

SECTION 331100 - WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes water-distribution piping and related components outside the building for water service and fire-service mains.
- B. The Section includes general requirements that will apply to all water systems. In addition, the operating utility (the authority having jurisdiction) has numerous specific requirements for materials and execution that are too varied to cover in this specification.
 1. For this Project, the operating utility is Mt. Pleasant Waterworks.
 2. Materials and execution requirements that are not covered in this Section shall comply with the requirements of the operating utility.
 3. Materials and execution requirements that are covered, but are in conflict with the requirements of the operating utility, shall comply with the higher quality or more restrictive requirement.
- C. Utility-furnished products include water meters that will be installed by the utility upon completion of utility required preparations by Contractor.
 1. Tap and Impact Fees will be paid directly to the utility by the Owner and payment of said fees shall not be included in the Contractor's scope of services.

1.3 DEFINITIONS

- A. CTS: Copper Tubing Size.
- B. DIP: Ductile iron pipe.
- C. EPDM: Ethylene propylene diene terpolymer rubber.
- D. HDPE: High density polyethylene pipe.
- E. LLDPE: Linear, low-density polyethylene plastic.
- F. NPS: Nominal pipe size.
- G. PE: Polyethylene plastic.
- H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 - 1. Ductile iron pipe.
 - 2. Polyvinyl chloride pipe.
 - 3. Tees, elbows, reducers and similar fittings.
 - 4. Joint restraint.
 - 5. Valves and valve boxes.
 - 6. Fire hydrants.
 - 7. Fire department connections.
 - 8. Backflow preventers.
 - 9. Service connection piping and fittings
 - 10. Corrosion-protection piping encasement.
 - 11. Protective enclosures.
- B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.
- C. Field quality-control test reports.
- D. Bacteriological test reports.
- E. Record Drawings: Include the following, as required by authorities having jurisdiction, for use by Owner's surveyor in preparing record drawings:
 - 1. Location of water mains from centerline of road or curb. Contractor shall coordinate with Owners surveyor to allow for location of water main prior to backfilling.
 - 2. Location of fire hydrants, valves, tees, elbows, reducers, and other fittings.
 - 3. Location and elevation of any other below ground appurtenances.
 - 4. Designation, size and length of water lines between fittings.
 - 5. Location and depth below finished grade of service connections.
- F. Minutes of preinstallation conference.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
 - 2. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.
 - 3. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.
- B. Preinstallation Conference: Conduct conference to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Review methods and procedures related to water system installation including, but not limited to, the following:
 - a. Review requirements of the operating utility.

- b. Review site conditions and preparatory work.
 - c. Review requirements for protecting work.
 - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - e. Review inspection schedule and procedures required to monitor and document quality assurance.
- C. Piping materials shall bear label, stamp, or other markings of specified testing agency.
 - D. Comply with ASTM F 645 for selection, design, and installation of thermoplastic (PVC and HDPE) water piping.
 - E. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
 - F. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
 - G. NSF Compliance: Comply with NSF 61 for materials for water-service piping and specialties for domestic water.
 - H. Lead Free Requirement: Section 1417 of the Federal Safe Drinking Water Act has mandated that "Any pipe, solder, or flux used after June 19, 1986, in the installation or repair of public water systems and plumbing used for drinking water must be "Lead Free". The act defines "Lead Free" as less than 0.2-percent lead in solder and flux and less than 8.0-percent lead in pipes and fittings.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
 - 1. Ensure that valves are dry and internally protected against rust and corrosion.
 - 2. Protect valves against damage to threaded ends and flange faces.
 - 3. Set valves in best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect from weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use hand wheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
1. Notify Architect, Owner, and Utility having jurisdiction no fewer than two days in advance of proposed interruption of service.
 2. Do not proceed with interruption of water-distribution service without Architect's written permission.

1.8 COORDINATION

- A. Where required, coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 STANDARDS OF OPERATING UTILITY

- A. See paragraph 1.2.B above for information regarding materials standards of the operating utility.

2.2 DUCTILE-IRON PIPE (DIP)

- A. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless mechanical joint or flanged ends are indicated on Drawings or required by operating utility.
1. Gaskets: AWWA C111, rubber. Use only non-toxic lubricants approved by the manufacturer and that will not support microbiological growth. Vegetable shortening shall not be used.
 2. Pressure class: Class 350 for NPS 3 to NPS 12; Class 250 for NPS 14 and larger.
 3. Cement mortar lining: AWWA C 104, standard thickness.
 4. Laying length: 18 feet-0 inches to 20 feet-0 inches.
 5. Pipe size: No metric sized pipe shall be permitted.
 6. Testing: All pipe lengths shall be tested to 500 psi working pressure prior to shipping.
 7. Marking: Clearly mark each joint of pipe at convenient intervals, as follows:
 - a. Manufacturer's name.
 - b. Nominal pipe size.
 - c. Letters "DI" or "Ductile".
 - d. Weight.
 - e. Pressure Class.
 8. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. American-Cast Iron Pipe Co.
 - b. Griffin Pipe Co.
 - c. McWane Cast Iron Pipe Co..
 - d. U.S. Pipe Co.
- B. Flanged Joints: where indicated on Drawings or where required by operating utility and in accordance with standards of operating utility.

- C. Mechanical Joints: where indicated on Drawings or where required by operating utility and in accordance with standards of operating utility.

2.3 POLYVINYL CHLORIDE PLASTIC PIPE (PVC)

- A. PVC, AWWA Pipe: AWWA C900 (4" thru 12" NPS) or AWWA C905 (14" and larger NPS), Class 235, with bell end with gasket, and with spigot end.
 - 1. Gaskets: ASTM F 477, rubber. Use only non-toxic lubricants approved by the manufacturer and that will not support microbiological growth. Vegetable shortening shall not be used.
 - 2. Joints: ASTM D 3139.
 - 3. Laying length: 18 feet-0 inches to 20 feet-0 inches
 - 4. Pipe size: comply with outside diameter dimensions of DIP.
 - 5. Standard dimension ratio: SDR 18.
 - 6. Pipe color: blue.
 - 7. Comply with UL 1285 for fire-service mains if indicated.
 - 8. The use of solvent weld joints is prohibited.
 - 9. Marking: Clearly mark each joint of pipe at convenient intervals, as follows:
 - a. Manufacturer's name.
 - b. Nominal pipe size.
 - c. Pressure class.
 - d. Material designation.
 - e. National Sanitation Foundation (NSF) seal.

2.4 FITTINGS (NPS 3 AND LARGER)

- A. Mechanical-Joint, Ductile-Iron Fittings: For NPS 3 and larger, AWWA C110, ductile-iron standard pattern or AWWA C153, ductile-iron compact pattern. For NPS 2 and smaller see "Service Connections" article below.
 - 1. Glands and Gaskets: AWWA C111, ductile-iron glands, rubber gaskets. Use only non-toxic lubricants approved by the manufacturer and that will not support microbiological growth. Vegetable shortening shall not be used.
 - 2. Nuts and Bolts: 316 Stainless Steel, material shall be marked on nuts and bolts.
 - 3. Material: Cast iron fittings are not permitted.
 - 4. Pressure class: Class 250.
 - 5. Fitting size: Metric sized fittings are not permitted.
 - 6. Cement mortar lining: AWWA C 104, standard thickness.
 - 7. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. American-Cast Iron Pipe Co.
 - b. Griffin Pipe Co.
 - c. McWane Cast Iron Pipe Co..
 - d. U.S. Pipe Co.

2.5 RESTRAINED JOINTS

- A. Push-on (DIP only) or mechanical joint type joint restraint where indicated on Drawings or where required by operating utility and in accordance with standards of operating utility.

1. Push-on Gaskets: AWWA C 111, for use on DIP only, approved for use on the pipe on which it is installed. Use only non-toxic lubricants approved by the manufacturer and that will not support microbiological growth. Vegetable shortening shall not be used.
2. Mechanical Joint Glands, Gaskets and Bolts: AWWA C 111, the gland, gasket and bolts shall be part of an integral system by the same manufacturer and approved for use on the pipe on which it is installed. Installation shall require only standard mechanical joint assembly techniques. Bolts shall be 316 Stainless Steel. Use only non-toxic lubricants approved by the manufacturer and that will not support microbiological growth. Vegetable shortening shall not be used.
3. DIP Pressure Rating: 350 psi.
4. PVC Pressure Rating: rated at a 2:1 safety factor for the pipe on which it is installed.
5. Products: Subject to compliance with requirements, provide products by one of the following:
 - a. American-Cast Iron Pipe Co.
 - b. Griffin Pipe Co.
 - c. McWane Cast Iron Pipe Co..
 - d. U.S. Pipe Co.
 - e. Ebba Iron Inc.
 - f. Ford Meter Box Co.
 - g. Sigma Corporation.

2.6 VALVES (NPS 3 AND LARGER)

A. General:

1. For NPS 2 and smaller: see "Service Connections" article below.
2. Available Manufacturers: Subject to compliance with these requirements and the standards of operating utility, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. Crane Co.; Crane Valve Group.
 - d. East Jordan Iron Works, Inc.
 - e. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - f. McWane, Inc.; Kennedy Valve Div.
 - g. McWane, Inc.; M & H Valve Company Div.
 - h. McWane, Inc.; Tyler Pipe Div.; Utilities Div.
 - i. Mueller Co.; Water Products Div.
 - j. U.S. Pipe and Foundry Company.
3. Opening direction: As required by operating utility.
4. Operating system: 2" square operating nut for below grade installation, wheel for above grade or vault installations.
5. Exterior Nuts and Bolts: 316 stainless steel
6. Interior Coating: Complying with AWWA C550.

B. AWWA, Gate Valves:

1. Nonrising-Stem, Resilient-Seated Gate Valves:
 - a. Description: For NPS 3 to NPS 12, gray- or ductile-iron body and bonnet; with bronze or ductile-iron gate, resilient seats, bronze stem, and stem nut.

1) Standard: AWWA C509.

- 2) Minimum Pressure Rating: 250 psig.
- 3) End Connections: AWWA C 111, mechanical joint.

C. UL/FMG, Gate Valves:

1. UL/FMG, Nonrising-Stem Gate Valves:

- a. Description: Gray- or ductile-body and bonnet with flange for indicator post, bronze seating material, and inside screw.
 - 1) Standards: UL 262 and FMG approved.
 - 2) Minimum Pressure Rating: 175 psig.
 - 3) End Connections: Flanged or mechanical joint as required.
- b. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2. OS&Y, Rising-Stem Gate Valves:

- a. Description: Iron body and bonnet and bronze seating material.
 - 1) Standards: UL 262 and FMG approved.
 - 2) Minimum Pressure Rating: 175 psig.
 - 3) End Connections: Flanged.

2.7 VALVE ACCESSORIES (NPS 3 AND LARGER)

A. Valve Boxes:

1. Material: Cast or ductile-iron, suitable for heavy traffic use and conforming to ASTM A-48, Class 20.
 - a. Available Manufacturers: Subject to compliance with these requirements and the standards of operating utility, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) East Jordan Iron Works
 - 2) Tyler Pipe
 - 3) Bingham and Taylor.
 - b. Model: as required by the operating utility.
 - c. Elevation Adjustment: as required by operating utility.
 - d. Inside Shaft Diameter: 5-1/4 inches.
 - e. Coating: Asphaltic, not less than 1 mil thick.
 - f. Cover: Heavy cast iron with the word WATER cast in raised letters.
 - g. Base: Enlarged to enclose and protect valve operating nut without actually being in contact with pipe or valve.

B. Valve Box Protection Rings:

1. Material: Reinforced, precast 3,000 psi concrete.

- a. Inside diameter: 9-1/4 inches.
- b. Outside Diameter: 27 inches.
- c. Thickness: 5 inches at inner diameter with top tapering to 2 inches at outer diameter.
- d. Reinforcing: Two #3 rebar, one at 21 inch diameter and one at 24 inch diameter.
- e. Min. Weight: 110 lbs.

2.8 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

1. Available Manufacturers: Subject to compliance with these requirements and the standards of authorities having jurisdiction, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. American AVK Co.; Valves & Fittings Div.
 - b. American Cast Iron Pipe Co.; American Flow Control Div.
 - c. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
 - d. American Foundry Group, Inc.
 - e. East Jordan Iron Works, Inc.
 - f. McWane, Inc.; Clow Valve Co. Div. (Oskaloosa).
 - g. McWane, Inc.; Kennedy Valve Div.
 - h. McWane, Inc.; M & H Valve Company Div.
 - i. Mueller Co.; Water Products Div.
 - j. Troy Valve; a division of Penn-Troy Manufacturing, Inc.
 - k. U.S. Pipe and Foundry Company.

2. Description: Freestanding, with one NPS 4-1/2 and two NPS 2-1/2 outlets, 5-1/4-inch main valve, drain valve, and NPS 6 mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
 - a. Standard: AWWA C502.
 - b. Pressure Rating: 150 psig minimum.
 - c. Outlet Threads: NFPA 1963, with external hose thread used by local fire department. Include cast-iron caps with steel chains.
 - d. Operating and Cap Nuts: Pentagon, 1-1/2 inches point to flat.
 - e. Direction of Opening: as required by authorities having jurisdiction.
 - f. Exterior Finish: Paint type and colors as required by authorities having jurisdiction.

2.9 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:

1. Available Manufacturers: Subject to compliance with these requirements and the standards of authorities having jurisdiction, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Elkhart Brass Mfg. Co., Inc.
 - b. Fire End & Croker Corporation.
 - c. Guardian Fire Equipment, Inc.
 - d. Kidde Fire Fighting.
 - e. Potter Roemer.

- f. Reliable Automatic Sprinkler Co., Inc.
2. Description: Freestanding, with cast-bronze body, thread inlets according to NFPA 1963 and matching local fire department hose threads, and threaded bottom outlet. Include lugged caps, gaskets, and chains; lugged swivel connection and drop clapper for each hose-connection inlet; 18-inch-high brass sleeve; and round escutcheon plate.
 - a. Standard: UL 405.
 - b. Connections: As required by local fire department.
 - c. Inlet Alignment: As required by local fire department.
 - d. Finish Including Sleeve: Polished bronze.
 - e. Escutcheon Plate Marking: "FDC"

2.10 WATER METERS

- A. See paragraph 1.2.C above regarding water meters.

2.11 BACKFLOW PREVENTERS

- A. Double-Check, Backflow-Prevention Assemblies:

1. Available Manufacturers: Subject to compliance with these requirements and the standards of authorities having jurisdiction, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Ames Fire & Waterworks; a division of Watts Regulator Co.
 - b. Conbraco Industries, Inc.
 - c. FEBCO; SPX Valves & Controls.
 - d. Flomatic Corporation.
 - e. Watts Water Technologies, Inc.
 - f. Zurn Plumbing Products Group; Wilkins Water Control Products Div.
2. Standards: AWWA C510 and any other requirements of authorities having jurisdiction.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.
5. Size: as indicated on Drawings.
6. Body: Cast iron with interior lining complying with AWWA C550.
7. End Connections: Flanged.
8. Configuration: Designed for horizontal, straight through flow.

2.12 CONCRETE VAULTS

- A. Description: Precast, reinforced-concrete vault, designed for A-16 load designation according to ASTM C 857 and made according to ASTM C 858.
 1. Access Hatch: of type and configuration required by operating utility.
 - a. Size: Sufficient to allow easy removal of equipment housed by vault.
 - b. Material: Aluminum.
 - c. Load Rating:

- 1) 300 psf for hatches not subjected to traffic.
 - 2) AASHTO H-20 for hatches in traffic areas.
- d. Available Manufacturers: Subject to compliance with these requirements and the standards of operating utility, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- 1) Bilco Co.
 - 2) US Foundry, Inc.
 - 3) Halliday Products, Inc.
2. Drain: ASME A112.6.3, cast-iron floor drain with outlet of size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

2.13 SERVICE CONNECTIONS (NPS 2 AND SMALLER)

- A. Polyethylene (PE) Tubing: AWWA C901, material type PE-3408/3608.
1. Copper tubing size (CTS), rated for min. working pressure of 160 psi.
 2. Marking: Clearly mark each joint of pipe at convenient intervals, as follows:
 - a. Manufacturer's name.
 - b. Nominal pipe size.
 - c. Material type.
 - d. Pressure rating.
 - e. National Sanitation Foundation (NSF) seal.
- B. Tapping Saddles and Sleeves: in accordance with standards of operating utility.
- C. Corporation Stops: in accordance with standards of operating utility.
- D. Curb Stops: in accordance with standards of operating utility.
- E. Meter Boxes: in accordance with standards of operating utility.
- F. Water Meters: see paragraph 1.2.C regarding water meters.
- G. Miscellaneous Fittings: in accordance with standards of operating utility.

2.14 CORROSION-PROTECTION PIPING ENCASEMENT

- A. Encasement for Underground Metal Pipe, Fittings and Appurtenances:
1. Standards: ASTM A 674 or AWWA C105.
 2. Form: Tube.
 3. Material: LLDPE film of 0.008-inch minimum thickness.
 4. Color: Blue.

2.15 PIPE DETECTION MATERIALS

- A. Detectable Warning Tape: specified in Section titled “Earth Moving”.
- B. Locator Wire In addition to warning tape where required by operating utility. Specified in Section titled “Earth Moving”.

2.16 PROTECTIVE ENCLOSURES

A. Weather-Resistant Enclosures:

- 1. Available Manufacturers: Subject to compliance with these requirements, the standards of authorities having jurisdiction, and approval by the Architect, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. DekoRRa Products.
 - b. G&C Enclosures.
 - c. Hot Box, Inc.
 - d. HydroCowl, Inc.
 - e. Watts Water Technologies, Inc.
- 2. Description: Uninsulated enclosure designed to protect aboveground water piping, equipment, or specialties from weather and damage.
 - a. Standard: ASSE 1060.
 - b. Class II: For pressure or atmospheric vacuum breaker equipment or devices. Include drain opening in housing.
 - 1) Housing: Reinforced aluminum or fiberglass construction.
 - a) Size: Of dimensions indicated, but not less than those required for access and service of protected unit.
 - b) Drain opening for units with drain connection.
 - c) Access doors with locking devices.
 - d) Insulation inside housing.
 - e) Anchoring devices for attaching housing to concrete base.

B. Enclosure Bases:

- 1. Description: 4 inch minimum thickness precast concrete, of dimensions required to extend at least 6 inches beyond edges of enclosure housings. Include openings for piping.

PART 3 - EXECUTION

3.1 STANDARDS OF OPERATING UTILITY

- A. See paragraph 1.2.B above for information regarding execution standards of the operating utility.

3.2 EARTHWORK

- A. Refer to Section titled "Earth Moving" for excavating, trenching, and backfilling.
- B. Refer to Section titled "Earth Moving" for installation requirements of pipe detection materials.

3.3 PIPING APPLICATIONS

- A. General: Use pipe, fittings, and joining methods for piping systems according to the following applications.
 - 1. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
 - 2. Do not use flanges or unions for underground piping.
 - 3. Flanges, unions, and special fittings may be used, instead of joints indicated, on aboveground piping and piping in vaults.
 - 4. Restrained joints shall be provided where required by the operating utility and where indicated on Drawings.
 - 5. Underground Water Main Piping NPS 3 and larger shall be the following, subject to approval by the operating utility and as indicated on the Drawings:
 - a. Ductile-iron, push-on-joint pipe with ductile-iron, mechanical-joint fittings and gasketed joints.
 - b. PVC, push-on-joint pipe with ductile-iron, mechanical-joint fittings and gasketed joints.
- B. Above Ground and Vault Water Main Piping NPS 3 and larger shall be ductile-iron, mechanical or flanged joint pipe and ductile-iron-pipe appurtenances; and gasketed, restrained joints.
- C. Underground Water-Service Piping NPS 3/4 to NPS 2 shall be the following, subject to approval by the operating utility:
 - 1. PE tubing with molded PE compression band fittings and heat-fusion joints.

3.4 VALVE APPLICATIONS

- A. General Application: Use mechanical-joint-end valves for NPS 3 and larger underground installation. Use flanged-end valves for installation above ground or in vaults. Use UL/FMG, nonrising-stem gate valves for installation with indicator posts. Use corporation stops and curb stops with ends compatible with piping, for NPS 2 and smaller installation.
- B. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 - 1. Underground Valves for Water Mains: NPS 3 and Larger: AWWA, cast-iron, nonrising-stem, resilient-seated gate valves with valve box.
 - 2. Underground Valves for Fire Protection Lines: NPS 3 and Larger, for Indicator Posts: UL/FMG, cast-iron, nonrising-stem gate valves with indicator post.
 - 3. Use the following for valves in vaults and above ground:
 - a. Gate Valves for Water Mains: NPS 3 and Larger: AWWA, cast iron, OS&Y rising stem, resilient seated.
 - b. Gate Valves for Fire Protection Lines: NPS 3 and Larger: UL/FMG, cast iron, OS&Y rising stem.

3.5 PIPING INSTALLATION

- A. Water-Main Connection: Install new tee in water main according to requirements of water utility company and of size and in location indicated.
- B. Install ductile-iron pipe according to AWWA C600, AWWA M41 and the standards of the operating utility.
 - 1. Install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- C. Install PVC, AWWA pipe according to ASTM F 645, AWWA M23 and the standards of the operating utility.
- D. Install PE tubing according to ASTM D 2774, ASTM F 645 and the standards of the operating utility.
- E. Install fire-service-main piping according to NFPA 24 and standards of authorities having jurisdiction
 - 1. For DIP, install PE corrosion-protection encasement according to ASTM A 674 or AWWA C105.
- F. Bury piping with depth of cover over top at least 36 inches, with top at least 12 inches below level of maximum frost penetration, and according to the following:
 - 1. Under Driveways and Streets: With at least 36 inches cover over top.
 - 2. Under Railroad Tracks: With at least 48 inches cover over top.
 - 3. In Loose Gravelly Soil and Rock: With at least 12 inches additional cover.
- G. Install piping by tunneling or jacking, or combination of both, under streets and other obstructions that cannot be disturbed.
- H. Install underground piping with restrained joints at horizontal and vertical changes in direction, at locations indicated on Drawings and where required by the operating utility. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports as accepted by the operating utility.

3.6 JOINT CONSTRUCTION

- A. Make pipe joints according to the following (as applicable):
 - 1. Ductile-Iron Piping, Gasketed Joints for Water Main Piping : AWWA C600, AWWA C111 AWWA M41 and standards of the operating utility.
 - 2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194 and standards of authorities having jurisdiction.
 - 3. PVC Piping Gasketed Joints: Use joining materials according to AWWA C900. Construct joints with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139, pipe manufacturer's written instructions and standards of the operating utility.
 - 4. PE Tubing, Pressure-Sealed Joints: Use brass fittings and fasteners according to fitting manufacturer's written instructions.
 - 5. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with correct OD, and with system working pressure at least equal to pipe. Install according to fitting manufacturer's written instructions

3.7 ANCHORAGE INSTALLATION

- A. Anchorage, General: Install water system piping with restrained joints at horizontal and vertical changes in direction, at locations indicated on Drawings, and where required by the operating utility. Subject to acceptance by the operating utility, anchorages and restrained-joint types that may be used include the following:
 - 1. Concrete thrust blocks.
 - 2. Set-screw mechanical retainer glands.
 - 3. Bolted flanged joints.
 - 4. Heat-fused joints.
 - 5. Pipe clamps and tie rods.
- B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
 - 1. Gasketed-Joint, Ductile-Iron, Water- Piping: According to AWWA C600 and the standards of the operating utility.
 - 2. Gasketed-Joint, PVC Water- Piping: According to AWWA M23 and the standards of the operating utility.
 - 3. Fire-Service-Main Piping: According to NFPA 24 and the standards of jurisdictions having authority.
- C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.8 VALVE INSTALLATION

- A. AWWA Gate Valves: Comply with AWWA C600, AWWA M44 and standards of the operating utility. Install each underground valve with stem pointing up and with valve box.
- B. AWWA Valves Other Than Gate Valves: Comply with AWWA C600, AWWA M44 and standards of the operating utility.
- C. UL/FMG, Gate Valves: Comply with NFPA 24 and standards of authorities having jurisdiction. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.
- D. UL/FMG, Valves Other Than Gate Valves: Comply with NFPA 24 and standards of the authorities having jurisdiction.
- E. Corporation and Curb Stops: Install according to the manufacturer's written instructions and to the standards of the operating utility with head pointed up and with service box.

3.9 FIRE HYDRANT INSTALLATION

- A. General: Install each fire hydrant with separate and adjoining gate valve in supply pipe, anchor with restrained joints or thrust blocks to standards of operating utility, and support in upright position.
- B. AWWA Fire Hydrants: Comply with AWWA M17, standards of operating utility, and standards of authorities having jurisdiction.

3.10 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Install in accordance with manufacturer's written instructions and standards of operating utility.
- B. Install straight and plumb and positioned such that the drain port is located below frost line.
- C. Install ball drip valves at each check valve for fire department connection to mains.
- D. Install protective pipe bollards on two sides of each fire department connection.

3.11 ROUGHING-IN FOR WATER METERS

- A. Rough-in piping and specialties, according to standards of the operating utility, ready to receive water meter installation by utility.

3.12 WATER METER BOX INSTALLATION

- A. Install meter boxes according to the manufacturer's written instructions and the standards of the operating utility.
- B. Install water meter boxes in paved areas flush with surface.
- C. Install water meter boxes in grass or earth areas with top 2 inches above surface.

3.13 BACKFLOW PREVENTER INSTALLATION

- A. Install backflow preventers of type, size, and capacity indicated. Include valves and test cocks. Install according to requirements of plumbing health department and authorities having jurisdiction.
- B. Do not install backflow preventers that have relief drain in vault, or in other spaces subject to flooding, without adequate provisions for drainage.
- C. Do not install bypass piping around backflow preventers.
- D. Support NPS 2-1/2 and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.14 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults according to ASTM C 891, the standards of the operating utility, and the standards of the authorities have jurisdiction.
- B. Install access hatch according to the manufacturer's written instructions, the standards of the operating utility, and the standards of the authorities have jurisdiction.

3.15 PROTECTIVE ENCLOSURE INSTALLATION

- A. Install protective enclosures according to the manufacturer's written instructions and the standards of the operating utility.

- B. Install concrete base level and with top approximately 2 inches above grade.
- C. Install protective enclosure over valves and equipment.
- D. Anchor protective enclosure to concrete base.

3.16 SERVICE CONNECTION INSTALLATION

- A. Extend water-service piping and connect to water meter and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

3.17 PIPE DETECTION MATERIALS INSTALLATION

- A. Install continuous underground detectable warning tape and locator wire, where required by operating utility, during backfilling of trench for underground water-distribution piping. Locate below finished grade, directly over piping and according to standards of operating utility. Pipe detection materials are specified in Section titled "Earth Moving."

3.18 FIELD QUALITY CONTROL

- A. Hydrostatic Test: Conduct test according to AWWA C 600 or C 605, as applicable, and the standards of the authorities having jurisdiction.
 - 1. Pre-testing: The Contractor shall conduct his on pre-tests and confirm that the system is capable of passing prior to requesting the Architect's presence to witness the test.
 - a. Conduct pre-tests only after all installation is complete including joint restraint. Concrete thrust blocks shall have been in place long enough to have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.
 - b. Leaks shall be immediately repaired and the test shall be repeated until acceptable results are obtained.
 - c. The Contractor shall notify the Architect at least 48 hours before the scheduled time of the official test. Passing test performed without the Architect present will be rejected. The Contractor will be required to retest, with the Architect present, without additional compensation.
 - 2. Test Procedures: The line shall be slowly filled with water and all air expelled through air valves or other means. A suitable test pump, water meter and potable water source, furnished by the Contractor, shall be connected to the line by means of a tap (or other suitable means) in the line and the proper test pressure slowly applied to the line. The test pressure shall be maintained for at least two hours.
 - a. Test at not less than 150 psi or one-and-one-half times working pressure, whichever is larger, for two hours. If pressure falls more than 5 psi during the test, the pump shall be reactivated and the pressure restored to the starting pressure as often as necessary. At the

end of two hours, the pressure shall be restored to the starting pressure a final time and the total quantity of water used (leakage) to maintain the pressure for two hours shall be read.

- b. Open and close each valve within the system several times during the test period.
- c. Service connections, if present, shall be subjected to the hydrostatic test concurrently with the main lines.

3. Allowable Leakage: Allowable leakage shall be determined by the following formula:

- a. $L = 0.000007SD\sqrt{P}$
- b. Where:
- c. L = allowable leakage in gallons per hour.
- d. S = the total length of the pipe tested in feet.
- e. D = the nominal diameter of the pipe in inches.
- f. P = the average test pressure in psi gauge.

B. Preliminary Inspection: Make arrangements with Architect to conduct preliminary final inspection.

1. Pre-inspection: The Contractor shall conduct his own pre-inspection and confirm that the system is capable of passing prior to requesting the Architect's presence to witness the preliminary inspection.

- a. Repair or remove and replace components where test results or pre-inspections indicate that they do not comply with specified requirements.

2. Preliminary Inspection: The Contractor shall notify the Architect at least 48 hours before the scheduled time of the preliminary inspection.

- a. Preliminary inspection shall include but shall not necessarily be limited to the following (as applicable):

- 1) A visual inspection of fire hydrants: Requirements include: verification that hydrant is plumb and at correct elevation, verification that caps are in place and operational, verification that hydrant is operational and that no apparent leakage exists, verification that gate valve is in place and operational, verification that hydrant finish is adequate, verification that hydrant location is correct.
- 2) A visual inspection of valves: Requirements include: verification that valves are operational, verification that valve boxes are centered, plumb, at correct elevation, and properly backfilled, verification that valve indicates that water line is at adequate depth, verification that valve location is correct, verification that valve protection rings are properly installed, and verification that any valve appurtenances are properly installed and functioning.
- 3) A visual inspection of connections to existing water system: Requirements include: verification of adequacy of connection work, verification that leakage does not exist, verification that connection valve is off, verification that safeguards are in place to prevent contamination of existing system by backflow from the new system.
- 4) A visual inspection of water meters, backflow preventers and other appurtenances to confirm proper installation.

- b. Repair or remove and replace components where test results or preliminary final inspections indicate that they do not comply with specified requirements.
- c. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- C. Final Inspection: Upon successful completion of the preliminary inspection and after any required documentation has been received and approved by the authorities having jurisdiction, the Contractor, Architect, representatives of the authorities having jurisdiction shall conduct a final inspection of the system.
 - a. The Contractor shall notify the Architect at least 48 hours before the desired time of the pre-inspection. The Architect shall endeavor to schedule attendance by representatives of the authorities having jurisdiction at the desired time; however, the Architect provides no guarantee of availability at that time. If unavailable, the Architect will schedule the representative at the soonest reasonable time. Final inspections will not be held without the attendance of both the Architect and a representative of the authorities having jurisdiction.
 - b. Final inspection shall include but shall not necessarily be limited to the items listed for the pre-inspection.
 - c. Repair or remove and replace components where test results or final inspections indicate that they do not comply with specified requirements.
 - d. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

- D. Reports of Inspection Activities.
 - 1. Where required, the Architect will provide final required documentation to authorities having jurisdiction for the purpose of obtaining a Permit to Operate. Promptly provide any documents required from Contractor. Once Permit to Operate is received, Architect will notify Contractor. Make final connections, when necessary, and place system in operation. Do NOT place system in operation before notification by Architect that Permit to Operate has been received.

3.19 DISINFECTION AND BACTERIOLOGICAL TESTING

- A. Clean and disinfect water-distribution piping as follows:
 - 1. Purge and disinfect according to AWWA C 651 and standards of authorities having jurisdiction.
 - a. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
 - 1) Provide adequate openings to ensure that required flushing velocities are met.
 - 2) Where applicable, provide protective measures as required to ensure that flushing waters do not damage property or cause erosion or flooding.
 - b. Fill lines to be disinfected with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for at least 24 hours.
 - c. At end of retention time, perform concentration testing of solution at the extreme end of the lines to be disinfected. Solution shall contain not less than 25 ppm of chlorine. If residual chlorine is less than 25 ppm, repeat procedure.
 - d. Once an acceptable residual chlorine count is obtained, flush system with clean, potable water until no chlorine remains in water coming from the system.

- B. Bacteriological Testing:
 - 1. Perform bacteriological testing according to AWWA C 651 and the standards of the authorities having jurisdiction.

- a. Using methods acceptable to the Architect and authorities having jurisdiction, take two successive samples, at each dead-end line and at points deemed representative of the water in the newly constructed mains, at a period of at least 24 hours apart.
 - 1) A test for residual chlorine content must be performed within 15 minutes of the time that the sample is drawn. Residual chlorine must be below the level required by AWWA C 651 and the authorities having jurisdiction.
- b. Perform tests, at an independent laboratory certified by the authorities having jurisdiction, for coliform growth, non-coliform growth and residual chlorine.
- c. Should the test values exceed the maximum acceptable values permitted by the authorities having jurisdiction, repeat disinfection, flushing and testing until acceptable values are obtained (with the exception of residual chlorine, in which case the samples are considered invalid and system must be only be flushed and retested).
- d. Prepare reports of purging, disinfecting, and testing activities, including water sample chain of custody and copies of passing bacteriological tests, and provide to Architect.
 - 1) No more than 30 days can have passed between the time that the first passing sample is drawn and the time the corresponding bacteriological test results are submitted, along with all other required water system closeout documents, to the authorities having jurisdiction.
- e. After passing samples are obtained, make arrangements for follow-up samples to be taken by the authorities having jurisdiction.
- f. As before, should the test values of the follow-up samples exceed maximum acceptable values, repeat disinfection, flushing and testing until acceptable values are obtained.

END OF SECTION 331100

SECTION 333100 – GRAVITY FLOW SANITARY SEWERAGE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes gravity sanitary sewer piping and related components outside the building.
- B. The Section includes general requirements that will apply to all gravity sanitary sewerage systems. In addition, the operating utility (the authority having jurisdiction) has numerous specific requirements for materials and execution that are too varied to cover in this specification.
 1. For this Project, the operating utility is Mt. Pleasant Waterworks.
 2. Materials and execution requirements that are not covered in this Section shall comply with the requirements of the operating utility.
 3. Materials and execution requirements that are covered, but are in conflict with the requirements of the operating utility, shall comply with the higher quality or more restrictive requirement.
- C. Tap and Impact Fees will be paid directly to the utility by the Owner and payment of said fees shall not be included in the Contractor's scope of services.

1.3 DEFINITIONS

- A. LLDPE: Linear, low-density polyethylene plastic.
- B. NPS: Nominal pipe size.
- C. PP: Polypropylene plastic.
- D. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
 1. Polyvinyl chloride pipe.
 2. Wyes, elbows, reducers and similar fittings.
 3. Precast concrete manholes, frame and covers, and related components.
 4. Cleanout caps and covers.
 5. Nonpressure-type pipe couplings.
- B. Field quality-control test reports.

- C. Record Drawings: Include the following, as required by authorities having jurisdiction, for use by Owner's surveyor in preparing record drawings:
 - 1. Designation, size and length of sewer lines between manholes or cleanouts.
 - 2. Location and depth below finished grade of service connections to sewer main.
 - 3. Location and elevation of any other below ground appurtenances.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with requirements of the authorities having jurisdiction.
 - 2. Comply with standards of operating utility for sanitary sewer-service piping, including materials, installation, and testing.
- B. Preinstallation Conference: Conduct conference to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Review methods and procedures related to sanitary sewerage installation including, but not limited to, the following:
 - a. Review requirements of the operating utility.
 - b. Review site conditions and preparatory work.
 - c. Review requirements for protecting work.
 - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - e. Review inspection schedule and procedures required to monitor and document quality assurance.
- C. Piping materials shall bear label, stamp, or other markings of specified testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic materials in direct sunlight. Support to prevent sagging and bending.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes and precast concrete structures, according to manufacturer's written rigging instructions.

1.7 PROJECT CONDITIONS

- A. Interruption of Existing Sanitary Sewer Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sanitary sewer service according to requirements indicated:
 - 1. Notify Architect, Owner, and Utility having jurisdiction no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of water-distribution service without Architect's written permission.

1.8 COORDINATION

- A. Where required, coordinate connection to existing sewer lines with operating utility.

PART 2 - PRODUCTS

2.1 STANDARDS OF OPERATING UTILITY

- A. See paragraph 1.2.B above for information regarding materials standards of the operating utility.

2.2 POLYVINYL CHLORIDE PLASTIC PIPE AND FITTINGS (PVC)

- A. PVC Sewer Pipe (ASTM): ASTM D 3034, Class 150, with bell end with gasket, and with spigot end.
 - 1. Gaskets: ASTM F 477, rubber. Use lubricants approved by the manufacturer.
 - 2. Fittings: ASTM D 3034. Use of saddle type fittings is prohibited.
 - 3. Joints: ASTM D 3212.
 - 4. Laying length: 18 feet-0 inches to 20 feet-0 inches
 - 5. Pipe size: comply with outside diameter dimensions of DIP.
 - 6. Standard dimension ratio: SDR 26, unless otherwise indicated on Drawings. SDR 21 where indicated for greater depth and crossings of other utilities (AWWA C900 or DIP may alternately be indicated for these applications).
 - 7. Pipe color: green.
 - 8. The use of solvent weld joints is prohibited.
 - 9. Marking: Clearly mark each joint of pipe at convenient intervals, as follows:
 - a. Manufacturer's name.
 - b. Nominal pipe size.
 - c. Pressure class.
 - d. Material designation.
 - e. National Sanitation Foundation (NSF) seal.

2.3 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 1. Diameter: 48 inches minimum or as required to accommodate pipe size, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
 - 3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
 - 4. Inverts (channels and benches): See "Concrete" article below.
 - 5. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
 - 6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
 - 7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 - 8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.

9. Steps: Individual ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12 to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
10. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
11. Manhole Frames and Covers: Ferrous; 24 inch ID by 7 to 9 inch riser with 4 inch minimum width flange and 26 inch diameter cover. Include indented top design with lettering cast into cover, using wording or design required by agency having authority. Where no specific wording or design is required by agency, wording equivalent to "SANITARY SEWER" shall be cast.
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise

2.4 FIELD INSTALLED PIPE TO MANHOLE CONNECTORS

- A. Resilient Pipe Connectors: ASTM C 923, design specifically for field installation, for each pipe connection.

2.5 CLEANOUTS

- A. PVC Cleanouts: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser to cleanout of same material as sewer piping.
 1. Manufacturers:
 - a. Canplas Inc.
 - b. IPS Corporation.
 - c. NDS Inc.
 - d. Plastic Oddities, Inc.
 - e. Sioux Chief Manufacturing Company, Inc.
 - f. Zurn Industries, Inc.; Zurn Light Commercial Specialty Plumbing Products.
- B. Frame and Cover: Traffic grade cast-iron according to the standards of the authorities having jurisdiction, as indicated or, where not indicated, in accordance with the following:
 1. Use medium-duty, top-loading classification cleanouts in landscaped and foot-traffic areas.
 2. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.
 3. Use extra-heavy-duty, top-loading classification cleanouts in roads areas.
- C. Concrete Collar: Where not located as a casting embedded in pavement, provide cast-in-place concrete collar as indicated on Drawings or, where not indicated 18 by 18 by 12 inches deep.

2.6 NONPRESSURE-TYPE PIPE COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and stainless steel tension band and tightening mechanism on each end.
- B. Sleeve Materials:

1. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Unshielded Flexible Couplings: Elastomeric sleeve with stainless steel shear ring and stainless steel-metal tension band and tightening mechanism on each end.
1. Manufacturers:
 - a. Dallas Specialty & Mfg. Co.
 - b. Fernco Inc.
 - c. Logan Clay Products Company (The).
 - d. Mission Rubber Company; a division of MCP Industries, Inc.
 - e. NDS Inc.
 - f. Plastic Oddities, Inc.
- D. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.
1. Manufacturers:
 - a. Fernco Inc.
 - b. Logan Clay Products Company (The).
 - c. Mission Rubber Company; a division of MCP Industries, Inc.

2.7 CONCRETE

- A. General: Class 3000 concrete in accordance with Section 701 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
- B. Portland Cement Design Mix: 3000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Manhole Channels and Benches: Field formed from concrete.
1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
 - a. Invert Slope: Minimum of 1 percent or as required to provide uniform slope between invert elevations indicated on Drawings.
 2. Benches: Concrete, sloped to drain into channel.
 - a. Slope: 8 percent.
- D. Ballast and Pipe Supports: Field formed from concrete.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.8 PIPE DETECTION MATERIALS

- A. Detectable Warning Tape: specified in Section titled "Earth Moving".
- B. Locator Wire In addition to warning tape where required by operating utility. Specified in Section titled "Earth Moving".

PART 3 - EXECUTION

3.1 STANDARDS OF OPERATING UTILITY

- A. See paragraph 1.2.B above for information regarding execution standards of the operating utility.

3.2 EARTHWORK

- A. Refer to Section titled "Earth Moving" for excavating, trenching, and backfilling.
- B. Refer to Section titled "Earth Moving" for installation requirements of pipe detection materials.

3.3 PIPING APPLICATIONS

- A. Flexible pipe couplings may be used in applications below, unless otherwise indicated.
 - 1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping of different material type or size, unless otherwise indicated. No other use of flexible couplings will be permitted.
 - a. Unshielded flexible couplings for same or minor difference OD pipes.
 - b. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.
 - c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
- B. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials as indicated on the Drawings.
 - 1. PVC sewer pipe and fittings, gaskets, and gasketed joints.

3.4 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, and other installation requirements.

- C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for service branch connections, unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or combination of both.
- F. Install gravity-flow, nonpressure, sanitary sewerage piping according to the following:
 - 1. Install piping pitched down in direction of flow, at the slope indicated or, where not indicated, at a minimum slope of 1/2 percent.
 - 2. Install piping with 36-inch minimum cover unless otherwise indicated.
 - 3. Install PVC sewer piping according to ASTM D 2321, ASTM F 1668 and the standards of the operating utility.
- G. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.5 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure, sanitary sewerage piping according to the following:
 - 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints and the standards of the operating utility.
 - 2. Join dissimilar pipe materials with nonpressure-type, flexible couplings in accordance with manufacturer's written instructions.

3.6 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. For manholes that occur in pavements, set tops of frames and covers flush with finished surface. Set tops 2 inches above finished surface elsewhere, unless otherwise indicated.

3.7 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to Sections 701, and 702 of the South Carolina Department of Transportation Standard Specifications for Highway Construction for measuring, mixing, transporting, and placing concrete.

3.8 CLEANOUT INSTALLATION

- A. Install cleanouts and riser extension from sewer pipe to cleanout at grade. Use pipe fittings of same material as pipe at branches for cleanouts and PVC pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
- B. Install cast-iron frames and covers.
 - 1. Use medium-duty, top-loading classification cleanouts in landscaped and foot-traffic areas.
 - 2. Use heavy-duty, top-loading classification cleanouts in vehicle-traffic service areas.
 - 3. Use extra-heavy-duty, top-loading classification cleanouts in roads areas.
 - 4. Set cleanout frames and covers located in earthen areas in cast-in-place concrete collar, 18 by 18 by 12 inches deep. Set with tops 1 inch above surrounding earth grade
 - 5. Set cleanout frames and covers in pavement with tops flush with pavement surface.

3.9 SERVICE CONNECTION INSTALLATION

- A. Extend sanitary sewer-service piping and connect to building sanitary sewer system at outside face of building wall in locations and pipe sizes indicated.
 - 1. Terminate sanitary sewer service piping at building wall until building sanitary sewer piping is installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building sanitary sewer piping systems when those systems are installed.

3.10 CONNECTIONS TO EXISTING SANITARY SEWER

- A. Where required by operating utility, connections to existing piping or manholes shall be made in the presence of an authorized inspector. Notify the Architect at least 48 hours before starting a connection.
- B. Where indicated, construct new manhole over existing gravity main by cutting upper half of existing pipe after base of manhole is completed so as not to obstruct flow of the existing pipe.
- C. Where indicated, make connections to existing piping using commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe; install wye fitting into existing piping; and encase entire wye fitting, plus 6-inch overlap, with not less than 6 inches of concrete.
- D. Where indicated, make connections to existing underground manholes as follows:
 - 1. Core drill opening into existing manhole large enough to allow installation of resilient manhole connector.
 - 2. Install resilient manhole connector in manhole opening accordance with manufacturer's written instructions.
 - 3. Install pipe in resilient connector in accordance with manufacturer's written instructions.
 - 4. Cut end of connection pipe passing through manhole wall to be flush with inside wall, unless otherwise indicated.
 - 5. On outside of manhole wall, encase entering connection and pipe in 6 inches of concrete for minimum length of 12 inches to provide additional support of connector from connection to undisturbed ground.
 - 6. On inside of manhole wall, encase outside of pipe to flush with face of wall with grout. Form smooth invert channel transition to existing invert or complete installation of internal drop piping as applicable.

7. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
- E. Protect piping and manholes to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.

3.11 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed:
 1. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
 1. Remove manhole and close open ends of remaining piping.
 2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section titled "Earth Moving."

3.12 PIPE DETECTION MATERIALS INSTALLATION

- A. Install continuous underground detectable warning tape and locator wire, where required by operating utility, during backfilling of trench for underground sanitary sewerage piping. Locate below finished grade, directly over piping and according to standards of operating utility. Pipe detection materials are specified in Section titled "Earth Moving."

3.13 FIELD QUALITY CONTROL

- A. During Installation: Inspect interior of piping, to determine whether line displacement or other damage has occurred, continuously during installation. Inspect after approximately 24 inches of backfill is in place, and again at completion of each section of piping between manholes.
 1. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping or manholes.
 - d. Infiltration: Water leakage into piping or manholes.
 - e. Exfiltration: Water leakage from or around piping.
 2. Replace defective piping and manholes using new materials, and repeat inspections until defects are within allowances specified.
- B. Testing: The Contractor shall notify the Architect at least 48 hours before the scheduled time of the official tests. Passing test performed without the Architect present will be rejected. The Contractor will be required to retest, with the Architect present, without additional compensation

1. Pipe deflection test: Each section of piping will be tested for internal diametric deflection by the use of a 5% mandrel.
 - a. The mandrel pull shall be performed according to the "Recommended Standards for Wastewater Facilities" by the Great Lakes - Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers (Ten State Standards)" and the standards of the operating utility.
 - b. The Contractor shall not use any mechanical device for the mandrel pull.
 - c. Deflections of greater than 5% shall be corrected.

2. Low Pressure Air Tests: Test gravity sewer piping according to UNI-B-6, and the standards of operating utility.
 - a. Prior to performing test, system shall be backfilled to final grade and a waiting period, specified by the operating utility, shall have passed.
 - b. All service connections shall be in place prior to testing.
 - c. Leaks and loss in test pressure constitute defects that must be repaired.
 - d. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

- C. Preliminary Inspection: Make arrangements with Architect to conduct preliminary final inspection.
 1. Pre-inspection: The Contractor shall conduct his own pre-inspection and confirm that the system is capable of passing prior to requesting the Architect's presence to witness the preliminary inspection.
 - a. Repair or remove and replace components where test results or pre-inspections indicate that they do not comply with specified requirements.
 - b. Remove all sand, dirt, brick, excess grout, and other foreign matter from manholes and piping. Material shall not be flushed into existing sewer lines

 2. Preliminary Inspection: The Contractor shall notify the Architect at least 48 hours before the scheduled time of the preliminary inspection.
 - a. Preliminary inspection shall include but shall not necessarily be limited to the following:
 - 1) A visual inspection of manholes. Requirements include: verification that manhole is plumb and at correct elevation; verification that frame and cover is properly installed, centered, grouted inside and out, and at proper elevation; verification that section joints are sealed watertight and properly grouted; verification that inverts and shelves are smooth, of correct slope, and properly formed; verification that steps are properly positioned, securely embedded, and undamaged; verification that drop manhole piping is properly installed and secure; verification that pipe openings are watertight, properly located, and properly grouted; verification that interior of manhole has been cleaned of dirt and construction debris and verification that grades in the vicinity of the manhole are properly established and well drained.
 - 2) A visual inspection of piping. Requirements include: verification that piping is clean and unobstructed; verification that piping is straight and not visually deflected from a circular cross-section (i.e.: full moon when flashed or lamped); verification that no infiltration or exfiltration is visually evident.
 - 3) Verification of proper elevations, slopes, and horizontal and vertical alignment (under no circumstances will a line be accepted which is below the minimum slope required by the authorities having jurisdiction for a given line size.

- b. Repair or remove and replace components where test results or preliminary inspections indicate that they do not comply with specified requirements.
 - c. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- D. Final Inspection: Upon successful completion of the preliminary final inspection and after any required documentation has been received and approved by the authorities having jurisdiction, the Contractor, Architect, representatives of the authorities having jurisdiction shall conduct a final inspection of the system.
 - a. The Contractor shall notify the Architect at least 48 hours before the desired time of the pre-inspection. The Architect shall endeavor to schedule attendance by representatives of the authorities having jurisdiction at the desired time; however, the Architect provides no guarantee of availability at that time. If unavailable, the Architect will schedule the representative at the soonest reasonable time. Final inspections will not be held without the attendance of both the Architect and a representative of the authorities having jurisdiction.
 - b. Final inspection shall include but shall not necessarily be limited to the items listed for the pre-inspection.
 - c. Repair or remove and replace components where test results or final inspections indicate that they do not comply with specified requirements.
 - d. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- E. Video Documentation: Immediately after final approval of the completed system, complete a videotaped inspection of the completed piping system utilizing equipment made expressly for the purpose. Provide a written report, inspection logs, and a copy of the inspection videotape to the Architect.
- F. Reports of Inspection Activities.
 - 1. Where required, the Architect will provide final required documentation to authorities having jurisdiction for the purpose of obtaining a Permit to Operate. Promptly provide any documents required from Contractor. Once Permit to Operate is received, Architect will notify Contractor. Make final connections, when necessary, and place system in operation. Do NOT place system in operation before notification by Architect that Permit to Operate has been received.

END OF SECTION 333100

SECTION 334100 - STORM DRAINAGE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes gravity-flow, nonpressure storm drainage outside the building with the following components:
 - 1. Pipe culverts.
 - 2. Drainage structures.
 - 3. Channel drainage systems.
 - 4. Outlet protection.
 - 5. Stormwater oil and sediment separators.

1.3 DEFINITIONS

- A. Drainage Structures: catch basins, curb inlets, junction boxes, weir inlets, pond outlet structures.
- B. NPS: Nominal pipe size
- C. PVC: Polyvinyl chloride plastic.
- D. SRCP: Reinforced Concrete Pipe (sealant joints)
- E. GRCP: Reinforced Concrete Pipe (gasket joints)

1.4 PERFORMANCE REQUIREMENTS

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: Pipe joints shall be at least silt-tight, unless otherwise indicated.

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Channel drainage systems.
 - 2. Outlet protection
- B. Shop Drawings: Include plans, elevations, sections, details, and frames and covers for the following:
 - 1. Drainage structures.
 - 2. Stormwater oil and sediment separators

- C. Field quality-control test reports.

1.6 QUALITY ASSURANCE

- A. Authorities Having Jurisdiction: Conform to requirements of all authorities having jurisdiction.
 - 1. Where conflicts exist between the requirements of the Contract Documents and those of authorities having jurisdiction, the higher quality or more restrictive requirement shall apply.
 - a. For locations within areas of DOT jurisdiction, perform all work, testing, and inspections in accordance with applicable DOT standards and procedures.
- B. Preinstallation Conference: Conduct conference to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Review methods and procedures related to storm drainage installation including, but not limited to, the following:
 - a. Review requirements of the authorities having jurisdiction.
 - b. Review site conditions and preparatory work.
 - c. Review requirements for protecting work.
 - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - e. Review inspection schedule and procedures required to monitor and document quality assurance.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic materials in direct sunlight. Support to prevent sagging and bending.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes, drainage structures and pipe culverts according to manufacturer's written rigging instructions.

1.8 PROJECT CONDITIONS

- A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
 - 1. Notify Architect no fewer than two days in advance of proposed interruption of service.
 - 2. Do not proceed with interruption of service without Architect's written permission.

PART 2 - PRODUCTS

2.1 POLYVINYL CHLORIDE PLASTIC PIPE AND FITTINGS (PVC)

- A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 26, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.
 - 1. Finished joint system shall meet the requirements of ASTM D 3212.

2.2 CONCRETE PIPE (GRCP and SRCP)

- A. Reinforced-Concrete Sewer Pipe: ASTM C 76, with bell-and-spigot or groove and tongue ends.
 - 1. Class III, Wall B.
 - 2. Joints shall be as follows:
 - a. Where indicated as GRCP on Drawings: gasketed joints with ASTM C 443, rubber gaskets.
 - b. Where indicated as SRCP on Drawings: sealant joints with ASTM C 990, bitumen or butyl-rubber sealant.

2.3 GEOTEXTILES

- A. Pipe Joint Wrap Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
 - 1. Width: Min. 18" or sufficient to extend beyond the joint and base of pipe bell at least 6 inches on each side.
 - 2. Length: One continuous piece of sufficient length to extend around the entire pipe circumference with a 12" overlap.
 - 3. Survivability: Class 1, Type A, B, or C; SCDOT Standard Specs
 - 4. Grab Tensile Strength: 90 lbf; ASTM D 4632.
 - 5. Puncture Strength: 60 lbf; ASTM D 4833.
 - 6. Trapezoidal Tear: 40 lbf; ASTM D-4533
 - 7. Apparent Opening Size: No. 70 sieve, maximum; ASTM D 4751.
 - 8. Permittivity: 2.2 second-1, minimum; ASTM D 4491.
 - 9. UV Stability: 70 percent after 500 hours' exposure; ASTM D 4355.
 - 10. Water Flow Rate: 150 gal/min/ft²; ASTM D-4491

2.4 MANHOLES

- A. Standard Precast Concrete Manholes: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
 - 1. Diameter: 48 inches minimum or as required to accommodate pipe size, unless otherwise indicated.
 - 2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.

3. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 4-inch minimum thickness, and lengths to provide depth indicated.
5. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12 to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches.
9. Adjusting Rings: Interlocking rings with level or sloped edge in thickness and diameter matching manhole frame and cover. Include sealant recommended by ring manufacturer.
10. Flat Slab Adapters For Transition to Square Drainage Structures: Precast reinforced concrete in accordance with Section 719 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
 - a. Configuration: as indicated on South Carolina Department of Transportation Standard Drawing 719-425.
11. Manhole Frames and Covers: Ferrous; 24 inch ID by 7 to 9 inch riser with 4 inch minimum width flange and 26 inch diameter cover. Include indented top design with lettering cast into cover, using wording or design required by agency having authority. Where no specific wording or design is required by agency, wording equivalent to "STORM SEWER" shall be cast.
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise

2.5 CONCRETE

- A. General: Class 3000 concrete in accordance with Section 701 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
- B. Portland Cement Design Mix: 3000 psi minimum, with 0.45 maximum water-cementitious materials ratio.
 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.6 CONCRETE DRAINAGE STRUCTURES

- A. Drainage Structure Boxes: Precast reinforced concrete in accordance with Section 719 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
 1. Design: ASTM C 913, designed according to ASTM C 890 for A-16 (ASSHTO HS20-44), heavy-traffic, structural loading.
 2. Configuration: as indicated on South Carolina Department of Transportation Standard Drawing 719-305.
 3. Depth and Size: as indicated on Drawings.
 4. Pipe Openings: as required for pipe size and location.

- a. Must be integral to design and provided at time of original casting.
 - b. Where possible, orient structure so pipes enter through walls. Pipes may enter through corners provided a minimum of 6" wall space is provided to top and other openings.
5. Risers: Precast reinforced concrete as indicated on South Carolina Department of Transportation Standard Drawing 719-315.
 6. Steps: Individual ASTM A 615/A 615M, deformed, 1/2-inch steel reinforcing rods encased in ASTM D 4101, PP wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12 to 16-inch intervals. Omit steps if total depth from floor of box to finished grade is less than 54 inches.
 7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 8. Mortar and Grout: Comply with ASTM C 270, Type M or S.
- B. Catch Basins: Conforming to Section 719 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
1. Transitional Top Slabs (where required): At a minimum, as indicated on South Carolina Department of Transportation Standard Drawing 719-330 with additional reinforcing as required for opening.
 2. Frames and Grates: as indicated on Drawings or as required by agency having authority.
 - a. Cast Iron: conforming to AASHTO M 105, Class 35B.
 - b. Steel Tubing: conforming to ASTM A 53, Schedule 80.
 - c. All finished frames and grates shall conform to the alternate load test of AASHTO M 306.
- C. Junction Boxes: Conforming to Section 719 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
1. Top Slabs: At a minimum, as indicated on South Carolina Department of Transportation Standard Drawing 719-330 with additional reinforcing as required for opening.
 2. Frames and Covers: Ferrous; 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange and 26-inch diameter cover. Include indented top design with lettering cast into cover, using wording or design required by agency having authority. Where no specific wording or design is required by agency, wording equivalent to "STORM SEWER" shall be cast.
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise noted.
- D. Curb Inlets: Conforming with Section 719 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
1. Top Slabs and Throats: As indicated on Drawings and conforming to South Carolina Department of Transportation Standard Drawings 719-016, 719-017, and 719-018 as applicable.
 2. Throat Transitions to Curb: Cast-in-place concrete, hand formed to provide smooth transition to adjoining curb. Finish to match adjoining curb.
 3. Frames and Covers: Ferrous; 24 inch ID. Frame designed to be embedded in concrete with top flush to concrete surface. 2-1/2 inch minimum width flange and 24 inch diameter cover. Include indented top design with lettering cast into cover, using wording or design required by agency having authority. Where no specific wording or design is required by agency, wording equivalent to "STORM SEWER" shall be cast.
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise noted.

- E. Pond Outlet Structures: Conforming to Section 719 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.
1. Top Slabs (where indicated): At a minimum, as indicated on South Carolina Department of Transportation Standard Drawing 719-330 with additional reinforcing as required for opening.
 2. Frames and Covers (where indicated): Ferrous; 24 inch ID. Frame designed to be embedded in concrete with top flush to concrete surface. 2-1/2 inch minimum width flange and 24 inch diameter cover. Include indented top design with lettering cast into cover, using wording or design required by agency having authority. Where no specific wording or design is required by agency, wording equivalent to "STORM SEWER" shall be cast.
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise noted.
 3. Frames and Grates (where indicated): as indicated on Drawings or as required by agency having authority.
 - a. Cast Iron: conforming to AASHTO M 105, Class 35B.
 - b. Steel Tubing: conforming to ASTM A 53, Schedule 80.
 - c. Plastic: HDPE
 4. Fastenings: Stainless steel, as recommended by manufacturer.

2.7 PVC DRAINAGE STRUCTURES

- A. Drain Basins: NDS 12" square polypropylene catch basin.
1. Grates: Oblio 12" Heel Proof Grate by Iron Age Designs.
 - a. Cast Iron with finish as provided by manufacturer.
 2. Manufacturers:
 - a. Catch Basin: NDS, Inc.
 - b. Grate: Iron Age Designs.

2.8 PIPE INLETS AND OUTLETS

- A. Turf Reinforcement Mat: Three dimensional, woven, highly UV resistant, polypropylene geotextile specifically designed for erosion control applications on steep slope and high velocity, vegetated waterway applications. Conforming to FHWA FP-03, Section 713.18. Include manufacturer's recommended installation anchor materials.
1. Manufacturers:
 - a. Propex Geosynthetics: (Pyramat)
 - b. North American Green: (P550)
 - c. American Excelsior Co.: (Recyclex)

2.9 STORMWATER OIL AND SEDIMENT SEPARATORS

- A. Description: ASTM C 478 or ASTM C 913 as applicable. Precast, reinforced, concrete structures, with provision for sealant joints. Installed unit shall be capable of bearing an AASHTO HS 20 traffic loading.
1. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
 2. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
 3. Internal components: Shall be of by the same manufacturer and of integral design to the complete system. Shall be of durable materials and shall not require cleaning or replacement as part of routine maintenance. System shall be of a design that provides for removal of accumulated oil and sediment by a self-contained vacuum truck of the type typically used for stormwater and sanitary sewer line cleaning.
 4. Manhole Frames and Covers: Ferrous; 24 inch ID by 7 to 9 inch riser with 4 inch minimum width flange and 26 inch diameter cover. Include indented top design with lettering cast into cover, using wording or design required by agency having authority. Where no specific wording or design is required by agency, wording equivalent to "STORM SEWER" shall be cast.
 - a. Material: ASTM A 48, Class 35 gray iron, unless otherwise indicated.
 - b. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 10-mil minimum thickness applied to all surfaces, unless otherwise
 5. Performance: The device shall remove oil and sediment from stormwater to the following standards:
 - a. Free Oil: 95% of the floatable free oil.
 - b. Total Suspended Solids: 80% of the average annual total suspended solids load without scouring previously captured pollutants.
 - c. Capacity: Device shall have sufficient storage capacity to provide for annual pollutant removal without loss of filtration efficiency.
 6. Manufacturers:
 - a. First Defense by Hydro International

PART 3 - EXECUTION

3.1 SCDOT JURISDICTION

- A. For drainage pipe culverts located within areas of SCDOT jurisdiction, installation shall be in accordance with Supplementary Technical Specification SC-M-714 of the South Carolina Department of Transportation Standard Specifications for Highway Construction.

3.2 EARTHWORK

- A. Excavation, trenching, and backfilling are specified in Section titled "Earth Moving."
- B. Protect and maintain erosion and sedimentation controls, which are specified in Section titled "Site Clearing," during earthwork operations.

3.3 PIPING INSTALLATION

- A. General Locations and Arrangements: Drawing plans and details indicate location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
- C. Install manholes or drainage structures for changes in direction unless fittings are indicated. Use manholes or drainage structures for branch connections unless direct connection into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.
- F. Install gravity-flow, nonpressure drainage piping according to the following as applicable:
 - 1. Install piping pitched down in direction of flow, at minimum slope of 0.20 percent, unless otherwise indicated.
 - 2. Install piping below frost line.
 - 3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
 - 4. Install reinforced-concrete sewer piping, elliptical concrete pipe, and concrete box culverts according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

3.4 PIPE JOINT CONSTRUCTION

- A. Join gravity-flow, nonpressure drainage piping according to the following as applicable:
 - 1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
 - 2. Join reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual" for rubber-gasket, bitumen, or butyl-rubber sealant joints as applicable.
- B. Wrap pipe joints with pipe joint wrap geotextile at least 18 inches in width. For larger pipe diameters where an 18 inch width is insufficient to completely cover the pipe bell, use a width sufficient to cover and extend beyond the bell at least 6 inches.

3.5 MANHOLE INSTALLATION

- A. General: Install manholes, complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections according to ASTM C 891.
- C. For manholes that occur in pavements, set tops of frames and covers flush with finished surface. Set tops 2 inches above finished surface elsewhere, unless otherwise indicated.

3.6 CONCRETE DRAINAGE STRUCTURE INSTALLATION

- A. General: Install drainage structures, complete with appurtenances and accessories indicated.
- B. Install precast concrete drainage structure sections according to ASTM C 891.
- C. Set tops, frames, grates and covers to elevations indicated.
- D. Fabricate inlet throats to shape and elevations indicated.
- E. Seal and grout all opening around pipe penetrations watertight.

3.7 PVC DRAINAGE STRUCTURE INSTALLATION

- A. Install manufactured, PVC drainage structures, complete with appurtenances and accessories indicated, according to manufacturer's written instructions and the following:
 - 1. Install PVC drainage structures according to ASTM D 2321 and ASTM F 1668.
 - 2. Join piping to structure according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
 - 3. Finished joint system shall meet the requirements of ASTM D 3212.
- B. Set frames, grates and covers to elevations indicated.

3.8 PIPE INLET AND OUTLET INSTALLATION

- A. Install outlets that spill onto grade, with flared end sections that match pipe, where indicated.
- B. Install turf reinforcement mat as indicated and in accordance with manufacturer's written instructions.

3.9 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to Sections 701, and 702 of the South Carolina Department of Transportation Standard Specifications for Highway Construction for measuring, mixing, transporting, and placing concrete.

3.10 STORMWATER OIL AND SEDIMENT SEPARATOR INSTALLATION

- A. General: Install stormwater oil and sediment separators, complete with appurtenances and accessories indicated.
- B. Install separators according to manufacturer's written instructions
- C. Install precast concrete sections according to ASTM C 891.
- D. For separators that occur in pavements, set tops of frames and covers flush with finished surface. Set tops 2 inches above finished surface elsewhere, unless otherwise indicated.

3.11 IDENTIFICATION

- A. Materials and their installation are specified in Section titled "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.
 - 1. Use detectable warning tape over piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

- A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.
 - 1. Submit separate reports for each system inspection.
 - 2. Defects requiring correction include the following:
 - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
 - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
 - c. Crushed, broken, cracked, or otherwise damaged piping.
 - d. Infiltration: Water leakage into piping.
 - e. Exfiltration: Water leakage from or around piping.
 - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
 - 4. Reinspect and repeat procedure until results are satisfactory.
- B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
 - 1. Do not enclose, cover, or put into service before inspection and approval.
 - 2. Test completed piping systems according to authorities having jurisdiction.
 - 3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
 - 4. Submit separate report for each test.
 - 5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
 - a. Test plastic piping according to ASTM F 1417.
 - b. Test concrete piping according to ASTM C 924.
- C. Leaks and loss in test pressure, if applicable, constitute defects that must be repaired.
- D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.
- E. Video Documentation: Upon completion and prior to final inspection, complete a videotaped documentation of the completed piping system, along its interior length, utilizing equipment made expressly for the purpose. Provide a written report, inspection logs, and a copy of the inspection videotape to the Architect.

3.13 CLEANING

- A. Clean interior of piping of dirt and superfluous materials. Collect flushed materials in sediment trapping devices: do not flush into downstream drainage systems or receiving waterbodies.

END OF SECTION 334100

SECTION 334600 – SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes subdrainage (underdrain) systems for the following:
 - 1. Pavement subgrades.
 - 2. Retaining walls.
 - 3. Landscaped areas.

1.3 DEFINITIONS

- A. PE: Polyethylene plastic.
- B. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Perforated-wall pipe and fittings.
 - 2. Special pipe couplings
 - 3. Geotextiles.

1.5 QUALITY ASSURANCE

- A. Authorities Having Jurisdiction: Conform to requirements of all authorities having jurisdiction.
 - 1. Where conflicts exist between the requirements of the Contract Documents and those of authorities having jurisdiction, the higher quality or more restrictive requirement shall apply.
- B. Preinstallation Conference: Conduct conference to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Review methods and procedures related to storm drainage installation including, but not limited to, the following:
 - a. Review requirements of the authorities having jurisdiction.
 - b. Review site conditions and preparatory work.
 - c. Review requirements for protecting work.

- d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- e. Review inspection schedule and procedures required to monitor and document quality assurance.

PART 2 - PRODUCTS

2.1 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

- 1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
- 2. Couplings: Manufacturer's standard, band type.

2.2 PIPE TO DRAINAGE STRUCTURE CONNECTORS

- 1. Resilient Pipe Connectors: ASTM C 923, cast into manhole wall at time of manufacture or fitted into walls in the field, for each pipe connection.
 - a. Fittings shall be specifically designed for integral casting or field installation as applicable.

2.3 AGGREGATE MATERIALS

A. Filter Aggregate: specified in Section titled "Earth Moving."

2.4 SOIL MATERIALS

A. Backfill: Satisfactory Soil specified in Section titled "Earth Moving."

2.5 GEOTEXTILES

A. Subsurface Drainage Geotextile specified in Section titled "Earth Moving."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.
- B. Locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Section titled "Earth Moving."

3.3 PIPING APPLICATIONS

- A. Subdrainage Piping:

- 1. Perforated PE pipe and fittings, couplings, and coupled joints.

- B. Header Piping:

- 1. PE drainage pipe or tubing, as applicable, and fittings, couplings, and coupled joints.

3.4 PEFORATED PIPE SUBDRAINAGE INSTALLATION

- A. Provide trench width to as indicated or, where not indicated, of sufficient width for subdrainage pipe and required distance between pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.
- B. Line trench with geotextile. Roll of geotextile shall be extended longitudinally along the trench in order to minimize joints. Roll width shall be sufficient to cover bottom, sides, and top of trench, with at a 6 inch overlap, without joints. Where a joint is required for a new roll of geotextile, overlap 6 inches.
- C. Place supporting layer of filter aggregate over compacted subgrade to compacted depth of not less than 4 inches.
- D. Install subdrainage pipe as indicated in Part 3 "Piping Installation" Article for basic subdrainage with horizontal distance as indicated on drawings or, where not indicated, of at least 9 inches between pipe and trench walls.
- E. Add filter aggregate to top of subdrainage pipe.
- F. After satisfactory testing, cover subdrainage pipe with filter aggregate to compacted depth indicated or, where not indicated, to within 12 inches of finish grade.
- G. Place filter aggregate in layers not exceeding 3 inches in loose depth; compact each layer as placed.
- H. Fold sides of geotextile fabric over top of filter aggregate, overlapping longitudinal edges a distance of 6 inches.
- I. Fill to Grade: Place satisfactory soil fill material over filter fabric. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.5 RETAINING-WALL SUBDRAINAGE INSTALLATION (PERFORATED PIPE TYPE)

- A. Place supporting layer of filter aggregate over compacted subgrade to compacted depth of not less than 4 inches. Place against wall to a width sufficient for subdrainage pipe and required distance between pipe and outside edge of filter aggregate.

- B. Install subdrainage pipe as indicated on drawings and in Part 3 "Piping Installation" Article for retaining-wall subdrainage.
- C. Add filter aggregate to width indicated on drawings or, where not indicated, of sufficient width to provide at least 9 inches between outside wall of pipe and outside edge of filter aggregate. Fill to a level 9 inches above top of pipe to perform tests.
- D. After satisfactory testing, place additional filter aggregate against wall to width of at least 12 inches to within 12 inches of finish grade.
- E. Place filter aggregate in layers not exceeding 3 inches in loose depth; compact each layer as placed.
- F. Place layer of flat-style geotextile filter fabric, of sufficient width to cover filter aggregate surface, over top of filter aggregate. Where required, overlap longitudinal edges at least 4 inches.
- G. Fill to Grade: Place satisfactory soil fill material over filter fabric. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.6 RETAINING-WALL SUBDRAINAGE INSTALLATION (WEEP HOLE TYPE)

- A. Provide weep holes in retaining wall as indicated on drawings. Where not indicated, bottom of weep holes shall be located 1 inch above finished grade on exposed face of wall, shall be located at intervals not to exceed 6 feet, and shall be between 3/8 and 1 inch in diameter. For masonry walls, weep holes provide by voids in mortar shall be 3/8 inch wide and one course high.
- B. Place filter aggregate over compacted subgrade against wall to width of at least 12 inches to a level 12 inches above top of weep holes to perform tests.
- C. After satisfactory testing, place additional filter aggregate against wall to width of at least 12 inches to within 12 inches of finish grade.
- D. Place filter aggregate in layers not exceeding 3 inches in loose depth; compact each layer as placed.
- E. Place layer of flat-style geotextile filter fabric, of sufficient width to cover filter aggregate surface, over top of filter aggregate. Where required, overlap longitudinal edges at least 4 inches.
- F. Fill to Grade: Place satisfactory soil fill material over filter fabric. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

- A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering aggregate. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
 - 1. Perforated Pipe Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
 - 2. Retaining-Wall Subdrainage (Perforated Pipe Type): When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated. However, when water discharges through wall at regular intervals, pipe may be installed with a minimum slope of zero percent.

3. Lay perforated pipe with perforations down.
- B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.
- C. Install PE piping according to ASTM D 2321.

3.8 PIPE JOINT CONSTRUCTION

- A. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.
- B. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system at concrete drainage structures as follows:
 1. Where resilient connector is not installed at time of drainage structure manufacture,
 - a. Core drill opening into structure large enough to allow installation of resilient manhole connector.
 - b. Install resilient manhole connector in accordance with manufacturer's written instructions.
 2. Install pipe in resilient connector in accordance with manufacturer's written instructions.
 3. Cut end of connection pipe passing through structure wall to be flush with inside wall, unless otherwise indicated.
 4. On inside of structure wall, encase outside of pipe to flush with face of wall with grout.
 5. Use epoxy-bonding compound as interface between new and existing concrete and piping materials.
 6. Protect piping and structures to prevent concrete or debris from entering while making connections. Remove debris or other extraneous material that may accumulate.

3.10 IDENTIFICATION

- A. Materials and their installation are specified in Section titled "Earth Moving." Arrange for installation of green warning tapes directly over piping.
 1. Install detectable warning tape over piping and over edges of underground structures.

3.11 FIELD QUALITY CONTROL

- A. Inspection: Before placing drainage course around and above pipe, inspect pipe to confirm that: it is not crushed or damaged; that joints are sound and properly made; that interior of pipe is unobstructed and

free flowing; that pipe is properly aligned and at indicated elevation and grade; and that connections to drainage structures are properly made, sound, and water-tight. As drainage course and backfill is installed, monitor operations to ensure that pipe is not damaged or displaced by placement or compaction operations.

3.12 CLEANING

- A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600