardant is used, it shall be applied two times: after screeding and after the first floating operation. The retardant should be applied at a rate of one gallon of sprayable solution per 200 - 400 square feet by spraying with an industrial type sprayer. If the nozzle of the sprayer becomes plugged, the Contractor shall clean, or replace, the nozzle. Under no circumstances shall the retardant be used except by spraying a mist with a nozzle. The retardant shall be applied in strict conformance with the manufacturer's recommendations and precautions. In no case shall the retardant be used as a finishing agent. The use of an evaporative retardant requires review and approval by the Engineer/Utility.

END OF SECTION

SECTION 03320

CONSTRUCTION JOINTS

PART 1 GENERAL

1.01 SECTION INCLUDES

The Contractor shall supply all labor, tools, equipment and material for the preparation of construction joints in concrete in accordance with these specifications and as shown in the Construction Drawings. This includes joints such as column-footing joints, wall construction joints, column capital-slab joints, grout closures around pipe-slab penetrations and footing-slab joints.

1.02 RELATED SECTIONS

A. Section 03110 - Structural Cast-In-Place Concrete Forms

B. Section 03151 - Hydrophilic Rubber Waterstop

C. Section 03210 - Reinforcing Steel

D. Section 03310 - Structural Concrete

E. Section 03615 - Grout

1.03 QUALITY STANDARDS

A. American Concrete Institute (ACI)

1. ACI 117 - Standard Tolerance for Concrete Construction and Materials

2. ACI 301 - Specifications for Structural Concrete for Buildings

3. ACI 302 - Guide for Concrete Floor and Slab Construction

4. ACI 318 - Building Code Requirements for Structural Concrete

1.04 CONSTRUCTION REVIEW

The Engineer/Utility shall review the preparation of all construction joints prior to concrete and grout closure placements. It is the responsibility of the Contractor to notify and provide a minimum of 24 hours notice to the Engineer/Utility of these activities. If joint placement is performed without the Engineer/Utility's presence, the work will be deemed unacceptable and non-conforming to these specifications. If the Engineer/Utility determines that construction review of a particular activity is unnecessary, he will provide notify the Contractor to proceed with that particular activity without his/her construction review.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.01 SURFACE PREPARATION

The surface of concrete construction joints shall be clean and all materials that inhibit bond, such as curing compounds, laitance, saw dust, wood, dirt, polyethylene, pipe tape coating and paper shall be removed. Concrete shall be roughened to produce a rough, plus or minus 1/16 inch, surface texture. Concrete surfaces shall be wetted with clean potable water and standing water removed immediately before new concrete or closure grout is placed. Unless otherwise called out in the Construction Drawings, a bonding agent shall be used prior to placing the concrete or grout.

3.02 PIPE GROUT CLOSURE SECTIONS

A. Pipe Surface Preparation

Unless otherwise detailed in Construction Drawings, all pipes penetrating concrete sections such as wall and floor slabs shall have all coatings and other materials that can inhibit bond completely removed from the portion of the pipe to be in contact with the concrete or slab closure grout.

B. Ground Surface Preparation

The ground surface at joints such as pipe / slab closures shall be smooth and properly graded and compacted. All debris such as Styrofoam™, paper, polyethylene and wood shall be removed. The ground surface shall be dampened and prepared to prevent the inclusion of dirt, pieces of aggregate or balls of soil in the concrete or grout.

3.03 CONCRETE AND CLOSURE GROUT PLACEMENT

Mixing, surface preparation in addition to that prescribed above, placement, and curing of grout at pipe closure joints shall be performed in strict accordance with Specification Section 03615 and when a proprietary grout is specified, with the grout manufacturer's directions. Special care shall be taken to insure that the grout is thoroughly and properly consolidated at waterstops, pipe weep rings, and existing concrete surfaces. An appropriate capacity vibrator shall be used when necessary or required by the manufacturer to properly consolidate the grout.

END OF SECTION

SECTION 03350

CONCRETE FINISHING

PART 1 GENERAL

1.01 SECTION INCLUDES

The Contractor shall supply all labor, tools, equipment and materials to finish properly placed concrete for structures such as box culverts, vaults, foundations, hydraulic and water retaining structures.

The means and methods of repair of improperly placed or finished concrete shall be reviewed by the Design Engineer and Engineer/Utility prior to performing the work. Regardless of prior approval of the means and methods of concrete finish repair, no concrete finish shall be repaired until the Engineer/Utility has reviewed the existing finish. This includes defects caused by ineffective and improper vibration such as honeycomb, excessive air voids on formed surfaces, placement “pour” lines (cold joints) and sand streaking. It also includes defects caused by excessive form deflections, form damage or form failure.

Unless otherwise called out in the Construction Drawings tie holes shall be finished as specified herein.

1.02 RELATED SECTIONS

A. Section 03110 - Structural Cast-In-Place Concrete Forms

B. Section 03310 - Structural Concrete

C. Section 03615 - Grout

1.03 QUALITY STANDARDS

A. American Concrete Institute

1. ACI 116 - Cement and Concrete Terminology

2. ACI 121 - Quality Assurance Systems for Concrete Construction

3. ACI 301 - Specifications for Structural Concrete for Buildings

4. ACI SP-15 - ACI 301 Field Reference Manual

5. ACI 304 - Placing Concrete by Pumping Methods

6. ACI 309 - Identification and Control of Consolidation-Related Surface Defects in Formed Concrete

7. ACI 311 - Guide for Inspection of Concrete

B. American Society for Testing and Materials

1. ASTM STP 169C - Significance of Tests and Properties of Concrete and Concrete-Making Materials

2. ASTM C 150 - Standard Specification for Portland Cement

3. ASTM C 33 - Concrete Aggregates

C. US Department of Interior - Bureau of Reclamation

1. M-47 Standard Specifications for Repair of Concrete

1.04 DELIVERY, STORAGE AND HANDLING

Deliver the materials to the project site in the manufacturer's containers with all labels intact and legible at the time of use. Materials shall be stored in a secure, indoor, dry area. Maintain grouts and aggregates in a dry condition during delivery, storage, and handling.

PART 2 PRODUCTS

2.01 PREMIXED PRE-PACKAGED GROUTS

A. Master Builders EMACO R320

B. Master Builders EMACO S66-CR

2.02 EPOXY BONDING AGENTS

A. Master Builders Concresive Liquid (LPL)

B. Master Builders Concresive Standard Liquid

2.03 CEMENT

ASTM C 150, Type 1

2.04 AGGREGATE

ASTM C 33, 100% passing the No. 30 mesh sieve

2.05 BOND COAT MORTAR

Mortar used to bond patching mortar shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse

aggregate shall be omitted and the mortar shall consist of 1 part cement to not more than 1 part sand by damp loose volume.

2.06 PATCHING MORTAR

Patching mixture shall be made of the same materials and of approximately the same proportions as used for the concrete, except that the coarse aggregate shall be omitted and the mortar shall consist of 1 part cement to not more than 2-1/2 parts sand by damp loose volume. White Portland Cement shall be substituted for a part of the gray Portland Cement on exposed concrete in order to produce a color matching the color of the surrounding concrete, as determined by a trial patch. The quantity of mixing water shall be no more than necessary for handling and placing. The patching mortar shall be mixed in advance and allowed to stand with frequent manipulation with a trowel, without addition of water, until it has reached the stiffest consistency that will permit placing.

2.07 WATER

Only clean potable water shall be used. A calibrated measuring device is required for measuring the proper amount of water to be added to pre-packaged grouts and mortars.

PART 3 EXECUTION

3.01 REPAIR OF SURFACE DEFECTS

Surface defects, unless otherwise specified by the specifications, shall be repaired immediately after form removal but not before review by the Engineer/Utility. The surface temperature of the concrete shall be 50° F and rising. The Contractor shall measure surface temperatures when requested by the Engineer/Utility. If necessary the Contractor shall enclose and heat the area to be repaired to bring the surface temperature of the concrete and air temperature to acceptable levels and to permit proper curing.

All honeycombed and other defective concrete shall be removed down to sound concrete. If chipping is necessary, the edges shall be perpendicular to the surface or slightly undercut. Feathered edges will not be permitted. The area to be patched and an area at least six inches wide surrounding it shall be dampened to prevent absorption of water from the patching mortar. A bonding grout shall be prepared, mixed to the consistency of thick cream, and after surface water has evaporated from the area to be patched, well brushed into the surface.

When the bond coat begins to lose the water sheen, the premixed patching mortar shall be applied. The mortar shall be thoroughly consolidated into place and struck off so as to leave the patch slightly higher than the surrounding surface. To permit initial shrinkage, it shall be left undisturbed for at least one hour before being finally finished. The patched area shall be kept damp for seven days. Metal tools shall not be used in finishing a patch in a formed wall that will be exposed.

3.02 TIE HOLES

A. Below Grade Vaults with Breakback Cone Ties

Fill tie holes solid as specified in Section 03615.

B. Other Structures

After being cleaned and thoroughly dampened, fill tie holes solid as specified in Section 03615.

3.03 PROPRIETARY MATERIALS

Certain types of defects may require the use proprietary compounds for adhesion or as patching ingredients. The Engineer/Utility will review these defects and request means and methods for these repairs from the Contractor.

In lieu of, or in addition to, the foregoing patching procedures using bond coat and patching mortars, epoxy bonding agents and premixed pre-packaged grouts may be used for repair of defective areas. Such compounds shall be used in accordance with the manufacturer's written recommendations and directions.

3.04 FINISHING OF FORMED AND UNFORMED SURFACES

Finishes shall be performed as called out in the Construction Drawings and in referenced specifications.

A. Formed Surfaces

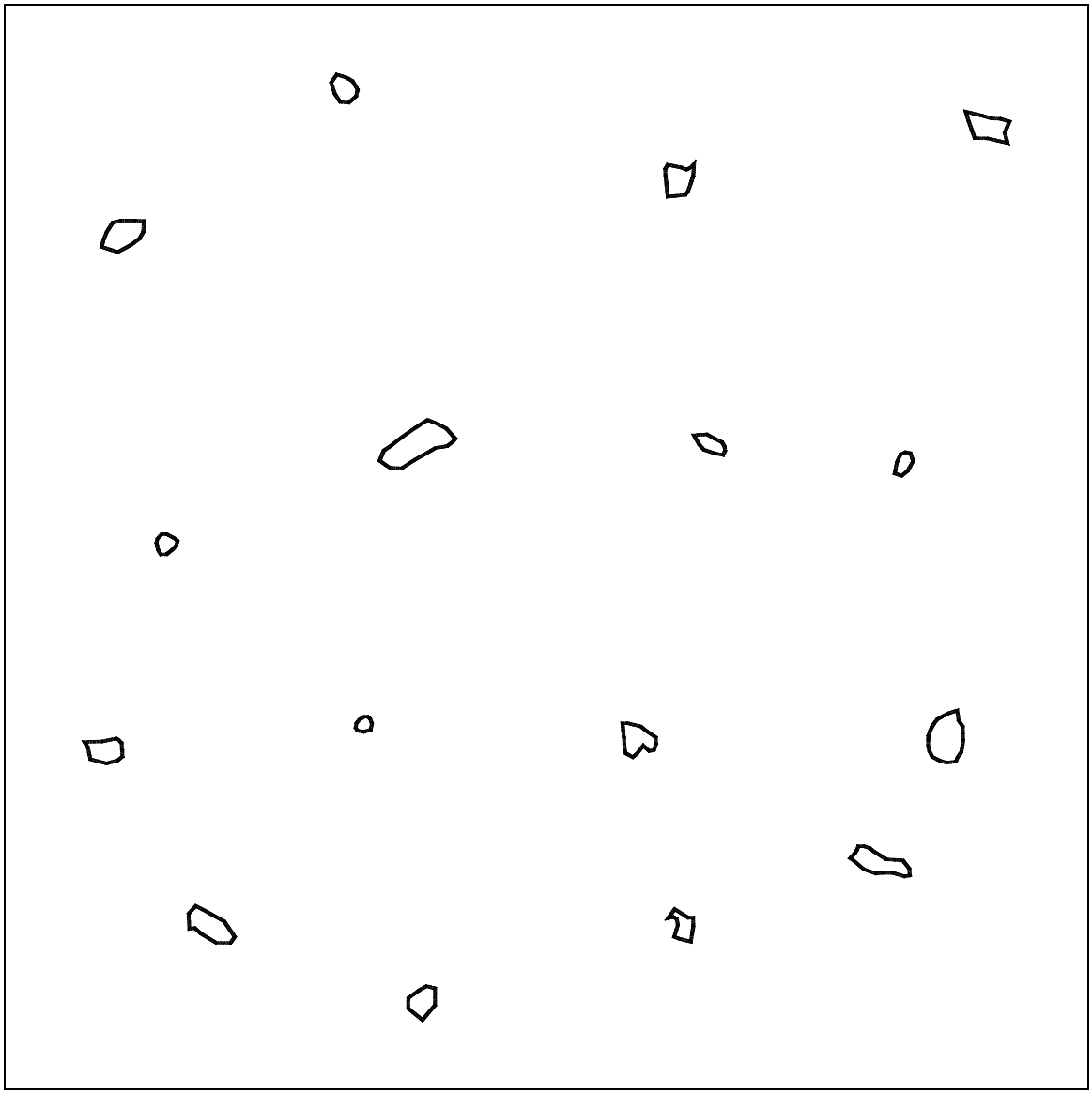
1. Smooth Form Finish

The form facing material shall produce a smooth, hard, uniform texture on the concrete. The arrangement of the facing material shall be orderly and symmetrical, with the number of seams kept to the practical minimum. Surface textures that result from forms with raised grain, torn surfaces, worn edges, patches, dents, or other defects shall be ground smooth or otherwise repaired.

a. Air Voids on Formed Surfaces

Air voids on formed surfaces deeper than 1/4 inch shall be filled with patching mortar. The frequency and size of air voids shall

Figure 1



be equal to or better than shown in Figure 1. The total void area is 1% of the surface area, or 0.36 sq. in. This 6-inch x 6-inch figure is the visual standard for acceptance of the finish that does not require filling of air voids.

b. Tie Holes

Tie holes shall be filled as specified in Section 03615.

c. Form Fins

Chip or rub-off form fins exceeding 1/16 inch in height.

d. Rock Pockets

Poorly consolidated concrete shall be removed to sound concrete and the defect repaired. The Engineer/Utility shall outline the area to be repaired.

2. As-Cast Finish

For as-cast concrete finish form materials shall produced a sound surface.

a. Air Voids

Fill air voids deeper than 1/4 inch. and larger than 0.50 sq. in. The total area of acceptable air voids is 0.72 sq. in. in a 6 inch by 6-inch square.

b. Tie Holes

Tie holes shall be filled as specified in section 03615.

c. Form Fins

Chip or rub-off form fins exceeding 1/8 inch in height.

3. Rubbed Finish

Immediately after removing the forms, form ties shall be broken back a minimum of 3/4 inch from the surface, honeycomb, voids and other surface defects grouted. The surfaces shall then be thoroughly dampened and rubbed with a No. 16 carborundum stone or equal abrasive to create a uniform surface paste. The rubbing shall be continued to remove all form marks and surface irregularities producing a smooth, dense surface. After setting, the surface shall then be rubbed with a No. 30 carborundum stone until the surface is smooth in texture and uniform in color. Unless otherwise shown in the Construction Drawings only exposed surfaces shall have a rubbed finish.

4. Grout Finish

Prepare surface as described in Rubbed Finishes above. Mix one part Portland cement and one-half parts fine sand with sufficient water to produce a grout with the consistency of thick paint. Wet surface of concrete to prevent absorption of water from grout and apply grout uniformly with brushes. Immediately after applying grout mix, scrub the

surface with a cork float or stone to coat surface and fill remaining air voids and other remaining surface defects. Remove excess grout by working the surface with rubber float. After the surface whitens from drying, rub with clean burlap. Cure surface for a period of 72 hours

B. Unformed Surface

Unless otherwise shown in the Construction Drawings unformed surfaces shall be finished as follows.

1. Slabs

Screed with straightedge to remove low and high spots bringing the surface to the required finish elevation of slope and float with a steel float at least 3 feet in width. When the concrete has reached its initial set, finish with a steel (power) trowel. Leave finish essentially free of trowel marks, uniform in texture and appearance and plane to the correct tolerance. Dusting the surface with dry cement, sand or sprinkling with water is prohibited

Finishes that are exposed and subject to foot traffic shall receive a broom finish with a texture of ± 1/16 inch.

2. Tops of Walls with Bearings

Strike smooth tops of walls and similar unformed surfaces that will have bearings or bearing pads, and finish with a steel trowel.

3. Stairways and Sidewalks

Strike smooth tops of stairs and sidewalks and finish with a light broom providing a texture of ± 1/16 inch.

4. Slabs with Waterproofing Membranes

Strike smooth and float finish.

5. Construction Joint Surfaces

Surface shall be broom or raked finished. Surface shall be water or grit blasted prior to placing additional concrete, such as columns on column footings and column footings on reservoir slabs.

C. Finishing Concrete Drainage Structures

1. Drainage structures which are either below ground or are not visible from a travel way, shall be finished a with a Class I finish. Drainage structures which are above ground and also visible from a travel way shall receive either a Class 2 or Class 5 finish at the Contractor's option. Concrete

surfaces other that those listed shall receive the finish shown on the Construction Drawings. The various classes of finish are described as follows:

a. Class I, Ordinary Surface Finish

All fins and irregular projections shall be removed from all surfaces except from those which are not to be exposed or are not to be waterproofed. On all surfaces, the cavities produced by form ties, honeycomb spots, broken corners or edges and other defects shall be thoroughly cleaned, moistened with water and carefully pointed and trued with a mortar consisting of cement and fine aggregate and the surface left sound, smooth, even and uniform in color. Mortar used in pointing shall not be more than 30 minutes old. The mortar patches shall be cured. All construction and expansion points in the completed work shall be left carefully tooled and free of all mortar and concrete. The joint filler shall be left exposed for its full length and clean and true edges.

Where cutting compound is used, the Class 1 finish shall be applied immediately after the forms are removed and forms may be removed for only that portion of the work that can be finished in the remainder of the work day. The exposed concrete shall be kept damp during the finishing period and covered with the curing compound immediately following the completion of the finishing.

b. Class 2, Rubbed Finish

After completion of Class 1 - Ordinary Surface Finish, the rubbing of concrete shall be started as soon as its condition will permit. Immediately before starting this work the concrete shall be kept moistened with water. Sufficient time shall have elapsed before the wetting down to allow the mortar used in the pointing to thoroughly set. Surface to be finished shall be rubbed with a medium course carborundum stone, using a small amount of mortar on its face. The mortar shall be composed of cement and fine sand mixed in the same proportions as the concrete being finished. Rubbing shall be continued until all form marks, projections, and irregularities have been removed, all voids filled and a uniform surface has been obtained. The paste produced by this rubbing shall be left in place.

After all concrete above the surface being treated has been cast, the final finish shall be obtained by rubbing with a fine carborundum stone and water. This rubbing shall be continued until the surface is of a smooth texture and uniform color.

After the final rubbing is completed and the surface has dried, it shall be rubbed with burlap to remove loose powder and shall be

left free from all unsound patches, paste, powder, and objectionable marks.

c. Class 5, Masonry Coating Finish

The specified surface shall be coated with a cement bas concrete coating as specified herein:

i. Materials: Masonry coatings shall be a hydraulic cement base coating designed for use on porous surfaces of concrete as a decorative, protective and water repellant coating. The powder shall consist of a heavy cement base coating packaged in a dry form and shall conform to Federal Specifications TT-P-21, Type I, Class B. The liquid acrylic shall be an approved combination of polymers, and modifiers designed for use with Portland cement, shall be fully compatible with water and shall be a product of the manufacturer of the cement base powder. Masonry coating shall be pearl gray in color unless otherwise specified.

ii. Preparation of Surface: Surfaces shall be thoroughly cleaned by approved methods, free of dirt, projections, loose mortar particles and laitance.

iii. Mixing: One part by volume of liquid acrylic to three parts by volume of water shall be mixed in a clean container. The dry powder shall be added to the liquid mixture and stirred until the resulting mixture attains the consistency of a matter mix. If the components are hand mixed, the mixture shall set for 15 minutes, additional liquid shall be added, and the mixture shall be re-stirred to the batter consistency. The Contractor shall not use mixed quantities that cannot be applied within time limits specified by the manufacturer.

iv. Application: The masonry coating shall be applied in two coats using a tempico fiber brush, roller, trowel, or spray. The first coat shall be applied at the rate of approximately 2 pounds per square yard of surface area and the second shall be applied at the rate of approximately one pound per square yard. The second coat shall be applied the day following the first application or before material has become too hard or glazed for good bond.

Surfaces to be coated shall be dampened immediately ahead of the application. The masonry coating shall not be applied as a thin coat, but shall be laid on the surface and leveled out. If the wall becomes dry or the coating starts to pull during application, the wall shall be

dampened again. The mixture shall not be applied on frost, covered surfaces, frozen walls, when temperature is below 40 degrees F, or when temperatures are predicted to fall below 40 degrees F within 24 hours. If the surfaces have been exposed to hot sun conditions, they shall be cooled by hosing with clean water.

When the work is progressing under hot sun, drying wind, or when evidence of extremely rapid drying appears, the finished surface shall be cured by fog spraying with water until final set occurs.

END OF SECTION

SECTION 03390

CONCRETE CURING

PART 1 GENERAL

1.01 WORK INCLUDED

The Contractor shall furnish all labor, tools and equipment for curing plain, reinforced and post-tensioned cast-in-place concrete.

1.02 RELATED WORK

A. Section 03310 – Structural Concrete

B. Section 03320 – Construction Joints

C. Section 03350 – Concrete Finishing

1.03 QUALITY STANDARDS

A. American Concrete Institute (ACI)

1. ACI 305 - Hot Weather Concreting

2. ACI 306 - Cold Weather Concreting

3. ACI 308 - Standard Practice for Curing Concrete

B. American Society for Testing Materials (ASTM)

1. ASTM C 171 – Sheet Materials for Curing Concrete

2. ASTM C 309 – Liquid Membrane-Forming Compounds for Curing Concrete

3. ASTM D 2103 – Polyethylene Film and Sheeting

1.04 QUALITY CONTROL

Perform the work in accordance with this specification and in accordance with applicable ACI standards. When a conflict occurs between this specification and ACI occurs, the ACI standard shall control.

1.05 DELIVERY, STORAGE AND HANDLING

Deliver curing materials in manufacturer's original packaging including applicable instructions and manufacturer's safety data sheets (MSDS).

PART 2 PRODUCTS

2.01 SHEET MATERIALS FOR CURING CONCRETE

White burlap-polyethylene sheeting weighing not less than 10 oz/linear yard, 40 inches wide, impregnated on one side with white opaque polyethylene 0.004 inches thick as specified in ASTM C 171 shall be used when called out in the Drawings or in other applicable specifications. The polyethylene shall be securely bonded to the burlap so that there will be no separation.

2.02 LIQUID MEMBRANE-FORMING COMPOUNDS FOR CURING CONCRETE

Liquid membrane-forming compounds for curing concrete shall and conform to ASTM C 309, Type 1-D with a red or white fugitive dye. Use a white dye unless otherwise directed by the Engineer/Utility.

2.03 POLYETHYLENE FILM

Polyethylene film shall conform to ASTM D 2103. The film shall have a thickness of 6 mils and be a white opaque color.

2.04 LIQUID MEMBRANE FORMING COMPOUND AND EVAPORATIVE RETARDANT APPLICATORS/ SPRAYERS

Membrane curing and evaporative retardant compounds shall be applied with a sprayer manufactured by Allen Engineering, Inc., or equal, capable of maintaining a constant pressure. (Allen Engineering, Inc., P.O. Box 819, Paragould, Arizona 74450, telephone (800) 643-0095.) Unless otherwise accepted in writing by the Engineer/Utility, spraying membrane curing compounds or evaporative retardants by other methods, such as hand pressurized sprayers, is unacceptable.

2.05 EVAPORATIVE RETARDANT

Confilm manufactured by Master Builders, Inc. or approved equal.

2.06 WATER

Water shall only be used when prior approval is granted by the Engineer/Utility. Only water that has been determined to be non-detrimental to concrete shall be used.

PART 3 EXECUTION

3.01 GENERAL

Beginning immediately after placement, concrete shall be protected from premature drying, excessively hot or cold temperatures, and mechanical injury, and shall be maintained with minimal moisture loss at a relatively constant temperature for the period

necessary for hydration of the cement and hardening of the concrete in accordance with ACI 308, "Standard Practice for Curing Concrete". The materials and method of curing shall be subject to review and acceptance by the Engineer/Utility. Specific curing requirements may be called out on the Construction Drawings or other specifications.

Curing shall be continued for at least seven days. Alternatively, if tests are made of cylinders kept adjacent to the structure and cured by the same methods, moisture retention measures may be terminated when the average compressive strength has reached 70% of the specified concrete strength.

When a spray applied membrane-curing compound is used, it shall be applied in two coats with the second coat applied at right angles to the first coat.

3.02 EVAPORATIVE RETARDANT

An evaporative retardant shall be used during concrete placement for water retaining structure floor and roof slabs and other slabs larger than 2,500 square feet in size. The retardant shall be sprayed using a power sprayer at a rate of 10 gallons per 2,000 square feet after screeding and repeated after the first floating operation. The evaporative retardant shall not be applied during the final steel troweling operations or after the water sheen has disappeared from the concrete surface.

3.03 SLABS

For concrete surfaces not in contact with forms, a procedure determined by the Design Engineer shall be applied immediately after completion of placement and finishing.

3.04 WALLS AND COLUMNS

Moisture loss from surfaces placed against wooden or metal forms exposed to heating by the sun shall be minimized by keeping the forms wet until they can be safely removed. After form removal, the concrete shall be cured until the end of the curing time by one of the previously described curing methods. Concrete shall not be placed against forms that have been exposed to air below freezing temperatures until the forms have been heated so that the surface temperature of the form is $\geq 40°$ F.

The top of walls and columns not covered by forms shall be cured using a membrane-curing compound conforming to ASTM C 309 immediately after placement

3.05 OTHER SURFACES

Unless otherwise shown in the Construction Drawings all other surfaces shall be cured using two applications of a membrane-curing compound conforming to ASTM C 309. The second application shall be applied at 90° to the first application.

3.06 COLD WEATHER

Curing during cold weather conditions shall include the above methods except for water cure unless measures are taken to prevent freezing of the water.

3.07 HOT WEATHER

If the rate of evaporation approaches 0.2 lb/ft^2/hr, as estimated by ACI 305, precautions against plastic shrinkage cracking are required. The Contractor shall have a recording thermometer, hygrometer and wind gage on site seven days prior to first concrete placement. When necessary, provision for windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material shall be made in advance of placement, and such protective measures shall be taken as quickly as concrete hardening and finishing operations will allow. Precautions against plastic shrinkage cracks may be required in conditions other than what is normally considered hot weather conditions.

3.08 RATE OF TEMPERATURE CHANGE

Changes in temperature of the air immediately adjacent to the concrete during and immediately following the curing period shall be kept as uniform as possible and shall not exceed 5° F in any one hour or 50° F in any 24-hour period.

3.09 PROTECTION FROM MECHANICAL INJURY

During the curing period, the concrete shall be protected from damaging mechanical disturbances, such as load stresses, heavy shock, and excessive vibration. All finished concrete surfaces shall be protected from damage by construction equipment, materials, or methods, by application of curing procedures, and by rain or running water. Self-supporting structures shall not be loaded in such a way as to overstress the concrete.

END OF SECTION

SECTION 03615

GROUT

PART 1 GENERAL

1.01 SECTION INCLUDES

The Contractor shall furnish all labor, tools and equipment for the placement of grout in tie holes and other locations as shown on the Construction Drawings and specified herein.

This section includes basic mixing, application, and curing methods for grout.

1.02 RELATED SECTIONS

A. Section 03110 - Structural Cast-In-Place Concrete Forms

B. Section 03310 - Structural Concrete

C. Section 03320 - Construction Joints

D. Section 03350 - Concrete Finishing

1.03 QUALITY STANDARDS

A. ASTM C 78 - Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading

B. ASTM C 109 - Test Method for Compressive Strength of Hydraulic Cement Mortars - Modified

C. ASTM C 469 - Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression

D. ASTM C 666 - Test Method for Resistance of Concrete to Rapid Freezing and Thawing

E. ASTM C 882 - Test Method for Bond Strength of Epoxy Resin Systems used with Concrete - Modified

F. ASTM C 1012 - Test Method for Length Change of Hydraulic Cement Mortars Exposed to Sulfate Solution - Modified

G. ASTM C 1202 - Electrical Indication of Resistance to Chloride Ion Penetration

1.04 QUALITY ASSURANCE

A. Field Tests

1. Contractor shall assist the concrete testing consultant as requested during the performance of quality control testing.

2. All mortar, already placed, that fails to meet the requirements of this specification, is subject to removal and replacement.

B. Construction Tolerances

Construction tolerances shall be as specified in the Section 03110 except as modified herein and elsewhere in the specifications.

1.05 ACCEPTABLE MANUFACTURERS/PRODUCTS

Master Builders Technologies

EMACO R320 - Polymer-Modified Vertical/Overhead Patching Mortar

MB 429, Masterkure CR, Masterkure 200W or Masterkure 100W - curing compounds

1.06 DELIVERY, STORAGE AND HANDLING

Cement based mortar shall be delivered and stored in manufacturer's packaging until it is ready to be mixed and placed. Mortar bags shall be stored off the ground and protected from water and all other substances that will penetrate packaging.

PART 2 PRODUCTS

2.01 MORTAR FOR TIE HOLES

EMACO R320 or approved equal.

2.02 BONDING ADHESIVES

Concresive Liquid LPL, Concresive Standard Liquid or approved equal.

2.03 WATER

Only clean potable water shall be used. A calibrated measuring device is required for measuring the proper amount of water to be added to grouts and mortars.

2.04 CURING COMPOUND

MB 429, Masterkure 100W, Masterkure 200Wor approved equal.

2.05 (EXPOSED) REINFORCING STEEL COATING

EMACO P22 or approved equal.

PART 3 EXECUTION

3.01 GENERAL

These grouts contain admixtures that increase grout strength and workability. The strength and performance of the grout is dependent on proper surface preparation, grout mixing and curing. The Contractor shall be required to use a calibrated measuring device to add clean potable water to the grout mix. Water added to a grout mix without a calibrated device is cause for grout rejection, removal and re-placement.

Curing is critical to prevent shrinkage cracks that can develop with grouts containing some admixtures. Curing shall begin immediately after placement.

All mixing, surface preparation, handling, placing, consolidation, and other means of execution for pre-packaged mortars shall be done according to the instructions and recommendations of the manufacturer and this specification. In the event that a conflict occurs between this specification and manufacturer's instructions, the manufacturer's instructions shall prevail in all cases.

3.02 GROUT FOR TIE HOLES

A. Preparation:

Thoroughly clean the roughened surface and any exposed reinforcement of rust, dirt, loose chips, and dust. Maintain substrate in a saturated, surface-dry condition.

Where applicable, exposed reinforcing steel shall be coated with EMACO P22 reinforcing steel bar protection coating prior to patching.

B. Mixing:

Comply with mortar manufacturer's recommendations for water quantity. Mechanically mix with a slow speed drill (400 to 600 RPM) and Jiffler-type paddle. Pour approximately 90% of the mix water into the mixing container; then add the bagged material while continuing to mix. Add remaining water as needed. Mix time shall not exceed 5 minutes.

C. Application:

Apply bonding adhesive such as Concresive Liquid LPL or Concresive Standard Liquid.

Place and finish with trowel or screed. In hot, windy, or dry conditions, where rapid surface evaporation may occur, use Confilm Evaporation Reducer.

D. Curing:

Apply Masterkure 200 W curing compound in accordance with label instructions.

END OF SECTION