# SPECIAL SPECIFICATION
# 5969
# Water Mains

**Table of Contents** **Page**

# SPECIAL SPECIFICATION

# 5969

# Water Mains

**1. Description.** Furnish labor, materials, and equipment necessary to provide a complete water main system in conformance with the plans and specifications, and in compliance with the Department's Utility Accommodation Policy (Title 43, T.A.C., Sections 21.31-21.55). Construct water mains of the sizes, materials, and dimensions shown on the plans including pipe, joints, and connections to new and existing pipes, casing, valves, fittings, fire hydrants, meters, blocking, etc., as may be required to complete the work.

Furnish materials and equipment for encasing existing water lines with split steel encasement pipes using the open cut method in accordance with this specification.

The abbreviations AWWA, ASA, ASTM, ANSI, AASHTO, NACE, NSF, SSPC, and TECQ used in this specification refer to the following organizations or technical societies:

- AWWA American Water Works Association
- ASA American Standards Association
- ASTM American Society for Testing and Materials
- ANSI American National Standards Institute
- AASHTO American Association of State Highway and Transportation Officials
- NACE National Association of Corrosion Engineers
- NSF National Sanitation Foundations
- SSPC Steel Structural Painting Council
- TCEQ Texas Commission on Environmental Quality (TCEQ)

References to specifications of the above organizations mean the latest standard or tentative standard in effect on the date of the proposal.

**2. Materials.**

**A. General.** Pipe 6 in. and larger is acceptable, without penalty, to the Texas Fire insurance Commission for use in water works distribution systems.

Provide new and unused materials for this project unless otherwise shown on the plans or in the proposal.

For water mains less than 24 in. in diameter, use casing insulators between the water main and casing unless otherwise shown on the plans. For water mains 4 in. through 14 in., use
8-in.wide casing insulators.

For water mains 16 in. through 20 in., use 12-in. wide insulators. For pipe materials up to 12 in., use Pipeline Seal and Insulator Model C8G-2 or approved equal. For water mains

larger than 12 in. use Pipeline Seal and Insulator Model C12G-2 or approved equal. Casing end seals: Pipeline Seal and Insulator Model C or approved equal.

**B. Steel Pipe and Fittings.**

**1. Steel Carrier Pipe.** Provide steel pipe for use as carrier pipe in the distribution system, conforming to the requirements of AWWA Standard C200. Install steel pipe 20 in. and smaller as aerial crossings, above-ground piping, and for encasement sleeves only. Do not bury steel pipe that is 20 in. and smaller directly or within a casing.

For pipe 24 in. and greater, conform to the requirements of AWWA C200, C207, C208 and AWWA M11 except as modified in this specification. Furnish pipe and fittings that have manufacturer's certifications ensuring that they have been hydrostatically tested at the factory in accordance with AWWA C200, Section 3.4. Ensure pipe steel meets the requirements of ASTM A36, ASTM A570 Grade 36, ASTM A53 Grade B, ASTM A135 Grade B, or ASTM A139 Grade B as a minimum. Pipe is also subject to the requirements of Underwriters Laboratories, Inc. Specification for "Steel Pipelines for Underground Water Service."

Provide pipe and fittings designed to withstand the most critical simultaneous application of external loads and internal pressures, based on the minimum of AASHTO HS-20 loading, AREMA E-80 loads, depths of bury as indicated on the plans, and the most critical groundwater level condition. The pipe design conditions follow:

- Working pressure = 100 psi.
- Hydrostatic field test pressure = 150 psi.

For pipe design (24 in. and larger) conform to AWWA M11 with the following conditions:

- Design stress due to working pressure: The maximum is 50% of the minimum yield strength or 16,500 psi maximum stress for mortar-coated pipe.
- Design stress due to hydraulic test pressure: The maximum is 75% of the minimum yield strength or 24,750 psi maximum stress for mortar-coated pipe.
- Design stress due to maximum hydraulic surge pressure: The maximum is 75% of the minimum yield strength or 24,750 psi maximum stress for mortar-coated pipe.
- Modulus of soil reaction (E'), <1,500 psi.
- Unit weight of fill (w) > 120 pcf.
- Deflection lag factor (D1) = 1.2.
- Bedding constant (K) = 0.1.
- Fully saturated soil conditions: hw = h = depth of cover above top of pipe. Maximum deflection from specified diameter = 3% for flexible coatings.

Provide pipe and fittings that have been designed by a licensed Engineer. Before manufacturing, submit these signed, sealed, and dated calculations for approval.

Supply pipe in double random lengths unless otherwise shown on the plans. Bevel the ends of the pipe for field butt welding as shown on the plans.

Provide a minimum of 3/8-in. inside joint recess between ends of pipe in straight pipe sections.

Provide a minimum allowable steel wall thickness in accordance with Tables 1 and 2 for HS-20 live loads and depths of bury of up to 16 ft.

**Table 1**
**Carrier Pipe (20 in. and Smaller)**

| Nominal Pipe Size (in.) | Outside Diameter (in.) | Minimum Wall Thickness (in.) | Approximate Weight Per Lineal Foot, Uncoated (lb.) |
|---|---|---|---|
| 4 | 4.500 | 0.250 | 11.35 |
| 6 | 6.625 | 0.280 | 18.97 |
| 8 | 8.625 | 0.322 | 28.55 |
| 10 | 10.750 | 0.365 | 40.48 |
| 12 | 12.750 | 0.375 | 49.56 |
| 16 | 16.000 | 0.375 | 62.58 |
| 20 | 20.000 | 0.375 | 78.60 |

**Table 2**
**Carrier Pipe (24 in. and Larger)**

| Net Inside Diameter (in.) | Minimum Wall Thickness (in.) | |
|---|---|---|
| | Flexible Coating | Mortar Coating |
| 24 | 0.149 | 0.136 |
| 30 | 0.149 | 0.136 |
| 36 | 0.178 | 0.163 |
| Note: Refer to the plans for carrier pipe thickness. However, never use a pipe wall thickness less than that defined in the above tables. | | |

2. **Steel Casing Pipe.** Ensure pipe intended for use as casing pipe is manufactured in accordance with Section 2.B.1, “Steel Carrier Pipe,” of this specification except ensure that the minimum allowable steel wall thickness conforms to those shown in Table 3 for HS-20 live loads and depths of bury of up to 16 ft.

**Table 3**
**Casing Pipe (Encasement Sleeves)**

| 30 in. and Smaller | | | |
|---|---|---|---|
| **Casing Pipe Size (in.)** | **Outside Diameter (in.)** | **Minimum Wall Thickness (in.)** | **Approximate Weight Per Lineal Foot, Uncoated (lb.)** |
| 8 | 8.625 | 0.219 | 19.64 |
| 10 | 10.750 | 0.219 | 24.60 |
| 12 | 12.750 | 0.219 | 29.28 |
| 16 | 16.000 | 0.219 | 36.86 |
| 18 | 18.000 | 0.250 | 47.39 |
| 20 | 20.000 | 0.250 | 52.73 |
| 24 | 24.000 | 0.250 | 63.41 |
| 30 | 30.000 | 0.250 | 79.43 |
| Note: Refer to the plans for casing thickness. However, never use a pipe wall thickness less than that defined in the above table. | | | |

Provide steel casing sections for split casing in lengths a maximum of 20 ft. Ensure each section is split in half sections. Bevel the ends and split sections for field butt-welding.

Steel casing pipe is not required to carry the label of the Underwriters Laboratories, Inc.

3. **Steel Pipe Fittings.** Provide factory forged steel pipe fittings unless otherwise shown on the plans. Ensure the wall thickness is equal to or greater than the pipe to which the fitting is to be welded. Bevel the ends of the fitting for field butt-welding.

   Provide approved sleeve-type flexible and flange adaptor couplings. Ensure the thickness of the middle ring is equal to or greater than the thickness of the pipe wall.

   Provide restraint joint connections for 16-in. and larger water main piping shown on the plans to have restraint lengths, unless otherwise shown on the plans. Joints are to be double-welded at butt or lap joints at aerial crossings as shown on the plans. Use flanged joint at valves.

   Elbows: Provide 2-piece for 0 degrees to 22-1/2 degrees; 3-piece for 23 degrees to 45 degrees; 4-piece for 46 degrees to 67-1/2 degrees; and 5-piece for 68 degrees to 90 degrees, unless otherwise shown on plans.

   Outlets: Reinforced in accordance with AWWA M11, Sections 13.3-13.7, AWWA C200, and AWWA C208. Provide interior lining and exterior coating in accordance with paragraphs on coating and lining, and matching pipe to access inlets, service outlets, test inlets, and air-vacuum valve and other outlets, including riser pipes.

   Radius: The minimum radius is 2.5 times pipe diameter.

4. **Hydrostatic Test of Pipe.** Ensure the pipe manufacturer performs hydrostatic testing in accordance with AWWA C200, Section 3.5.3, at the point of manufacture, conducts the test for a minimum of 2 minutes, and thoroughly inspects the pipe. Repair or reject pipe revealing leaks or cracks. Obtain from the manufacturer and submit to the Engineer, the manufacturer's written certification that the pipe and fittings used on this project have passed the hydrostatic test.

   Calibrate pressure gauges within 1 year before testing, as specified in AWWA C200, Section 1.04 L.

5. **Butt Straps for Closure Piece.** Provide a minimum 12-in. wide split butt strap; minimum plate thickness equal to the thinnest member being joined; fabricated from material equal in chemical and physical properties to the thinnest member being joined.

   Provide a minimum lap of 4 in. between the member being joined and the edge of the butt strap, welded on both the inside and outside, unless otherwise approved.

   Provide a minimum 6-in. welded outlet for inspecting each closure section, unless the access man way is within 40 ft. of the closure section. Provide forged steel threaded outlets of approved design, where required, for use in passing hose or lead wires into the pipe. Tap plugs with standard pipe threads and weld to the pipe in an approved manner, and use solid forged steel plugs for closure.

   Provide full penetration butt or welded joints as shown on the plans. Use flanged joints at valves unless otherwise shown on the plans. Perform x-ray or ultrasonic testing of manual welds on special pipe and fittings.

   Dished Head Plugs: Provide dished head plugs (test plugs) to withstand field hydrostatic test pressure from either side of the plug. Ensure the design stress due to hydrostatic pressure is at most 50% of minimum yield. Pipe on the opposite side of the hydrostatic test may or may not contain water. Ensure the manufacturer of the steel pipe hydrostatically tests the plugs at the factory.

   Make curves and bends by deflecting joints, by using beveled joints, or by combining these methods, unless otherwise shown on the plans. Do not exceed the joint deflection angle recommended by the pipe manufacturer.

   Make penetration of spigot into bell at all points of circumference at least equal to minimum required penetration shown on the plans. Provide beveled pipe sections used in curved alignment of standard length except when shorter sections are required to limit the radius of curvature. In this case, provide equal length sections throughout the curve. Do not allow the bevel to exceed 5 degrees.

6. **Steel Pipe Flanges.** Ensure steel pipe flanges shown on the plans conform to AWWA Standard C207 for Class D Flanges (same diameter and drilling as Class 125 cast-iron flanges ASA B16.1).

   Make cast-iron to steel pipe connections with 1 cast-iron bell flange and 1 steel slip-on flange, and ensure they are electrically isolated.

The use of insulating gaskets, plastic bolt sleeves, and washers of insulating gasket material backed with zinc plated or hot-dip galvanized washers, or epoxy coated bolts, nuts, and washers used with an insulating gasket, are approved for this purpose.

For inline flange joints 12 in. in diameter and greater and for butterfly valve flanges, use Pyrex LineBacker Type E phenolic gaskets manufactured by Pipeline Seal and Insulator Inc., or approved equal.

Use full-face gaskets for other flanged joints not listed above. Provide cloth-inserted rubber gasket material, 1/8-in. thick in accordance with AWWA C207. Ensure gaskets are factory-cut to proper dimensions.

Maintain electrically isolated flanged joints between steel and cast-iron by using epoxy coated bolts, nuts, washers, and insulating type gaskets unless, otherwise approved.

Fabricate flanges with oversize bolt holes, with flanges drilled in pairs, to accommodate insulating sleeves.

**7. Steel Pipe Protective Coatings.**

**a. General.** Use shop-applied protective coatings except for field repairs and coatings of field welded joints. The Engineer may provide for witness of inspection and testing of shop-applied coatings, however, such witness does not relieve the Contractor of the responsibility to furnish material, perform work, and provide quality control in conformance with the applicable AWWA Standard and the requirements of these specifications.

The substrate surface profile and minimum and maximum individual and total dry film thickness (DFT) indicated in this specification apply. No requirement of this specification cancels or supersedes the specific written directions and recommendations of the specific coating manufacturer so as to jeopardize the integrity of the applied system. Measure the dry film thickness in accordance with SSPC PA2.

Field test shop coating and field repairs for holidays, pinholes, or discontinuities, at voltage levels required by the applicable AWWA Standard and in accordance with the applicable NACE procedure, i.e., PRO 188, RPO 274, TMD 384, etc. Submit the test procedure, including voltage levels to be used, before testing. Repair holidays in conformance with the applicable AWWA Standard.

Provide documentation by a NACE-certified inspector of compliance with the required tests.

Handle, store, and use field procedures for shop-coated pipe in conformance with the applicable AWWA Standards. Adequately seal and protect pipe ends from damage during handling and storage. Do not remove such protection until immediately before installing. Do not lift pipe using caliper clamps or hooks at ends of the pipe.

Repair damage to the pipe or the protective coating caused while installing the pipe and before final acceptance by the owner, as directed and in conformance with the applicable standards.

Keep the interior of the pipe and fittings clean of foreign matter before installing and until the work is accepted. Keep joint contact surfaces clean until jointing is complete.

Furnish an affidavit of compliance that all materials and work furnished comply with the requirements of the applicable AWWA Standard and these specifications.

**b. Internal Lining for Steel.** Ensure the material used for the internal coating of the steel carrier pipe is NSF61-listed as suitable for contact with potable water as required by Chapter 290, Rules & Regulations for Public Systems, Texas Commission on Environmental Quality (TCEQ).

Supply steel pipe with epoxy lining, capable of conveying water at temperatures not greater than 140 $^{o}$F. Provide linings conforming to American National Standards Institute/National Sanitation Foundation (ANSI/NFS) Standard 61, and certification from an organization accredited by ANSI. Unless otherwise noted, coat exposed (wetted) steel parts of flanges, blind flanges, bolts, and access manhole covers, with epoxy lining as specified.

**(1) Epoxy Lining.** Use Liquid Epoxy meeting the requirements of AWWA C-210, "Liquid Epoxy Coating System for the Interior and Exterior of Steel Water Pipelines," except as modified in this specification. Provide a Liquid Epoxy system consisting of three coats of polyamide epoxy (no coal tar material) as follows:

- Prime Coat: 2-part, chemically cured, NSF certified epoxy, 4-6 mils dry film thickness (DFT),
- Intermediate Coat: 2-part NSF certified epoxy; 4-6 mils (DFT), and
- Finish Coat: 2-part NSF certified epoxy, 4-6 mils (DFT).

Ensure the total system has a minimum DFT of 12 mils and a maximum DFT of 18 mils. Apply each coat in contrasting colors, using a buff prime and intermediate coat and a white finish coat. Use the same manufacturer to supply all material. Coal-tar epoxy material is not permitted. For surfaces to be coated, abrasive blast clean them to a near-white finish in accordance with SSPC-5(64) to establish an average anchor profile of 2.0 to 3.0 mils, with no individual reading greater than 4.0 mils or less than 1.5 mils. Before applying, inspect the prepared and cleaned surface for evidence of non-visible contaminants such as soluble salts or chlorides in accordance with NACE Technical Committee Report "Surface Preparation of Contaminated Steel Surfaces," NACE Publication 6G 186.

Re-clean the surface as necessary, until it is free of such contaminants.

Perform an interior adhesion test on pipe 30 in. in diameter and larger in accordance with ASTM D 4541.

Minimum field adhesion: 700 psi. Perform this test on pipe for project at a frequency of one for every 1000 sq. ft. of epoxy lining. Perform a cure test in accordance with ASTM D 4752 (solvent rub test) and ASTM D 3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

Provide Fusion Bonded Epoxy in accordance with AWWA C-213, "Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines."

**c. External Coating.**

**(1) Above Ground.** Externally coat above ground steel piping and fittings with a 3-coat epoxy/epoxy/polyurethane system in accordance with AWWA C-218, "Coating the Exterior of Aboveground Steel Water Pipelines and Fittings," Section 2.5, Coating System No. 4-91, except as modified in this specification.

- Prime Coat: 2-component, inhibitive epoxy primer; DFT of 4-6 mils,
- Intermediate Coat: 2-component, chemical resistant epoxy; DFT of 4-6 mils, and
- Finish Coat: 2-component aliphatic polyurethane; DFT 1.5-2.5 mils.

Ensure the total system has a minimum DFT of 9.5 mils and a maximum DFT of 14.5 mils. Apply each coat in contrasting colors, using a buff prime coat and a blue finish coat, or as directed. Use the same manufacturer to supply all material. For surfaces to be coated, abrasive blast clean them to a near-white finish in accordance with SSPC-SP10 (NACE 2) to establish an average anchor profile of 2.0 to 3.0 mils, with no individual reading greater than 4.0 mils or less than 1.5 mils. Before coating, inspect the prepared and cleaned surface for evidence of non-visible contaminants such as soluble salts or chlorides in accordance with NACE Technical committee Report "Surface Preparation of Contaminated Steel Surfaces," NACE Publication 6G 186. Re-clean the surface as necessary, until it is free of such contaminants.

Perform an interior adhesion test on pipe 30 in. in diameter and larger in accordance with ASTM D 4541. Minimum field adhesion: 700 psi. Perform this test on pipe for the project at a frequency of one for every 1000 sq. ft. of epoxy lining. Perform a cure test in accordance with ASTM D 4752 (solvent rub test) and ASTM D 3363 (pencil hardness) for each section of pipe. Repair tested areas with approved procedures.

Provide Fusion Bonded Epoxy in accordance with AWWA C-213, "Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines."

**(2) Buried Steel Pipe, 24-Inch Diameter and Larger Only.** Coat buried steel pipe and fittings (except tunneled, cased, or augered holes) with either of the following systems:

**(a) Tape Coating.** Provide an approved tape for external tape coating. Apply in accordance with AWWA C214 and the requirements of this Section; 80-mil. shop-applied, Polyken YG-III, Tek-Rap Yard-Rap, or approved equal. Components: Primer, one 20-mil layer of inner-layer tape for corrosion protection and two 30-mil layers of outer-layer tape for mechanical protection. Bond coupling to adjacent pipes with bonding cables as shown on the plans.

Use approved filler putty, type Polyken 939 insulating putty, or approved equal, to fill in the gap and create a smooth sloped transition between the top of the reinforcing plate and the pipe, before applying the tape coating.

Primer: Compatible with the tape coating, supplied by the coating-system manufacturer.

Provide pipe with shop coatings cut back approximately 4 to 4-1/2 in. from the joint ends to facilitate joining and welding of pipe. Taper successive tape layers by 1-in. staggers to facilitate field wrapping and welding of joints. Inner and outer tape width: 12 in. or 18 in.

Do not expose tape coating to direct sunlight for more than 60 days.

Wrap specials and fittings that cannot be machine wrapped due to configuration, with primer layer and two layers of prefabricated tape, each 35 mils thick. Overlap machine applied tape with hand applied tape by minimum of 2 in. and bind to it.

Apply Polyken approved 30 mil filler tape 931, or approved equal, parallel to spiral weld seams if weld height measures greater than or equal to 1/8 in.

**(b) Polyurethane Coating.** Refer to Section 2.B.7.c.(1) above. Heat Shrink Joint Sleeves for Tape Coating: Aqua-shield, or approved equal. For repairs to heat shrink joint sleeves, use Aqua-shield Repair Patch Kit, or approved equal.

**(3) Steel Pipe in Tunneled, Cased, Bored, or Augered Holes.**

**(a) 24-Inch and Larger.** Prime steel pipe in tunneled or cased holes with 3.0 to 4.0 mils of a 2-part chemically cured rust inhibitive polyamide epoxy. Prepare the surface the same as for above ground external coating, of Section 2.B.7.c.1 of this specification. Fill the annular space between the tunnel or casing with the specified grout.

**(b) 20-Inch and Smaller.** Coat steel pipe in bored or augered holes, or holes in a tunnel or casing, with Corropipe II-TX or Corroclad 2000 as manufactured by Madison Chemical Industries, Inc., or approved equal, and apply in strict conformance with the manufacturer's recommendations.

For external field welds and other field repairs, use Madison Chemical “GP” II or “TX” Touch Up, or approved equal, in conformance with the manufacturer’s recommendations.

**d. Inspecting and Testing Coatings.** Perform electrical inspection on the inner layer of tape before applying the intermediate layer of tape. If holidays are detected, repair holidays immediately before applying the outer layer of tape. Clear the holiday area of material and re-prime if necessary. Re-coat the area with inner wrap tape. Overlap the inner wrap tape onto the surrounding inner wrap coating by at least 2 in. Perform an electrical re-test at the repaired area after repairing the holiday, and before continuing the outer wrap.

Shrink Wrap: Perform an electrical inspection on the shrink wrap to check for holidays. Perform peel tests over the heat affected zone. Minimum acceptable result: 15 lbs.-ft. per inch.

## C. Ductile-Iron Pipe and Fittings.

**1. Ductile-Iron Pipe.** Provide ductile-iron pipe conforming to the requirements of AWWA Standard C151. Provide minimum lengths of 18 ft. and minimum thickness of Class 51 for water lines. Provide minimum thickness Class 53 for flanged pipe and minimum thickness Class 52 for areas with pipe offset sections. Use joints of the push-on type or flanged type unless otherwise shown on the plans. Use push-on joints conforming to the requirements of ASA Specification A21.11 (AWWA C111). Use flanged joints conforming to the requirements of AWWA C115 including a cloth inserted rubber gasket material 1/8 in. thick for flanged joints. Do not use threaded or grooved type joints which reduce the pipe wall thickness below the minimum required.

Provide polyethylene encasement material and install in accordance with AWWA C105, and backfill as specified. Apply a minimum of two complete wraps of 8-mil-thick polyethylene. Use polyethylene encasement for open cut installations only. For augered sections or sections installed inside a tunnel or casing, provide polyurethane coating.

Ensure the pipe manufacturer performs hydrostatic testing in accordance with AWWA C 151, Section 5.2.1, at the point of manufacture, conducts the test for a minimum of
2 minutes and thoroughly inspects the pipe. Repair or reject pipe revealing leaks or cracks. Obtain from the manufacturer and submit to the Engineer, the manufacturer’s written certification that the pipe and fittings used on this project have passed the hydrostatic test.

Prevent any lateral movement of thrust restraints throughout the pressure testing and operation. Passive resistance of soil will not be permitted in the calculation of thrust restraint.

Clearly mark the pipe section to show the location and thickness or pressure class color code.

Provide an exterior coating, in open cut excavations, consisting of a prime coat and an outside asphaltic coating conforming to AWWA C110, C115, or C151 for pipe and fittings. Encase the water line in a double wrap of polyethylene. Use polyethylene wrap conforming to the requirements of Section 2.M., "Polyethylene Film Wrap," and 3.P., "Polyethylene Film Wrap," of this specification. Install bond wire as specified in this Item.

Coat Ductile-Iron pipe in augered holes with a polyurethane coating. Use a polyurethane coating conforming to the same requirements as those in Section 2.B.7.c.3., "Steel Pipe in Tunneled, Cased, Bored, or Augered Holes" of this specification.

2. **Fittings for Ductile-Iron Pipe.** Ensure fittings for use with ductile-iron pipe of nominal sizes 4-in. through 48-in. conform to AWWA Standard C110 or C153.

   Use joints of the push-on type or flanged type unless otherwise shown on the plans. Use push-on joints conforming to the requirements of ANSI Specification A21.11 (AWWA C111), rated for a 250 psig working pressure or A21.53 (AWWA C153). Use flanged fittings conforming to AWWA C110, of cast or ductile iron and conforming to ANSI B16.1, class 125 rated at 250 psig working pressure. Screw flanged fittings on threaded pipe ends done in the shop in accordance AWWA C115 for attaching, aligning, and facing.

   Coat the inside and outside surfaces of the fittings as specified for the regular lengths of ductile-iron pipe.

   Regardless of the coating system, for flanged joints in buried service, provide a petrolatum wrapping system, Denso, or approved equal, for the complete joint and alloy steel fasteners. Alternatively, provide bolts made of Type 304 stainless steel.

   Bond joints in accordance with Section 2.F., "Joint Bonding and Electrical Insulation."

3. **Restrained Joints.** For buried services, restrain ductile iron pipe 16 in. in diameter and larger from movement, using special joints. Provide the following or approved equal:

   - Super-Lock Joint by Clow Corporation,
   - Flex-Ring or Lok-Ring by American Cast Iron Pipe Company, or
   - TR-Flex or Field-Lok Joint by U.S. Pipe and Foundry Company.

   Provide restrained joints with enough distance from each side of the bend, tee, plug, or other fitting to resist thrust developed at the design pressure for the pipe.

   Use water main interior coatings conforming to AWWA C104 or ANSI A21.4, cement-lined with seal coat or ANSI A 21.16 fusion-bonded epoxy coating.

   Ensure the material used for internal coating is NSF 61 and listed as suitable for contact with potable water as required by Chapter 290, Rules and Regulation for Public Water Systems, Texas Natural Resources Conservation Commission (TNRCC).

**D. Polyvinyl Chloride (PVC) Pipe and Fittings.**

**1. Polyvinyl Chloride Pipe, 2-Inch Through 20-Inch.** Provide PVC pipe 4 in. and larger with integral bell type gasketed push-on joints or plain end pipe with twin-gasketed couplings conforming to the requirements of ASTM Designation D3139 for push-on-type joints. Use rubber gaskets conforming to the requirements of ASTM Designation D1869. Lubricate gaskets with a nontoxic water-soluble lubricant before joining pipe units. Fit pipe units together in such a manner to avoid twisting or damaging the rubber gasket.

Mark furnished PVC pipe on the spigot end for proper depth of makeup to the bell end of a joining length of pipe or fitting.

Provide valves for use with PVC pipe conforming to the requirements of Section 2.I., "Gate Valves, Tapping Valves, and Tapping Sleeves," of this specification, except provide valve ends of the push-on-joint type for use with PVC pipe. Provide self-extinguishing PVC pipe that bears Underwriter's Laboratories mark of approval and is acceptable without penalty to Texas State Fire Insurance Committee for use in fire protection lines. Ensure PVC pipe bears the National Sanitation Foundation Seal of Approval (NSF-PW).

Provide PVC meeting the following thickness when using restrained joints:

- DR 18: For restrained joints where shown on the plans.
- DR 14: For alternate to offset pipe sections shown on the plans. Do not use PVC pipe for offset sections with depth of cover greater than 20 ft. or less than 4 ft. Do not use PVC pipe in potentially petroleum-contaminated areas.

Make curves and bends by deflecting joints. Do not exceed the maximum deflection recommended the by the pipe manufacturer. Submit details of other methods of providing curves and bends for review by the Engineer.

Gaskets: Use gaskets meeting the requirements of ASTM F 477. Use elastomeric factory-installed gaskets to make joints flexible and watertight. Flat Face Mating Flange: Full faces 1/8 in. thick ethylene propylene rubber (EPR). Raised Face Mating Flange: Flat ring 1/8 in. EPR, with filler gasket between the outside diameter (OD) of the raised face and the flange OD to protect the flange from the bolting moment. Lubricant for rubber-gasketed joints: Water- soluble, non-toxic, non-objectionable in taste and odor imparted to fluid, non-supporting of bacteria growth, and causing no deteriorating effect on PVC or rubber gaskets. Use one manufacturer to furnish PVC pipe. When an approved PVC system is used as alternate to offset pipe section, a second manufacturer may be used. Do not use PVC pipe in potentially or known contaminated areas. Do not use PVC pipe in areas exposed to direct sunlight.

Ensure the pipe manufacturer performs hydrostatic testing accordance with AWWA
C 900, AWWA C 905, AWWA C 909, and ANSI A 21.10 (AWWA C 110) at the point of manufacture. Obtain from the manufacturer and submit to the Engineer, the manufacturer's written certification that the pipe and fittings used on this project have passed the hydrostatic test.

2. **Fittings for Polyvinyl Chloride Pipe, 2-Inch.** Provide PVC pipe manufactured in accordance with the requirements of ASTM Designation D1784 for PVC 12454B (Type I, Grade 1) or PVC 12454C (Type I, Grade 1) and with a standard thermoplastic pipe dimension ratio (SDR) equal to 21.

   Use fittings for 2-in. PVC pipe with a minimum pressure rating of 200 psi. Use fittings of the solvent-weld, socket type conforming to the requirements of ASTM D2466, or the gasketed push-on type conforming to the requirements of ASTM D2241. Use PVC solvent cements manufactured in accordance with ASTM D2564.

3. **Polyvinyl Chloride Pipe, 4-Inch Through 20-Inch.** PVC pipe 4-in. through 12-in.: AWWA C 900, AWWA C 909, Class 150, DR 18; AWWA C 900, Class 200, DR 14 as alternate to offset pipe sections; nominal 20-ft. lengths; cast-iron equivalent outside diameters. Pipe 14-in. through 20-in.: AWWA C 905; Class 235; DR 18; nominal 20-ft. lengths; cast-iron equivalent outside diameter.

   Use joints conforming to the same requirements as those specified for 2-in. PVC pipe.

4. **Bends and Fittings for PVC Pipe, 4-Inch Through 20-Inch.** Provide fittings conforming to the requirements of Section 2.C.2., "Fittings for Ductile-Iron Pipe." Use polyethylene wrapped fittings as required by Sections 2.M., "Polyethylene Film Wrap" and 3.P, "Polyethylene Film Wrap," of this specification.

   Provide restrained joints with enough distance from each side of the bend, tee, plug, or other fitting to resist thrust developed at the design pressure for the pipe.

   Approved Certa-Lok PVC restrained joints, 200-250 psi, may be provided for up to 12 in. in diameter. Where preventing movements of 12-in. diameter or greater pipe due to thrusts is necessary, provide the following restrained joints, or approved equal:

   a. **Fittings.** JCM 610 Sur-Grip Fitting Restrainer by JCM Industries, Inc., Series 500
      Fitting Restrainer by Ebba Iron, Inc., One Bolt by One Bolt, Inc., or approved equal.

   b. **Bell and Spigot.** JCM 620 or 621 Sur-Grip Bell Joint Restrainer by JCM Industries, Inc. or Series 1500 or Series 1100HV Joint Restrainer by Ebba Iron, Inc., One Bolt by One Bolt, Inc., or approved equal.

5. **Nonmetallic Pipe Detection.** Where nonmetallic pipe is installed longitudinally underground, provide for a method of detecting the location of the nonmetallic pipe. The specific method is shown on the plans or will be approved. This system may involve some components to be installed in the trench around the pipe to be detected using a metal detector. Or the system may consist of locating equipment capable of creating a non-destructive pressure wave which can be detected above ground using a portable detection device with both audible and visual indicators. Ensure either system of detection is capable of accurately locating the pipe to a maximum depth of 3 ft. over the areas shown on the plans.

Either system must be capable of locating lines under earth, concrete, or asphaltic surfaces. Use equipment, materials, and installation as specified by the manufacturer.

**E. Fiberglass Reinforced Plastic (FRP) Pipe for Casing.**

**1. FRP Casing Pipe.** Ensure pipe used for casing is centrifugally cast fiberglass pipe conforming to the requirements of AWWA Standard C 950 and the requirements of this section.

Design fiberglass casing pipe wall thickness to withstand the most critical simultaneous application of external loads, including construction loads and internal pressures. Base the design on the minimum of AASHTO HS-20 loading, AREMA E-80 loads, and depths of bury as indicated on the plans. Design for the most critical groundwater level condition. The pipe design conditions follow:

- Working Pressure = 100 psi.
- Hydrostatic Field Test Pressure = 150 psi.

Provide the pipe with pressure rated fiberglass sleeve couplings or O-ring bell-and-spigot joints that use elastomeric sealing gaskets to maintain joint water-tightness conforming to the requirements of ASTM D 4161. Provide the casing end treatments with rubber boot type seals capable of maintaining casing water-tightness. Provide casing pipe, gasketing and end treatments that have a very-low to zero corrosive reaction to the chemicals listed on the pipeline product lines shown in the plans. The pipeline products encountered at proposed water line crossings include, but are not limited to:

- MTBE (Methyl Tertiary Butyl Ether),
- TBA(tertiary butyl arsine),
- Nitrogen,
- Benzene,
- Petroleum,
- Natural Gas, and
- Ethane.

Provide pipe manufactured with an epoxy vinyl ester resin with the physical and chemical properties of HETRON 970-35 by Ashland, or approved equal.

Provide fiberglass casing sections in nominal lengths of 20 ft. Provide a stiffness class of fiberglass pipe that satisfies design requirements, but not less than 46 psi, when used in direct bury operation. For tunneled and augered sections, use pipe and pipe joints designed to carry loads including but not limited to: Overburden and lateral earth pressures, subsurface soil, grouting, other conditions of service, thrust of jacks, and stress anticipated during handling and installation. Do not create grout holes with pipe.

Submit shop drawings signed and sealed by a Professional Engineer licensed in the State of Texas showing following:

- Manufacturer's pipe design calculations including thrust restraint design,
- Details of pictorial nature of critical features and specials indicating alignment and grade, laying dimensions, fabrication, fitting, flange, and fully dimensioned details, with plan view detailing pipe invert elevations, bends, and other critical features. Indicate station numbers for fittings corresponding to the plans. Do not start production of pipe and fittings before review and approval by Engineer. Provide final approved lay schedule on CD-ROM in Adobe Portable Document Format (*.PDF),
- Certification from the manufacturer that the design was performed for the project in accordance with the requirements of this section. This Certification is to be signed and sealed by a Professional Engineer licensed in the State of Texas, and
- Gasket and resin selection for approval.

**F. Joint Bonding and Electrical Insulation.** For electrical bond wires, use a minimum No. 2 AWG, 7 strand, and copper cable, furnished with high molecular weight polyethylene insulation (HMWPE). Remove 1 in. of HMWPE insulation from each end of the bond wire. Provide 2 bond wires as shown on the plans.

Provide a flange adaptor with an insulating kit, as required, when connecting new piping to existing piping and piping of different materials. Provide electrical flange insulation through the installation of the following materials:

**1. Insulating Gasket.**

**a. For Piping Sized 30 Inches in Diameter and Greater,** provide Pyrox G-10 with nitrile seal, Type E LineBacker gasket as manufactured by Pipeline Seal and Insulator, Inc., or approved equal.

**b. For Piping Sized Between 12 Inches and 24 Inches in Diameter,** provide Phenolic PSI with nitrile seal, Type E LineBacker gasket as manufactured by Pipeline Seal and Insulator, Inc., or approved equal.

The Contractor may provide a plain-faced phenolic gasket, as manufactured by Pipeline Seal and Insulator, Inc., or approved equal. Place the phenolic gasket between two full-faced gaskets. Provide cloth-inserted rubber gasket material, 1/8-in. thick in accordance with AWWA C207. Use gaskets that are factory cut to proper dimensions.

**2. Sleeves and Washers.**

**a. For Piping Sized 30 Inches in Diameter and Greater**, provide full length Mylar sleeves with Pyrox G-10 washers, double washer sets as manufactured by Pipeline Seal and Insulator Inc., or approved equal.

**b. For Piping Sized Between 12 Inches and 24 Inches in Diameter,** provide full length Mylar sleeves with phenolic washers, double washer sets as manufactured by Pipeline Seal and Insulator, Inc., or approved equal.

**G. Copper Tubing for Copper Service Lines and Small Mains.** For 3/4-in., 1-in., 1-1/2 in., and 2-in. diameter copper tubing for underground service, use Type "K" soft annealed and seamless with the proper bending temper and conforming to ASTM Designation B88 and Federal Specification WW-T-799 with the following exceptions:

Section 14 of ASTM Designation B88 is hereby modified to provide for the following number of samples for each size of tubing:

- For each 7,500 ft. of tubing, 1 sample.
- Items of less than 7,500 ft. of tubing, 1 sample.

Furnish 3/4-in. and 1-in. tubes in coils, each containing 60 ft. Furnish 1-1/2 in. and 2-in. tubes in coils of minimum 40-ft. lengths. Use minimum joint spacing in multiples of 60 ft. or 40 ft. respectively.

Provide flared or compression-type brass fittings for use with Type K annealed copper tubing in accordance with AWWA C 800.

**H. Brass Fittings for Underground Services Lines and Small Mains (Less Than 24 Inches in Diameter).**

**1. General.** Unless otherwise provided in this specification, use brass fittings in underground installations of service lines and small mains in the water distribution system.

Use brass fittings composed of Copper Alloy No. C 83600 conforming to the requirements of ASTM Designation B62. Ensure the general pattern for each fitting conforms to that of standard brass fittings as manufactured by Mueller Company, Hays Manufacturing Company, or an approved equal.

Compression fittings may be used for unions except where they occur under existing or future paving. Use compression tube fittings with Buna-N beveled gaskets.

Ensure each fitting has the manufacturer's name or trademark and size plainly stamped into or cast on the body. Provide straight pipe adjacent to fittings for at least 10 in.

Provide waterways no smaller in diameter than the nominal size of the stop and accurately finish to a watertight joint; face all nuts and washers to a true fit; and

design them such that the joint remains watertight and reasonably easy to operate after repeated use over a number of years. Use external threads conforming to AWWA Standard C800 and, on corporation stops, protect them in shipment by using plastic coatings or an alternate approved method.

**2. Corporation Stops.** Provide inlet ends of one of the following types: Standard corporation stop threads as specified in Table 1, AWWA C800; iron pipe thread (permissible for use with service saddles only); or Hays 4200- 4202 or approved equal.

Use one of the following types of valve body: Tapered plug type; "O-ring" seat ball type; or the rubber seat ball type.

Provide outlet ends with a flared-copper connection for use with Type-K soft copper or compression type fitting.

For PVC pipe, provide all brass corporation stops specifically designed for use with PVC pipe.

3. **Curb Stops.** Provide inlet ends with flared copper connections or compression type fittings.

   Use a valve body with a straight through or angled meter stop design equipped with padlock wings and of the "O-ring" seal straight plug type or the rubber seat ball type.

   Provide the outlet with female iron pipe threads or swivel nut meter spud threads, 3/4-in. and 1-in. stops, and with 2-hole flanges for 1-1/2 in. and 2-in. sizes.

4. **Service Saddles.** Provide service saddles with dual straps and of one of the following types: Brass body and straps; ductile-iron body and straps, vinyl coated; ductile-iron body, vinyl coated with stainless steel straps.

   Taps for PVC Water Mains: Use dual strap or single, wide band strap saddles which provide full support around the circumference of the pipe and a bearing area with enough width along the axis of the pipe, 2 in. minimum, to ensure that the pipe will not be distorted when the saddle is tightened. Use Romac Series 101N wide band, stainless-steel tapping saddle with AWWA standard thread (Mueller thread), or approved equal.

5. **Angle Stops.** Provide angle stops in accordance with AWWA C800; ground-key, stop type with bronze lock-wing head stop cap; inlet and outlet threads conforming to the application tables of AWWA C800; and inlet side with a flared connection or Mueller 110 compression type, or an approved equal.

   a. **Outlet for 3/4-Inch and 1-Inch Size.** Meter swivel nut with saddle support.

   b. **Outlet for 1-1/2 Inch Through 2-Inch Size.** "O-ring" sealed meter flange, iron pipe threads.

6. **Fittings.** Provide fittings in accordance with AWWA C800 and as described below:

   a. **Castings.** Smooth, free from burrs, scales, blisters, sand holes, and defects which would make them unfit for their intended use.

   b. **Nuts.** Smooth cast and with symmetrical hexagonal wrench flats.

   c. **Flare-joint fittings.** Smooth cast. Machine seating surfaces for metal-to-metal seal, to proper taper or curve, free from any pits or protrusions.

   d. **Thread fittings.** Use N.P.T. threads and protects male threaded ends in shipment by using plastic coatings or other equally satisfactory means.

**e. Compression Tube Fittings.** Provide with a Buna-N beveled gasket.

Brass fittings will require the following factory testing:

- Submerge in water for 10 seconds at 85 psi with stops in both closed and open positions.
- Reject any fittings that show air leakage. The Department may confirm tests locally. An entire lot from which samples were taken will be rejected when random sampling discloses unsatisfactory fittings.

## I. Gate Valves, Tapping Valves, and Tapping Sleeves.

**1. Gate Valves.** Use gate valves conforming to AWWA Standard C500, C509, C515, and the following supplemental specifications:

Provide direct-bury valves and valves in subsurface vaults that open clockwise. Provide above-ground valves that open counter-clockwise.

If the type of valve is not indicated on the plans, use gate valves as line valves for sizes less than 20 in. If the type of valve is specified, no substitute will be allowed.

Use a valve body of straight-through or angled, meter-stop design equipped with the following:

- **O-Ring Seal.** Straight plug type.
- **Rubber Seat.** Ball type.

Provide the outlet end with female, iron-pipe threads or swivel-nut, meter-spud threads on 3/4-in. and 1-in. stops; and with a 2-hole flange on 1-1/2 in. and 2-in. sizes.

**a. Gate Valves 1-1/2 Inches in Diameter and Smaller.** Use an operating pressure of 125 psi; bronze mounting; rising-stem; single-wedge; disc type; screwed ends; Crane No. 428, or approved equal.

**b. Gate Valves 2 Inches in Diameter.** Use an iron body; double gate; non-rising stem; 150-lb. test; 2-in. square nut operating clockwise to open.

**c. Gate Valves 4 Inches to 12 Inches in Diameter.** Non-directional; standard-wall resilient-seated in accordance with AWWA C509, parallel seat double disc in accordance with AWWA C500, or reduced-wall resilient-seated gate valves AWWA C515; operating pressure of 200 psi; pressure rating bronze mounting; push-on bell ends with rubber joint rings and nut-operated unless otherwise specified; resilient-seated provided by American Darling AFC-500, US Pipe Metro Seal 200, or approved equal; Reduced-wall resilient seated valves by American Flow Control Series 2500, or approved equal; double disc provided by American

Darling 52, Clow F-6102, or approved equal; and comply with following unless otherwise shown on the plans:

(1) **Design.** Fully encapsulated rubber wedge or rubber seat ring mechanically attached with minimum 304 stainless steel fasteners or screws; threaded connection isolated from water by compressed rubber around opening.

(2) **Body.** Cast or ductile iron; flange bonnet and stuffing box together with ASTM A307 Grade B bolts. Cast the manufacturer's initials, pressure rating, and year manufactured into the valve body.

(3) **Bronze.** Ensure that the valve components in the waterway contain at most 15% zinc and at most 2% aluminum.

(4) **Stems.** ASTM B763 bronze, alloy number 995 minimum yield strength of 40,000 psi; minimum elongation in 2 in. of 12%; non-rising.

(5) **"O-rings."** For AWWA C509, Sections 2.2.6 and 4.8.2. For AWWA C500, Section 3.12.2. For AWWA C515, Section 4.2.2.5.

(6) **Stem Seals.** Consist of 3 "O-rings," 2 above and 1 below the thrust collar, with an anti-friction washer located above the thrust collar.

(7) **Stem Nut.** Independent or integrally cast of ASTM B62 bronze.

(8) **Resilient Wedge.** Molded; synthetic rubber; vulcanized and bonded to cast-iron or ductile-iron wedge tested to meet or exceed ASTM D429 Method B; or attached with 304 stainless steel screws; seat against epoxy-coated surface in the valve body.

(9) **Bolts.** Furnish in accordance with AWWA C509 Section 2.2.5, AWWA C500 Section 3.4, or AWWA C515 Section 4.4.4 stainless steel; cadmium-plated, or zinc-coated.

**d. Gate Valves 14 Inches and Larger in Diameter.** AWWA C500; parallel seat double disc, or AWWA C515; reduced-wall, resilient-seated gate valves; flanged ends and nut-operated unless otherwise specified. Provide reduced-wall resilient-seated valves with 250 psig pressure rating and manufactured by American Flow Control Series 2500, or approved equal. Provide double disc valves with 150 psig pressure rating and manufactured by American Darling 52, Clow F-6102, or approved equal. Comply with following requirements unless otherwise shown on the plans:

(1) **Body.** Cast iron or ductile iron; flange together bonnet and stuffing box with ASTM A 307 Grade B bolts. Cast the following into the valve body: manufacturer's initials, pressure rating, and year manufactured. When mounting horizontally, equip valves greater in diameter than 12 in. with rollers, tracks, and scrapers.

(2) **"O-rings."** For AWWA C500, Section 3.12.2. For AWWA C515, Section 4.2.2.5.

(3) **Stems.** ASTM B 763 bronze, alloy number 995 minimum yield strength of 40,000 psi; minimum elongation in 2-in. of 12%, non-rising.

**(4) Stem Nuts.** Machined from ASTM B 62 bronze rod with integral forged thrust collar machined to size; non-rising.

**(5) Stem Seals.** Consist of 3 "O-rings," 2 above and 1 below the thrust collar, with an anti-friction washer located above the thrust collar for operating torque.

**(6) Bolts.** AWWA C500 Section 3.4 or AWWA C515 Section 4.4.4; stainless steel: cadmium-plated, or zinc-coated.

**(7) Discs.** Cast iron with bronze disc rings securely pinned into machined dovetailed grooves.

**(8) Wedging Device.** Solid bronze or cast-iron, bronze-mounted wedges. Thin plates or shapes integrally cast into cast-iron surfaces are acceptable. Provide other moving surfaces integral to wedging action that are bronze monel or nickel alloy-to-iron.

**(9) Gear Cases.** Cast iron; furnished on 18-in. and larger valves and of extended type with steel side plates; lubricated; gear case enclosed with oil seal or "O-rings" at shaft openings.

**(10) Bronze Mounting.** Built as integral unit mounted over, or supported on, cast-iron base and of sufficient dimensions to be structurally sound and adequate for imposed forces.

**(11) Stuffing Boxes.** Located on the top of the bonnet and outside the gear case.

Provide a bypass for double-disc gate valves 24 in. and larger.

**e. Gate Valves 14 Inches to 36 Inches in Diameter.** Provide AWWA C515, reduce-wall, resilient- seated gate valves with 250 psi pressure rating. Furnish with spur or bevel gearings.

Mount valves horizontally if proper ground clearance cannot be achieved by normal vertical installation. For horizontally mounted gate valves, provide bevel operation gear mounted vertically for above ground operation.

Use valve body, bonnet, wedge, and operator nut constructed of ductile-iron.

Fully encapsulate the exterior of the ductile-iron wedge with rubber. Ensure the wedge is symmetrical and seals equally well with flow in either direction.

Bolts: AWWA C515, Section 4.4.4, stainless steel; cadmium-plated or zinc-coated.

Provide high-strength bronze stem and nut.

"O-rings:" AWWA C515, Section 4.2.2.5, pressure "O-rings" as gaskets. Provide stem sealed by 3 "O-rings." The top 2 "O-rings" are to be replaceable with the valve fully open at the full rated working pressure. Provide thrust washers for the thrust collar for easy valve operation.

Where installing at depths greater than 4 ft., provide gate valves with a non-rising, extension stem with a coupling able to attach securely to the operating nut of the valve. Terminate the upper end of the extension stem in a square wrench nut no deeper than 4 ft. from the finished grade. Support the extension stem with an arm attached to the wall of the manhole or structure that loosely holds the extension stem and allows rotation in the axial direction only.

Provide gate valves in factory mutual type meter installations conforming to the provisions of this specification with outside screw and yoke valves, and carrying the label of Underwriter's Laboratories, Inc.

Provide coatings in accordance with AWWA C550; Indurall 3300 or approved equal, that are non-toxic; do not impart taste to water; function as a physical, chemical, and electrical barrier between base the metal and surroundings; and are a minimum 12-mil thick fusion-bonded epoxy. Before assembling the valve, apply the protective coating to the interior and exterior surfaces of the body.

Provide flange joints when the valve is connected to steel pipe.

Mount valves horizontally if the proper ground clearance cannot be achieved by a normal vertical installation. For horizontally mounted gate valves, provide bevel operation gear that is mounted vertically, for above ground operation.

**2. Tapping Valves.** Provide double disc or resilient wedge type tapping valves meeting the requirements of gate valves, as listed above, except for the type of joints; inlet flanges meeting AWWA C110, Class 125 or meeting AWWA C110, Class 150 or higher and with a minimum eight-hole flange. Provide outlets with standard mechanical or push-on type joints that fit any standard tapping machine.

Provide a valve seat opening such that a full-size shell cutter for the nominal size tap may pass through the valve without any contact with the valve body.

Provide valve boxes conforming to the requirements of Section 2.K, "Valve Boxes," of this specification.

**3. Tapping Sleeves.** Provide tapping sleeve bodies in accordance with AWWA C110 ductile-iron; or AWWA C111 carbon steel; in 2 sections to be bolted together with high-strength, corrosion-resistant, low-alloy, steel bolts, and with mechanical joint ends.

Provide flanged branch outlets of tapping sleeves; machined recess in accordance AWWA C207 Class D, ANSI 150 lb. drilling. Ensure the gasket is affixed around the recess of the tap opening to preclude rolling or binding during installation.

Provide tapping sleeves with a 3/4-in. NPT test opening for testing before tapping. Provide a 3/4-in. bronze plug for the opening.

**a. Steel Sleeves.** Do not use steel sleeves for taps greater than 75% of the pipe diameter.

Use steel sleeves only on pipe diameters 6-in. and larger. No "size-on-size" sleeve will be permitted (i.e., 6 in. x 6 in., etc.).

To accomplish size-on-size connections, the next smaller tap may be made and a LEB (large end bell) increaser used. Where fire service from a 6-in. main is approved, only a ductile-iron split sleeve is permitted.

Provide a body of heavy welded steel construction. Groove the top half of the body to permanently retain a neoprene "O-ring" seal against the outside diameter of the pipe.

Provide fusion-bonded steel sleeves, epoxy-coated to a minimum 12 mil thickness. Ensure the finished epoxy coat is free of laminations and blisters; does not peel; remains pliant and resistant to impact. Ship steel sleeves in wooden crates that protect the epoxy coating during transport and storage.

Use bolts and nuts conforming to AWWA Standard C500, Section 3.5, and coated with a 100% vinyl resin (or made of corrosion resistant material).

Steel Tapping Sleeves: Use Smith Blair No. 622, Rockwell No. 623, JCM No. 412, or approved equal.

**4. Air Release and Vacuum Relief Valves.**

**a. Combination Air Valves.** Provide where combination air valves are designed to fulfill the functions of air release, permitting the air accumulated in the line at the high point of elevation to escape while the line is under pressure, and vacuum relief. Valve exterior: Paint with shop-applied primer suitable for contact with potable water. Provide Apco Model 145C or 147C, Val-matic Series 200, or approved equal valves as shown on the plans.

**b. Air Release Valves.** Provide with flanged inlet and outlet connections as specified on the plans. For 2-in. and 3-in. single body valves, size the orifice for a 100 psi working pressure. Fabricate the air relief valve of materials as follows: body and cover, ASTM A 48, Class 30 cast-iron; float and leverage mechanism, ASTM A 240 or A 276 stainless steel; orifice and seat, stainless steel against Buna-N or Viton mechanically retained with hex head nut and bolt. Other valve internals: stainless steel or bronze.

**c. Air Release and Vacuum Valves.** Provide single-body standard combination or duplex-body custom combination valves as shown on the plans.

**(1) For 2-Inch and 3-Inch, single-body valves,** provide inlet and outlet sizes as shown on the plans and an orifice sized for a 100 psi working pressure. Valve materials: Body, cover, and baffle, ASTM A48, Class 35, or ASTM A126, Grade B cast iron; plug or poppet, ASTM A276 stainless steel; float, ASTM A240 stainless steel; seat, Buna-N; other valve internals, stainless steel. Paint valve exterior with an epoxy shop-applied primer. Provide Apco Model 145C or 147C, Val-Matic Series 200, or approved equal.

**(2) For 3-Inch and larger duplex-body valves,** as shown on the plans, provide an Apco Series 1700 with a No. 200 air release valve, GA Industries Fig. No. AR/GH-21K/280, or approved equal.

Air and vacuum valve materials: Body and cover, ASTM A48, Class 35, cast iron; float, ASTM A240 stainless steel; seat, Type-304, stainless steel and Buna-N; other valve internals, stainless steel or bronze. Air release valve: Construct as specified in Section 2.I.4.b., "Air Release Valves."

5. **External Coating Above Ground Valves.** Coat valves with a polyurethane coating conforming to the same requirements under Section 2.B.7.c.(2)(b), "Polyurethane Coating."

**J. Butterfly Valves.** Provide butterfly valves and operators conforming to the requirements of AWWA Standard C504 Class 150B, except as modified or supplemented in this specification. Provide short-body valves with a flanged design for closing against a flow velocity of 16 ft. per second at a normal working pressure of 150 psi and with a downstream pressure of 0 psi (Class 150B).

Provide direct-bury valves and valves in subsurface vaults that open clockwise. Provide above-ground and plant valves that open counter-clockwise.

Body: Cast iron, ASTM 126, Class B.

Discs for Butterfly Valves: Either cast-iron or ductile-iron.

Provide valves with Buna-N or neoprene seats mounted either on the disc or in the body. Mechanically secure the seats, not relying solely on adhesive properties of epoxy or similar bonding agents to attach the seats to the body. Mechanically retain the seats on the disc by using stainless steel (18-8) retaining rings held in place by stainless steel (18-8) cap screws that pass through a rubber seat for added retention. When the seat is on the disc, retain the seat in position by using shoulders located on both the disc and the stainless-steel retaining ring. Provide mating surfaces for seats of Type 304 or Type 316 stainless steel, secured to the disc by mechanical means. Sprayed on or plated mating surfaces will not be allowed. Provide a cast-iron disc conforming to ASTM A126, Class B or ductile-iron conforming to AWWA C151. The seat must be replaceable in the field for valves greater than 30 in. in diameter. Valves with segmented retaining rings will not be accepted.

Coat interior wetted ferrous surfaces of the valve, including the disc, with epoxy suitable for potable water conditions. Furnish epoxy, perform surface preparation, and apply epoxy in accordance with AWWA C550 and the coating manufacturer's recommendations. Provide 3 coats of 2-component, high-build epoxy with a minimum dry thickness of 12 mils. Use Indurall 3300, or approved equal, epoxy coating. Holiday test and measure the coatings for thickness.

Use Type 304 or Type 316 stainless steel for the valve shaft and keys, 24 in. in diameter and greater, that require a minimum of 2 in., or taper pins used for attaching the valve shaft to the valve disc. Do not use a torque plug to attach the valve shaft to the valve disc. All portions of shaft bearings: Stainless steel, bronze, nylon, or Teflon (supported by fiberglass mat or backing material with a proven record of preventing Teflon flow under load) in accordance with AWWA C504, stainless steel bearing material. Design the valve shaft to withstand 3 times amount of torque necessary to the open the valve.

Packing: Field-adjustable, split-V type, and replaceable without removing the operator assembly.

Retaining hardware for seats: Type 304 or Type 316 stainless steel. Nuts and screws used with clamps and discs for rubber seats: Securely held with lock tight, or other approved method, from loosening by vibration or cavitational effects.

Seat the valve disc in a position 90 degrees to the pipe axis and ensure it rotates 90 degrees between the fully-opened and tightly-closed position. Install valves with valve shafts horizontal and the convex side of the disc facing the anticipated direction of flow, except where shown otherwise on the plans.

Use push-on or flanged (flanged valves coupled to Bell-Flange adapters may be used) joint types for installation with cast-iron or ductile-iron pipe. Use flanges conforming in dimensions and drilling to ANSI B16.1 for cast-iron body valves, Class 125. Use bolts conforming to AWWA Standard C500, Section 9, in valve installations, including bolts for operators, housing, etc. Use flanged joints for steel or concrete steel cylinder pipes.

Provide properly sized gear type actuators for valves 8-in. and larger. Provide fully enclosed and traveling-nut type, rack and pinion type, or worm-gear type gear actuators. Equip direct-bury valves with a 2-in. square nut operating clockwise to open the valve. Completely enclose the space between the actuator housing and the valve body. Ensure that no moving parts are exposed to the soil or elements. Provide oil-tight and water-tight actuators, factory packed with suitable grease. Use operators conforming to the requirements of AWWA Standard C504 and equipped with adjustable limit stop devices.

Design worm-gear and traveling-nut operators so a torque of 150 ft.-lb. or less will operate the valve at the most adverse condition for which the valve is designed. Ensure the vertical axis of the operating nut does not move as the valve is opened or closed.

If the type of valve is not indicated on the plans, use butterfly valves for line valve sizes 24 in. and larger. For valves 24 in. and larger, provide valves manufactured by Pratt, Dezurik, or approved equal. Provide valves from an approved manufacturer. Provide valves and actuators from the same valve or actuator manufacturer. Ensure the shaft connecting the actuator to the valve body is fully enclosed. Provide a fully enclosed, watertight bonnet and extension.

**K. Valve Boxes.** Provide Type “A,” cast-iron or ductile-iron slide-type valve boxes as manufactured by Bass and Hays Foundry, Inc. or approved equal. Ensure the chemical composition of Casting “A” conforms to the requirements of AWWA Standard C110. Fabricate the base of each valve box from 6-in. cast-iron or ductile-iron pipe, conforming to the requirements of this specification except that the lining and coating will comply with this Section.

Cast a letter “W” into the lid, 1/2 in. in height and raised 3/32 in., for valves serving potable water lines.

Coat boxes, bases, and lids by dipping them in hot bituminous varnish.

## L. Fire Hydrants.

**1. General.** Provide fire hydrants, including 6 in. gate valve and box, conforming to the requirements of AWWA C502, except as modified or supplemented in this specification, and that are on the Utility Owner's approved products list.

Provide fire hydrants conforming with AWWA C 502, Standards for Dry Barrel Fire Hydrants (Latest Edition). Provide hydrants that are approved by the City of Houston. Only hydrants with a current Certification of Responsibility will be allowed. The hydrants shown in Table 4 are currently approved. Alternative hydrants will not be considered.

**Table 4**
**Approved Hydrants**

| Hydrant | City of Houston Engineering Control Drawing |
|---|---|
| U.S. Pipe and Foundry Co. M-94 Metropolitan 5-1/4 in. A495 | DWG 960324 Rev. dated 2/06/02 |
| Mueller Company Super Construction 250 5-1/4 in. A423 | DWG FH-70 Rev. B dated 7/2/08 |
| American AVK Company AVK Series 2780 Nostalgic | DWG 2780-Houston-2 Rev. AAD3, dated 3/24/04 |

Ensure they are of dry-barrel, tamper resistant, and collision-safety construction design. Provide hydrants from same manufacturer throughout the project.

Installation of used, salvaged, or reconditioned fire hydrants will not be permitted.

**2. Hydrant Barrel.** Fabricate the lower hydrant barrel as a ductile-iron single piece, and connect it to the upper hydrant barrel by means of a joint coupling that will provide a 360 degree rotation of the upper barrel. Clearly mark the finish grade on the barrel. Provide the specified bury length, equal to the distance from the bottom of the inlet to the ground line.

Provide the hydrant barrel with a non-tapped, non-corrodible drain or drip valve, completely made of bronze or bronze-lined. Ensure the drain valve operates, automatically and positively, to drain the barrel when the hydrant valve is in the fully-closed position, and to completely close the drain opening so as to prevent leaking when the hydrant valve is in the open position.

Equip each hydrant barrel with two 2-1/2 in. nominal inside diameter hose nozzles and a single 4-in. nominal inside diameter pumper nozzle conforming with National (American) Standard Fire Hose Coupling Screw Threads, bronze (minimum Grade D) (per NFPA No. 194 and ANSI B26-1925).

Security fasten field-replaceable nozzles into the upper barrel by mechanical means, install by turning counterclockwise, seal with "O-rings," and mechanically lock in place with a security device. Provide nozzles with nozzle caps and neoprene gasket seals. Securely attach the caps to the hydrant barrel with chains of not less than 1/8-in. diameter. Situate the pumper nozzle to allow an unobstructed radius of

10 in. from the threaded surface of the nozzle throughout the path of travel of a wrench or other device used to fasten a hose to the nozzle.

Orient the hydrant so that the pumper nozzle faces the curb or street nearest the hydrant.

Design the barrel joint connecting the upper and lower hydrant sections so that the hydrant shut-off valve will remain closed and reasonably tight against leakage in the event of an impact accident resulting in damage to or breaking of the hydrant above or near ground level. Provide the joint with a breakable bolt flange or breakable coupling including an adequate number of bolts, above finish grade.

Fabricate the operating and hold down nuts of stainless steel, cast-iron, or ductile-iron with bronze inserts. Provide a security device with each hydrant employing a bronze operating nut to protect this feature of the hydrant from malicious mischief or unauthorized removal. Ensure that such security devices do not require special tools for normal off/on operation of the hydrant. For the operating nut, use a tapered pentagon 1-1/2 in. point to face at the base, and 1-1/8 in. point to face at the top of the nut, opening left (counter-clockwise). Fabricate hold down assemblies of metallic materials suitable for the intended service.

Design the hydrant barrel to permit the use of one or more standard extensions, available from the hydrant manufacturer, in lengths from 6-in. to 60-in. in 6-in. increments.

3. **Shut-Off Valve and Inlet Shoe.** Provide hydrants with circular, compression-type shut-off valves which close with the water pressure, with center stem construction and which remain closed and tight against leakage upon impact. Ensure each shut-off valve is circular and not less than 5-1/4 in. in diameter. Seal the bottom end of the stem threads from contact with water by using a cap nut. Provide a bronze valve seat ring, threaded into a bronze drain ring to provide an all-bronze drain way. Ensure the seat ring and main valve assembly is removable from above ground through the upper barrel by using a light-weight seat removal wrench.

   Construct the valve seat facing of molded rubber with a Durometer rating of 90 ± 5, a minimum thickness of 1/2 in., and that is resistant to microbiological attack.

   Unless otherwise shown on the plans, provide a hydrant inlet shoe that is an elbow with the AWWA standard bell designed for a nominal 6-in. mechanical joint hub end, or push-on assembly as specified. Provide a hydrant shoe of cast-iron or ductile-iron pipe that is flanged, swivel or slip joint with harnessing lugs for restrained joints. Coat the interior of the shoe with a minimum of 12 mils of fusion-bonded epoxy conforming to NSF Standard 61. For underground flanging, incorporate a minimum of 6 full 3/4-in. diameter electro-galvanized or cadmium-coated steel bolts or four 5/8-in. diameter stainless or cadmium-coated steel bolts.

4. **Valve Stem.** Where threads are located in the barrel or waterway, use Everdure operating stems, or other high-quality, non-correctible metal.

Use bronze-to-bronze working parts in the waterway; genuine wrought-iron or steel where threads are not located in the barrel or waterway, bronze bushed at the penetration of the stuffing box; seal the threads against contact with water regardless of the (open or closed) position of the main valve. Provide the valve stem with a breakable stem coupling opposite the barrel breakaway feature. Construct connecting pins and locking devices of bronze or other corrosion-resistant material. Provide the valve stem with a bronze sleeve, "O-ring" seals, and travel stop. Ensure the operating threads, working parts, and bearing surfaces are fully lubricated during normal operation of the fire hydrant. Ensure the lubricant is contained in a lubricating reservoir that is sealed at the top and bottom. Equip the operating assembly with a thrust bearing or lubricated thrust collar to minimize operating torque. Provide a lubricant meeting the requirements of FDA 21 CFR 178.3570 and manufactured with FDA-approved oxidation inhibitors.

Provide a valve stem that operates counterclockwise (turning to the left) to open.

5. **Gaskets and Seals.** Provide dynamic seals of "O-ring" type, oil-resistant material, which do not require adjustment for a watertight seal. Provide moving parts in contact with the seal made of bronze or other corrosion-resistant material.

   Provide static seals of Buna "N" or other approved synthetic composition.

6. **Painting.** Shop coat the fire hydrant's exterior with 1 coat of rust prohibitive primer. Ensure the top half of the hydrant from the traffic flange up, receives 1 coat of blue enamel before delivery to the jobsite as outlined by the following:

   a. **Exterior Above the Traffic Flange (Including Bolts and Nuts).** Prepare the surface in accordance with SSPC-SP10(NACE 2), near-white blast-cleaned surface.

      Coat with a 3-coat alkyd/silicone/alkyd system with a total dry film thickness (DFT) of 6-9 mils as follows:

      - Prime Coat - Oil Modified Alkyd Primer, Acro Products No. 1104, Heavy Duty Tank & Steel Primer, or approved equal, in general accordance with SSPC Paint Specification No. 25. Apply with a total dry film thickness (DFT) of 2-3 mils.
      - Intermediate Coat - Heavy Duty Industrial Alkyd Enamel, Acro Products No. 2214, or approved equal, in general accordance with SSPC Paint Specification No. 104, and Federal Standard TT-E-489. Apply with a total dry film thickness (DFT) of 2-3 mils.
      - Finish Coat - Silicone Alkyd Resin Enamel, Acro Products No. 2215, or approved equal, in general accordance with SSPC Paint Specification No. 21. Total dry film thickness (DFT) of 2-3 mils. Except do not finish shop coat the hydrant bonnet, only intermediate coat it. Field applies and color code the finish coating when installed.
      - Colors – For primer, use the manufacturer's standard color. For the finish coat of the hydrant body, use blue (Acro 555 crystal blue or equivalent).

Finish coat the hose connection caps white, and paint a white band of finish coat 2 in. in width on the hydrant body approximately 6 in. above and parallel to the traffic flange. For intermediate coat, use a contrasting color to the blue finish coat, such as white.

**b. Exterior Below the Traffic Flange.** Prepare the surface in accordance with SSPC-SP10 (NACE 2), near-white blast-cleaned surface.

Coat with a 3-coat system as follows:

Primer and intermediate coat - coal tar epoxy, Acro Products No. 4467, or approved equal, in general accordance with SSPC Paint Specification No. 16. Apply 2 coats with a dry film thickness (DFT) of 8-10 mils each, for a total dry film thickness (DFT) of 16-20 mils.

Finish coat - water based vinyl acrylic mastic, Acro Products No. 7782, or approved equal. Apply 1 coat with a dry film thickness (DFT) of 6-8 mils. For the color of the finish coat, use the same as for the finish coat for the exterior above the traffic flange i.e., blue (Acro 555 crystal blue or equivalent).

**c. Interior Surfaces Above and Below the Main Valve.** Provide material used for internal coating of hydrant interior ferrous surfaces below the main valve that is NSF61 listed as suitable for contact with potable water, as required by Chapter 290, "Rules and Regulation for Public Water Systems," Texas Commission on Environmental Quality (TCEQ).

Prepare the surface in accordance with SSPC-SP10 (NACE 2), near-white blast-cleaned surface.

Provide a liquid or powder epoxy system coating in accordance with AWWA Standard C-550. Apply the coating in 2 or 3 coats, according to the manufacturer's recommendations, for a total dry film thickness of 12-18 mils.

**d. General.** Apply coatings in strict conformance with the manufacturer's recommendation. No requirement of this specification cancels or supersedes the written directions and recommendations of the specific coating manufacturer so as to jeopardize the integrity of the applied system.

Ensure the hydrant supplier furnishes an affidavit of compliance that the materials and work furnished comply with the requirements of this specification and applicable standards referenced in this Item.

After installing the hydrants and before the main is accepted, paint the bonnet portion of each fire hydrant as shown in Table 5.

**Table 5**
**Fire Hydrant Bonnet Colors**

| Size of Supply Line (in.) | Color of Bonnet |
|---|---|
| 6 | Yellow |
| 8 | White |
| 10-20 | Green |
| 24-and larger | Orange |

Ensure the color shades and paint quantities are approved and comply with the current specifications.

**7. Performance Standards.** Provide hydrants capable of a free discharge of 1,500 gal. per minute (gpm) or greater, from a single pumper nozzle at a hydrant inlet static pressure not exceeding 20 psig as measured at or corrected to the hydrant inlet at its centerline elevation.

Provide hydrants capable of a discharge of 1,500 gpm or greater from a single pumper nozzle at a maximum permissible head loss of 8.0 psig (when corrected for inlet and outlet velocity head) for an inlet operating pressure not exceeding 37 psig as measured at or corrected to the hydrant inlet at its centerline elevation.

Hydraulic Performance Testing: AWWA C502; ensure the certified pressure loss and quantity of flow test is conducted by a qualified testing laboratory on a production model (5-ft. bury length) of the hydrant (same catalog number) proposed for certification. Submit a certified test report containing following information:

**a.** Date of test, within the previous 5 years, on a fire hydrant with similar hydraulic characteristics.

**b.** Name, catalog number, place of manufacture, and date of production of hydrants tested.

**c.** Schematic drawing of testing apparatus, containing dimensions of piping elements including:

**(1)** Diameter and length of inlet piping.

**(2)** Distance from flow measuring points to pressure measurement point.

**(3)** Distance from flow and pressure monitoring points to hydrant inlet.

**(4)** Distance from pressure monitoring point to nozzles.

**(5)** Diameter and length of discharge tubing.

**d.** Elevation of points of measurement, inlet, and outlet.

**e.** Reports or certificates documenting the accuracy of the measuring devices used in testing.

Conduct the tests on at least 3 hydrants of the same fabrication design. Inlet water temperature: 70 F ± 5 F.

For traffic impact testing, submit a certified test report outlining the results of the traffic impact test involving standard production models of the fire hydrant with breakable barrels of the same design as that proposed for certification. Install these hydrants per AWWA C600; strike at a point 18 in. ± 2 in. above the designated ground line. Conduct tests using the point of impact on hydrant barrel within 2 in. of a line perpendicular to base and equidistant from the pumper nozzle and one hose nozzle.

Conduct successive tests simulating impacts by standard American-made vehicles with gross weights of 3,500 lb., 5,500 lb., and 10,500 lb.

**f.** Document the tests to provide the following minimum information:

**(1)** Detailed schematic drawings of the test facility.

**(2)** Complete description of the mechanical impact testing equipment used.

**(3)** Complete list of the hydrant parts and materials damaged in each impact test.

**(4)** Photographs.

**(5)** Size and static pressure of the line to which the hydrant is attached.

**(6)** Estimated of amount of water discharged, if any, from the hydrant within 30 minutes immediately following the collision.

**8. Hydrant Leads.** Provide hydrant branch leads conforming to the same requirements under Sections 2.B.3., "Steel Pipe Fittings;" 2.C., "Ductile-Iron Pipe Fittings;" or 2.D., "Polyvinyl Pipe Fittings" of this specification.

## M. Polyethylene Film Wrap.

**1. General.** Except where noted on the plans, use polyethylene film as a wrap to protect cast-iron pipe, ductile-iron pipe, and fittings. Provide polyethylene film conforming to the requirements outlined in this specification and use only in open-cut construction.

**2. Film.** Provide polyethylene film in accordance with ASTM 1248 and AWWA C105, Type 1, Class C, Category 5, Grade J-3, 2.5 to 3% carbon black content. Unless otherwise shown on the plans, provide film 8 mils thick with a minimum tensile strength of 1,200 to 2,500 psi, elongation up to 600% and either in tubular or sheet form. Furnish film supplied in tubular form in the minimum widths shown in Table 6.

**Table 6**
**Minimum Width of Film Tube (when laying flat)**
**Push-on Joint**

| Nominal Pipe Size (in.) | Flat Tube Width (in.) |
|---|---|
| 4 | 14 |
| 6 | 17 |
| 8 | 21 |
| 10 | 25 |
| 12 | 29 |
| 14 | 33 |
| 16 | 37 |
| 18 | 41 |
| 20 | 45 |
| 24 | 53 |

For film in sheet form, furnish in widths equal to twice that shown for tube widths.

3. **Polyethylene Tape.** For taping film edges and overlays, use 3-in. wide plastic-backed adhesive tape. Use Polyken No. 900, Scotch Wrap No. 50, or approved equal.

**N. Bedding Material.** Unless otherwise shown on the plans, provide one of the following types of bedding for water mains:

1. **Bank Run Sand.** Furnish bank run sand bedding as called for in these specifications and consisting of soil classified as SP, SW, or SM by the Unified Soil Classification System (USCS). Provide sand with a plasticity index, when tested, of less than 7% and a liquid limit of 25 or less. Ensure the bank run sand gradation has a maximum of 15% passing the No. 200 sieve when tested, and is free of roots, organic material, trash, clay lumps, or other deleterious or objectionable material.

2. **Concrete Sand.** Furnish concrete sand bedding conforming to the specifications for Fine Aggregates specified in ASTM Standard C-33. Provide Fine Aggregates consisting of natural sand, manufactured sand, or a combination of the two, within the gradation limits shown in Table 7.

**Table 7**
**Fine Aggregate Gradation**

| Sieve Size | Percent Passing |
|---|---|
| 3/8 in. | 100 |
| No. 4 | 95-100 |
| No. 8 | 80-100 |
| No. 16 | 50-85 |
| No. 30 | 25-60 |
| No. 50 | 10-30 |
| No. 100 | 2-10 |

Ensure the aggregates do not contain any roots, organic material, trash, clay lumps, or other deleterious or other objectionable materials, in excess of the limits prescribed in the C-33 Standard.

3. **Pea Gravel.** Furnish pea gravel bedding conforming to the specifications for Coarse Aggregates specified for No. 8 size in ASTM Standard C-33. Provide Coarse Aggregates consisting of gravel composed of small, smooth, rounded, stones or pebbles, within the gradation limits shown in Table 8.

**Table 8**
**Coarse Aggregate Gradation**

| Sieve Size | Percent Passing |
|---|---|
| 1/2 in. | 100 |
| 3/8 in. | 85-100 |
| No. 4 | 10-30 |
| No. 8 | 0-10 |
| No. 16 | 0-5 |

Ensure the aggregates do not contain any roots, organic material, trash, clay lumps or other deleterious or other objectionable materials, in excess of the limits prescribed in the C-33 Standard.

4. **Gem Sand.** Furnish gem sand generally conforming to specifications for Coarse Aggregates specified for No. 8 size in ASTM Standard C-33. Specifically, provide aggregates within the gradation limits shown in Table 9.

**Table 9**
**Gem Sand Gradation**

| Sieve Size | Percent Passing |
|---|---|
| 3/8 in. | 95-100 |
| 1/4 in. | 60-80 |
| No. 4 | 15-40 |
| No. 10 | 0-5 |

Ensure the aggregates do not contain any roots, organic material, trash, clay lumps, or other deleterious or other objectionable materials, in excess of the limits prescribed in the C-33 Standard.

**O. Backfill Material.** For sand backfill encasement of water mains, use one of the following materials, unless otherwise shown on the plans:

1. **Cement Stabilized Sand.** Furnish cement stabilized backfill containing a minimum of 5% cement per cubic yard of material placed, based on the dry weight of the aggregate in accordance with Tex-120-E. Provide materials consisting of aggregate, cement, and water. Use cement and water conforming to the material requirements of Item 421, "Hydraulic Cement Concrete." Provide sand aggregate, free from deleterious matter, with a plasticity index not greater than 6 when tested by Tex-106-E.

2. **Earth or Native Soil.** Furnish earth or native soil backfill consisting of soil containing no deleterious material such as trash, wood fragments, organic, or other objectionable material. Supply the material from either the material removed from the excavation or from offsite sources.

   The material may consist of soil classified by the Unified Soil Classification System (USCS) as ML, CH, CL, CL-ML, SC, SP, SM, SW, or GC. Use earth backfill that meets the compaction requirements specified in this Item and does not cause any settlement.

3. **Bank Run Sand.** Furnish bank run sand backfill as called for in these specifications and conforming to the same requirements as those under Section 2.N.1., "Bank Run Sand."

**P. Concrete.** Use Class "A" concrete conforming to the requirements of Item 421, "Hydraulic Cement Concrete," unless otherwise shown on the plans. Leave the forms in place unless directed to remove certain sections of the forms.

## Q. Water Meters, Meter Vaults, and Meter Boxes.

**1. Water Meters.** Provide meters of the type and size indicated on the plans.

**a. Provide Bolted Split Casings.** Main casings of meters and external fasteners: Copper alloy with minimum 75% copper for 5/8 in. to 2 in., bronze or cast-iron, hot-dipped galvanized or epoxy coating for coating for 3 in. and larger.

**b. Straightening Vanes.** Use non-corrosive material compatible with the case material.

**c. Intermediate Gear Train.** Do not allow the intermediate gear train to come in contact with water; operate in suitable lubricant.

Register: Automatic Meter Reading (AMR) type that provides pulse, contact closure, piezo switch, or encoder-generated output signal, compatible with Utility Owner's radio and telephone AMR systems. Provide a minimum 12 ft. of wire when permanently connected to the register. Lens: impact resistant. Register box: tamper resistant by means of a tamper screw or plug: Register: permanently sealed, straight-reading, center-sweep test hand, magnetic driven, reading in U.S. gallons. Digits: 6, black in color with the lowest registering three digits (below 1,000-gallon registration) in contrasting digit and background colors. Register capacity of meters: 9.99 million gallons for 5/8-in. to 2-in. and 999.999 million gallons for 3-in. and larger.

Connections: 5/8 in. to 1 in.: threads at each end; 1-1/2 in. to 2 in.: two-bolt oval flanges each end; 3 in. and larger: flange at each end.

Stamp the manufacturer's meter serial number on the outer case. Stamp the manufacturer's meter serial number on the outside of the register lid, when provided. Ensure the manufacturer's serial numbers are individual and not duplicated.

Meters: Equip with AMR type register to connect to the Utility Owner's AMR system. Compound Meter manufactured by: Badger, Hersey Products, Neptune, Sensus, or approved equal. Turbine Meters: manufactured by Badger, Hersey Products, Neptune, Sensus, or approved equal.

Fire Service Meters: manufactured by Hersey Products, Neptune, Sensus, or approved equal. Displacement Meters: manufactured by Badger, Neptune, Hershey, Kent, Sensus, or approved equal.

**d. Manufacturing Quality Control.** Permit successful interchangeability from one meter to another of same size; registers, measuring chambers and units, discs or pistons as units, change gears, bolts, nuts, and washers, without affecting the accuracy of the new meters.

**e. Commercial Meter Valves for Meter Installations.** Provide commercial meter valves identical to line valves except provide them with Class 125 flanges and equip them with hand wheels operating counterclockwise to open.

For pipe and fittings inside the meter box or meter vault, use ductile-iron conforming to Section 2.C., “Ductile-Iron Pipe and Fittings” of this Item and as specified on the plans.

**2. Meter Vaults.**

**a. General.** Furnish meter vaults in either of the following designs: precast concrete vault, cast-in-place concrete vault, or solid masonry, unless a specific type of construction is required on plans. Ensure dimensions and reinforcement complies with the Utility Owner’s standard meter vault drawings for the type and size shown on the plans. Use Class “S” concrete conforming to the requirements of Item 421, “Hydraulic Cement Concrete.”

**b. Precast Concrete Vaults.** Construct precast concrete vaults as shown on the plans. Use reinforcing steel conforming to the requirements of Item 440, “Reinforcing Steel.”

Install precast vaults in conformance with the manufacturer recommendations. Set level and on a minimum 3-in.-thick bed of sand conforming to the requirements of Section 2.O., “Backfill Material,” of this specification. Seal lifting holes with cement mortar or non-shrink grout.

**c. Meter Vault Floor Slab.** Slope the floor 1/4 in. per foot toward the sump. Make the sump 12 in. in diameter, or 12 in. square, and 4 in. deep, unless other dimensions are shown on the plans. Install dowels at a maximum of 18 in., center-to-center, or install a mortar trench for keying the walls to the floor slab.

**d. Cast-In-Place Concrete Vaults.** Construct cast-in-place concrete vaults as shown on the plans. Use reinforcing steel conforming to the requirements of Item 440, “Reinforcing Steel.” Key the walls to the floor slab.

**e. Frame and Cover.** Use A-36 welded steel, or approved equal. Fabricate the cover plate with a 1/4 in. skid-resistant raised pattern floor plate. Fabricate the meter access door from the same material as the cover plate. Perform welding in accordance with the provisions of Item 441, “Steel Structures.” Nondestructive testing will not be required.

Furnish castings for frames, grates, rings, and covers conforming to ASTM A48 Class 30. Provide locking covers if indicated on the plans. Use castings capable of withstanding the application of an AASHTO HS-20 loading, unless otherwise specified.

Provide covers and frames conforming to the shape dimensions, and with the wording or logos shown on the plans. The standard diameter dimension for manhole covers is 32 in. Furnish frames, grates, rings, and covers conforming to Item 471, “Frames, Grates, Rings, and Covers” except as noted above and except for measurement and payment.

**3. Meter Boxes.**

**a. General.** Furnish meter boxes for 5/8-in. through 1-in. meters of the following materials:

**(1) Non-traffic bearing locations.** Cast-iron, concrete, or plastic as specified on the plans.

**(2) Traffic bearing locations.** Cast-iron.

Meter boxes for 1-1/2 in. and 2-in. meters: cast-iron. Provide meter box lids with a key-operated, spring type, locking device and a reading lid. Ensure the lids contain enough metals so that the meter box is easily located with metal a detector. If words are specified on the plans, cast them into lid with letters of 1/2-in. height and raised by 3/32-in. Ensure the size reads 5/8-in. to 1-in. or 1-1/2 in. to 2-in.

Furnish meter boxes conforming to the following approximate dimensions:

- Length: At the top, 15-1/2 in.; at the bottom, 20 in.
- Width: At the top, 12-1/2 in.; at the bottom, 14-3/4 in.
- Height: 12 in.

Ensure that meter box extensions 3 in. and 6 in. in height are available from the manufacturer.

**b. Cast-Iron Meter Boxes.** Furnish cast-iron boxes that are clean and free from sand blow-holes or other defects, and conforming to the requirements of ASTM A48. Machine the bearing surfaces so that the covers seat evenly in the frames. Provide boxes and lids with a dipped, coal-tar-pitch, varnish finish. Provide lock-type meter boxes when shown on the plans. Ensure the lock mechanisms work with ease.

**c. Concrete Meter Boxes.** Furnish concrete meter boxes made of Class "A" concrete conforming to requirements of Item 421, "Hydraulic Cement Concrete." Construct boxes as shown on the plans. Furnish castings that are free from fractures, large or deep cracks, blisters or surface roughness, or any other defects that may affect serviceability.

**d. Plastic Meter Boxes.** Furnish plastic meter boxes made of high-density polyethylene conforming to the ASTM Specifications shown in Table 10.

**Table 10**
**ASTM Test Requirements for Plastic Meter Boxes**

| ASTM Test | Requirement |
|---|---|
| D256 | Impact Strength = 1.9 ft.-lb./in. (Izod, Notched) |
| D256 | Impact Strength = 6.4 ft.-lb./in. (Izod, Un-Notched) |
| D638 | Tensile Strength (2.0 Min) = 3,400 psi |
| D648 | Deflection Temperature = 170 degrees F |
| D790 | Flexural Modulus = 90,000 psi |
| D676 | Shore D Hardness, 55-65 Impact |

| | |
|---|---|
| | Strength, Falling Dart Method, 100 in.-lb. |

Provide meter boxes meeting the following test requirements:

**(1) Static Load.** Not less than 2,500 lb. using a 6-in. disc with direct compression exerted at the center of the top of the meter box with a solid plastic lid.

**(2) Deflection.** Not less than 1,000 lb. load required to deflect the top edge of the meter box 1/8 in.

Provide a meter box body, without lid, weighing approximately 7 lb.

**R. Affidavit of Compliance.** Unless otherwise directed, furnish a manufacturer's affidavit of compliance for each of the materials used in this project. Ensure the affidavit certifies that factory inspection and specified tests were performed and that the material furnished complies with the requirements outlined in this specification.

**S. Pressure Reducing Station.** Unless otherwise shown on the plans, furnish new and unused station piping, valves, and fittings, of the same type as specified on the plans.

Use Class "S" concrete conforming to Item 421, "Hydraulic Cement Concrete."

Provide reinforcing steel conforming to Item 440, "Reinforcing Steel."

Provide a Pressure Reducing Valve (PRV) with a strainer, in the location and arrangement shown on the plans. Provide a valve body made of ductile iron with Class 150 ANSI B16.1 flanges. Provide a valve cover made of ASTM A 48 cast iron. Use Buna-N rubber parts. No leather parts are allowed. Provide a resilient seat with a rectangular cross-section.

Valve internals: Provide a single moving disc and diaphragm assembly. Use a flexible nylon fabric-reinforced elastomer diaphragm integral with assembly. Provide valve internal trim (seat ring, disc guide, and cover bearing) made of stainless steel. Apply a heat fusion bonded epoxy coating to the internal and external surfaces of the valve body including the disc retainer and diaphragm washer. Holiday test the coating applied to the valve body to confirm a minimum even coating of 5-7 mils. Treat the stem with a penetrative salt nitride process. Use a Xylan-coated seat. Leather parts are not allowed. Prepare threaded connections by first using an approved pipe tape.

Furnish control tubing containing shutoff cocks with a "Y" strainer. Equip the valve to allow installing control tubing on either side of the valve. Equip the valve with a valve position indicator.

Ensure the valve and valve box are initially set in the field by an authorized manufacturer's representative. Set the downstream pressure at 60 psi unless otherwise specified. Ensure the PRV includes an adjustable and pressure sustaining pilot system. Use a diaphragm type or piston type valve for the main valve.

Provide Cla-Val Model 90-01BDSYKCKD, Watts ACV Model 115-3M, or approved equal.

Provide a basket strainer upstream of the pressure reducing valve as shown on the plans. Furnish a quick-opening type strainer body, of fabricated steel construction with ANSI Class 150 flanges. Use Type 304 stainless steel for the basket.

Provide a Hayward Model 90, or equal, for PRVs 4 in. to 24 in. When there are space constraints, provide a Hayward Model 510, or equal, for PRVs 14 in. or greater.

## 3. Construction.

### A. Excavation.

**1. Trenches.** Construct water lines and fire hydrant branches (leads) in open cut trenches with vertical sides except in those locations where the pipe is tunneled, cased, or augered. Construct the trenches to the dimensions shown in the excavation and backfill details.

Sheath and brace the trenches to the extent necessary to maintain the sides of the trench in a vertical position throughout the construction period. Protect excavation greater than 5 ft. in depth as specified by Item 402, “Trench Excavation Protection” or Item 403, “Temporary Special Shoring.”

Open and excavate the trenches to the finished grade. To allow for possible adjustment of the alignment and grade, locate the water mains to which the mains and fire hydrant branches (leads) under construction are to be connected, well in advance of making connections.

Construct water mains and fire hydrant branches (leads) in dry trenches. If necessary, employ well pointing or additional sheathing to accomplish this objective, at no additional cost to the Department.

For pipes less than 18 in. in diameter, the minimum trench width below the top of the pipe is the outside diameter of the pipe, plus 18 in. For pipes 18 in. and larger, the minimum trench width below the top of pipe is the outside diameter of pipe plus 24 in. Additional width will be required for unstable conditions. The Engineer will determine unstable conditions.

Where it is necessary to excavate trenches adjacent to improved property, take precautions to avoid damaging or impairing that property. Where it is necessary to disturb grass, shrubs, driveways, etc., restore such improvements to their original condition.

Use enough trench width or benches above the embedment zone when installing well point headers or manifolds and pumps, where the trench depth makes it uneconomical or impractical to pump from the surface elevation. Provide enough space between the shoring cross braces to permit equipment operations and handling the forms, pipe, embedment and backfill, and other materials.

Before moving the supports, place and compact the embedment to enough depth to provide protection of the pipe and stability of the trench walls. As the supports are moved, finish placing and compacted the embedment.

Immediately before placing the embedment materials, ensure the bottoms and sidewalls of trenches are free of loose, sloughing, caving, or otherwise unsuitable soil.

Place and compact the embedment materials directly against the undisturbed soils in the trench sidewalls or against sheeting which will remain in place.

Do not place trench shields or shoring within the height of the embedment zone unless using some means to maintain the density of the compacted embedment material. If using moveable supports in embedment zone, lift the supports incrementally to allow placing and compacting of the material against undisturbed soil.

Place haunching material around the pipe and compact it to provide uniform bearing and side support.

Place trench dams in Class I embedments near the midpoint of line segments longer than 100 ft. between manholes.

Where damage to the completed pipe installation work is likely to result from withdrawal of the sheeting, leave the sheeting in place.

**2. Existing Streets.** Unless otherwise shown on the plans, open cut existing streets.

Where water line construction requires cutting through existing streets outside the limits of new street construction, replace those streets in kind in conformance with the appropriate specifications in the proposal or as directed. When cutting pavement outside the Department's right of way, comply with the Utility Owner Street Cutting Ordinance.

Where, in the opinion of the Engineer, it is necessary to maintain traffic across a trench, construct temporary bridges as necessary to facilitate the movement of traffic.

At locations where the proposed water main parallels the edge of an existing permanent pavement (i.e., concrete pavement, concrete base with asphalt surface, etc.), and is 3 ft. or less from the edge of that pavement, protect the trench with timber sheathing and bracing. Leave the bracing in place at intervals of 5 ft. maximum.

Keep the street surface adjacent to the trench free of surplus spoil. Place construction materials at locations that minimize interference with the traveling public.

Do not close more than 2 street intersections at any one time unless authorized in writing.

**B. Jacking, Tunneling, Boring, or Augering.**

**1. General.** Perform jacking, tunneling, or augering for water mains and fire hydrant branches (leads) at the locations shown on the plans and at other locations specifically designated by the Engineer.

Unless otherwise shown on the plans, use casing pipe conforming to the requirements of Section 2.B.2., “Steel Casing Pipe,” of this specification.

Excavate auger pits to a finished grade at least 6 in. lower than that indicated by the construction stakes or as approved, to ensure that a dry pit bottom is encountered.

Provide a minimum width of jacking, tunneling, or augering pits such that there is at least 6 in. of space between the pipe and the walls of the auger pit. The maximum allowable width of the pit is 5 ft., unless otherwise approved. Ensure the width of the pit at the surface is not less than at the bottom. The maximum allowable length of the pit is 5 ft. longer than 1 full joint of pipe of the type being used and does not exceed 25 ft., unless approved.

Grout in place tunnels for water lines with 36 in. diameters. When casing size is 48 in. in diameter or greater, or when using a tunnel liner plate, regardless of the water line diameter, grout in place unless otherwise directed. Provide an annular grout consisting of a sand-cement mortar mix with a 28-day compressive strength of at least 1,500 psi, when tested in accordance with ASTM C 942. The maximum allowable density is 130 pcf.

Use admixtures meeting ASTM C 494 and ASTM C 1017 as required, to improve pump ability, control the time of set, hold sand in suspension, and reduce segregation and bleeding. Fill the annular space in 3 lifts to prevent pipe floating. In addition, place appropriate blocking between the carrier pipe and the top of the liner to maintain position. Place a concrete invert to facilitate threading the carrier pipe.

Do not allow inadvertent metallic contact between the casing and the carrier pipe. Place spacers to ensure that the carrier pipe is adequately supported throughout its length, particularly at ends, to offset setting and possible electrical shorting, unless otherwise approved by Engineer. Ensure the end spacer is within 6 in. of the end of the casing pipe, regardless of the size of the casing and carrier pipe or the type of spacer used. Casing spacers are designed to withstand much greater loads than can be safely applied to most coatings. Therefore, the spacing between spacers depends largely on the load bearing capabilities of the pipe coating and the flexibility of the pipe.

Install casing spacers in conformance with the manufacturer’s instructions. Use special care to ensure that subcomponents are correctly assembled, evenly tightened, and that no damage occurs while tightening the insulators or inserting the carrier pipe.

Seal the annulus between the carrier pipe and casing with casing end seals at each end of the casing.

Insulator Spacing:

- Provide spacing as shown on the plans with a maximum distance between spacers of 10 ft. for pipe sizes 4 in. to 14 in. and 8 ft. for pipe sizes 16 in. to 30 in.

- For ductile-iron pipe, flanged pipe, or bell-and-spigot pipe, install spacers within
  1 ft. on each side of the bell or flange, and one in the center of the joint when 18-ft. to 20-ft. long joints are used.
- If the casing or carrier pipe is angled or bent, reduce the spacing. Provide the casing with a smooth, continuous interior surface.

Perform bedding and backfilling of jacking, tunneling, boring, or augering pits in conformance with the details on the plans and these specifications.

**2. Jacking Steel Casing.** Perform jacking of steel casing in accordance with the requirements of Item 476, "Jacking, Boring, or Tunneling Pipe or Box."

**3. Tunneling.** Perform tunneling in accordance with the tunneling requirements of Item 476, "Jacking, Boring or Tunneling Pipe or Box."

**4. Boring or Augering.** Perform boring or augering in accordance with the requirements of Item 476, "Jacking, Boring or Tunneling Pipe or Box."

Do not exceed 100 ft. for the length of the auger hole without a receiving pit.

Do not exceed 75 ft. for the length of the auger hole for PVC pipe 12 in. and less in diameter without a receiving pit.

Do not exceed 40 ft. for the length of the auger hole for PVC pipe 16 in. and greater in diameter without a receiving pit.

At locations where water pipes cross underneath driveways (of 16 ft. or less in width) or sidewalks, install the pipe in tight fitting augered holes.

At locations where the centerline of the proposed water main is 10 ft. or less from the centerline of an 8 in. diameter or larger growing tree, place the pipe in a tight fitting augered hole. Extend the bored hole at least 4 ft. beyond each side of the tree.

Block the void space around the pipe in the augered hole with approximately 12 in. of packed clay or similar approved material, so that the bedding or backfill does not escape into the void around the pipe in the auger hole, when compacted.

Around the pipe, a use minimum volume of clay or similar acceptable material as shown in Table 11.

**Table 11**
**Volume of Clay or Acceptable Material for Blocking Voids**

| Pipe Diameter (in.) | Minimum Quantity (cu. ft.) |
|---|---|
| 4 through 8 | 0.5 |
| 12 through 16 | 0.75 |

**5. Bedding for Trenches and for Jacking, Tunneling, Boring, or Augering Pits.**

**a. Pipe Bedding for Water Mains Less Than 24 Inches in Diameter.**

**(1) Open Cut Trench Installation.** Construct trenches with a minimum of 6-in. bedding. Remove the soil in the bottom of the trench, excavate to a minimum depth of 6 in. below the bottom of the pipe, and replace the soil with bedding material. Remove saturated material from the bottom of the pit before placing the bedding. Place the pipe in the bedding such that there is a 6-in. bedding below and up to the spring line of the pipe.

Compact the bedding material to within 95% of the standard density within 5% of the optimum moisture as determined by Tex-113-E. Mechanically compact the bedding material by using vibratory equipment or any other acceptable equipment.

**(2) Jacking, Tunneling, Boring or Augering Pits.** Construct pits with a minimum of 6-in. bedding. Remove the soil in the pit, excavate to a minimum depth of 6 in. below the bottom of the pipe and replace the soil with bedding material.

If the bottom of the excavation becomes wet due to the presence of groundwater and a dewatering system is not required, and if directed, over excavate an additional 6-in. to a depth of 1 ft. below the bottom of the pipe. Place a non-woven geotextile fabric and then compact 12 in. of bank run sand or concrete sand in a single lift on top of the fabric. Compact the upper 6 in. to 90% of the standard maximum density as determined by Tex-113-E. The Engineer may require the Contractor to remove unstable or unsuitable material, even though the Contractor has not determined the material to be unsuitable.

Mechanically compact the bedding material by using vibratory equipment or any other acceptable equipment. Compact the bedding material to 95% of the standard density within 5% of the optimum moisture, as determined by Tex-113-E.

**(3) Bedding Materials.** The following are the acceptable materials for bedding as described in Section 2.N., “Bedding Material,” of this specification:

- Pea Gravel
- Bank Sand.

Bank run sand may be used as bedding material around the pipe only if, in the opinion of the Engineer, the trench bottom and sides are dry. If sand is used, place the pipe in the bedding so that there is at least a 6-in. bedding around and on top of the pipe. Compact the sand as described in Section 3.B.5.a.(1), “Open Cut Installation” above.

**b. Pipe Bedding for Water Mains, 24 Inches or Greater in Diameter.**

Open Cut: Provide pipe bedding as described in Section 3.B.5.a. above, with the following exceptions: Use bank run sand for the bedding material as described in Section 2.N., “Bedding Material,” of this specification.

Compact cement stabilized sand used as backfill or as pipe bedding as specified on the plans, in 6-in. lifts to 95% of the standard maximum density as determined by Tex-113-E, at the optimum moisture content.

**C. Handling Pipe and Accessories.** During pipe construction operations, use caution to prevent injury to the pipe, protective linings, and coatings in conformance with the manufacturer's recommendations. Do not place debris, tools, or other materials in the pipe.

Repair any damage to the pipe or the protective lining and coating from any cause during the installation of the pipeline and before final acceptance by the purchaser. Perform this work as directed, in conformance with the applicable standards, and at no cost to the Department.

Unload pipe, fittings, valves, and accessories at the point of delivery and haul them to the project site. Distribute the material opposite or near the place where it will be laid in the trench such that storm water or runoff will not enter or pass through the pipe. Do not drop the materials. Do not allow pipe handled on skid ways to be skidded or rolled against pipe already on the ground.

Load, transport, unload, and otherwise handle pipe and fittings in a manner and by methods which prevent damage of any kind. Handle and transport pipe with equipment designed, constructed, and arranged to prevent damage to the pipe, lining, and coating. Do not allow bare chains, hooks, metal bars, or narrow skids or cradles to come in contact with the coatings. Provide pipe fittings with enough interior strutting or cross-bracing to prevent deflection under their own weight.

Hoist the pipe and fittings from the trench side into the trench by means of a sling of smooth steel cable, canvas, leather, nylon, or similar material. Do not lift pipe by using hooks at each end of the pipe. When stacking pipe, ensure it is packaged on timbers. Place protective pads place under the banding straps at the time of packaging.

When using fork trucks to relocate pipe, pad the forks using carpet or some other suitable type of material. When relocating pipe using a crane or backhoe, use nylon straps or smooth steel cable, do not use chains, around the pipe for lift.

**D. Cutting Pipe.** Cut pipe 12 in. in diameter and smaller in conformance with the manufacturer's recommendations. Cut pipe larger than 12 in. in an approved manner. Perform each cut at right angles to the axis of the pipe and file or grind to remove sharp edges. Use a cutting machine unless otherwise approved by Engineer. Do not damage pipe or linings and coatings, while cutting.

**E. Defective or Damaged Material.** Inspect pipe and accessories for defects before lowering into the trench. Repair or replace any defective, damaged, or unsound material as directed.

If a damaged piece of pipe, furnished by the Contractor, is placed in the water main, furnish the labor and materials necessary to remove and replace the defective pipe and to restore the street to its original condition at no cost to the Department.

If the Contractor damages the pipe after installation, the Engineer may permit the damaged section to be cut from the length, unless it is the opinion of the Engineer that the entire length was damaged. The cost of and replacement of broken pipe is at the expense of the Contractor.

**F. Cleaning Pipe and Accessories.** Remove lumps, blisters, and excess coating from the bell and spigot ends of steel pipe, ductile-iron pipe, valves, hydrants, and fittings. Wire brush the outside of the spigot and the inside of the bell and wipe clean, dry, and free from oil and grease before laying the pipe.

Remove foreign matter or dirt from the interior of water pipe, accessories, and from the mating surfaces of the joints, before lowering the material into the trench. Keep the pipe and accessories clean during and after laying by approved means.

Use cleaning solutions, detergents, solvents, etc. with caution when cleaning PVC pipe.

Provide cleanup and restoration crews to work closely behind the pipe laying crews, and where necessary, during disinfection, testing, service transfers, abandonment of old mains, backfilling, and surface restoration.

Upon completely installing a section not exceeding 4,000 ft. per crew, immediately prepare to disinfect and pressure test between valves or plugs. No later than 3 days after completing disinfection preparatory work, submit to the Utility Owner an appropriate request for disinfection.

Begin transfer of services no later than 7 calendar days after successfully completing the disinfection and pressure testing.

Immediately after transfer of services, begin abandonment of the old mains, including re-sodding and placing sidewalks and pavements.

Do not begin construction of additional sections if the above conditions are not met.

For large diameter water mains, do not install more than 2,000 ft. of main, until the previous 2,000 ft. is cleaned up and the site is fully restored. Schedule paving crews so that the repaving work will not lag behind the pipe laying work by more than 1,000 ft.

Completely restore the site within 30 days from the date the water main is successfully disinfected and hydrostatically tested, unless extended in writing by the Engineer.

For projects involving multiple locations, limit water main installation to a maximum of 2 project site locations.

Remove construction debris or foreign material and thoroughly clean and flush piping systems as approved. Provide temporary connections, equipment, and labor for cleaning. The Engineer must inspect the water main for cleanliness before filling.

Disinfection of Water Lines: Conform to the requirements of Section 3.Q.1., “Disinfecting Mains,” of this specification.

**G. Laying Pipe.** For the work of laying the pipe, employ only workers who are skilled and experienced in laying pipe of the type and joint configuration being furnished.

Provide watertight pipe and pipe joints. Lay pipe with the bell ends facing in the direction of laying, unless otherwise directed.

Lay pipe to the lines and grades shown on the plans. To ensure proper placement, use adequate surveying methods and equipment, and employ personnel competent in using this equipment. Ensure the pipe does not deviate from the horizontal and vertical alignment indicated on the plans by more than 0.10 ft., without prior approval. Measure and record the “as-built” horizontal alignment and vertical grade at a maximum of every 50 ft. on the on-site recorded plans.

During pipe laying operations, keep pipe trenches free of water which might impair the laying operations. Ensure holes for bells are of ample size to prevent the bells from coming in contact with the subgrade. Carefully grade pipe trenches to provide uniform support along the bottom of the pipe.

Do not lay more than 50 ft. of pipe in the trench ahead of the backfilling operations. If pipe laying operations are interrupted overnight, cover the pipe laid in the trench simultaneously on each side of the pipe or completely backfill, to avoid lateral displacement of the pipe and damage to the joints. If adjustment of the position of a length of pipe is required after it is laid, remove and re-lay it in conformance with these specifications and at no expense to the Department. After pipe laying and joining operations are complete, clean the inside of the pipe and remove debris.

Use care to prevent damage to the coating when placing backfill. Backfill in accordance with Section 3.K., “Backfilling,” of this specification.

Lay pipe in a straight line unless otherwise shown or approved. Long radius curves, either horizontal or vertical, may be laid with standard pipe using deflections at the joints. If curved pipe is shown, needing no special fittings, the curves can be made by deflection of the joints with standard lengths of pipe as approved. If maximum pipe joint deflections are permitted, do not exceed the manufacturer’s recommendation for maximum pipe joint deflections. Joint the gasketed pipe in a straight alignment and then deflect it to the curved alignment.

If the vertical deflection exceeds the maximum recommended by the manufacturer, remove the entire portion of the deflected pipe section and install new pipe as directed. Perform this work at no expense to the Department. The Engineer may measure assessment of deflection at any location along the pipe. Arithmetical averages of the vertical deflection or similar average measurement methods will not be deemed as meeting the intent of the standard.

Where field conditions require horizontal deflection curves not shown on the plans, the Engineer will determine the methods to be used.

No additional payment will be made for laying pipe on curves as shown, or for change orders involving standard lengths of pipe deflected at the joints. Adjust the pipe, valves, hydrants, and fittings to be at their proper locations and prepare each joint as specified in Section 3.H., “Joining Pipe and Accessories,” of this specification. As each joint of pipe is laid in the trench, center the spigot end in the bell of the previously laid pipe, then force home the pipe and bring it to the correct line and grade.

Ensure each length of pipe rests on the bottom of the trench and is inspected for damage throughout its entire length.

When pipe lying is discontinued for the day or for an indefinite period, tightly place a cap or plug in the end of the last pipe laid to prevent the intrusion of water. When water is excluded from the interior of pipe, place enough backfill on the pipe to prevent floating. Schedule the work to prevent the possibility of floatation. Remove from the trench any pipe that has floated and re-lay as directed.

When assembling PVC pipe on top of the trench, allow it to cool to ground temperature before backfilling, to prevent pull-out due to thermal contraction.

Do not schedule night works or plant shut down to begin within 2 working days before or after Utility Owner-designated holidays.

For tie-ins to existing water mains, provide the necessary material on-hand to facilitate connection before shutting down the existing water main.

Ensure that separation from gravity sanitary sewers and manholes, or from force mains, is a minimum of 9 ft. clearance in all directions or as specified, unless a special design is shown on the plans.

Minimum Clearances:

- Parallel water line and gravity sanitary sewer, force main, or manhole with no leaks: Minimum 4 ft. horizontal clearance from the outside wall of the water line to the outside wall of the gravity sanitary sewer, force main, or manhole.
- Water line crossing above a gravity sanitary sewer or force main with no leaks: Minimum 2 ft. vertical clearance.
- Water line crossing below a gravity sanitary sewer or force main with no leaks: Minimum 2 ft. vertical clearance.

**H. Joining Pipe and Accessories.**

**1. Ductile-Iron Pipe, Valves, Hydrants, and Fittings.** After thoroughly cleaning the inside of the bell and the outside of the spigot, install members in conformance with the manufacturer's recommendation and AWWA C600, or as modified by these specifications.

Mark pipe and accessories that are not furnished, with a depth mark before assembly to ensure that the spigot end is inserted to the full depth of the joint.

Brace the fittings on small mains with short pieces of 2-in. galvanized pipe as directed.

Brace each plug installed under this contract by a standard pipe clamp, a 3-ft. nipple of the same diameter pipe as the nearby sections of mains, and a block of concrete.

For 4-in. through 12-in. water mains, use pipe clamps that are Underwriters Lab-approved for underground water service piping. For water mains 16-in. and larger, use pipe clamps conforming to details shown on the plans.

For rubber-gasketed joints use lubrication that is water soluble, non-toxic, non-objectionable in taste and odor imparted to the fluid, non-supporting of bacteria growth, and has no deteriorating effect on coatings or rubber gaskets.

2. **Polyvinyl Chloride Pipe and Accessories.** Join plastic pipe in conformance with the instructions furnished by the manufacturer. To prevent weakening the joint, do not handle or install in the trench pipe joined using solvent cementing techniques, until the joints "cure."

   For rubber-gasketed joints, use lubrication that is water soluble, non-toxic, non-objectionable in taste and odor imparted to the fluid, non-supporting of bacteria growth, and has no deteriorating effect on PVC or rubber gaskets.

3. **Welded Joints for Steel Pipe.** Ensure the joints receive a full-penetration butt weld type double weld, in accordance with AWWA C206. It is the Contractor's option to use either automatic or hand welders. Before starting the work, provide proof of certification of qualification for welders employed on the project for every type of work procedure and position involved. Ensure qualification is in accordance with AWWA C206. Ensure complete penetration of deposited metal with the base metal. Provide inside fittings and joints that are free from globules of weld metal that would restrict flow or become loose.

   Miter end cuts of both ends of butt-welded joints may be used for joint deflections of up to 2-1/2 degrees.

   Set fittings and joints square and true, and preserve the alignment during welding operations. Align the butting ends to minimize the offset between surfaces. For pipe of the same nominal wall thickness, do not exceed 1/16 in. offset. Use line-up clamps for this purpose; however, exercise caution to avoid damaging to the linings and coatings.

   Furnish each welder employed with a steel stencil for marking welds, so the work of each welder can be identified. Mark pipe with the assigned stencil adjacent to the weld. If a welder leaves the job, void that stencil and do not duplicate it. Welders making defective welds must discontinue work and leave the project site. Such welders may return to the project site only after recertification.

   During welding, protect the lining by draping an 18-in. wide strip of heat-resistant material over the top half of the pipe on each side of the lining holdback to avoid damage to the lining by the hot splatter. Protect the tape coating similarly.

   Provide welding rods of a type compatible with the metal being welded, to obtain the strongest bond, E-70XX.

   Deposit the metal in successive layers so there will be at least 2 passes or beads for automatic welding and 3 passes or beads for manual welding in the completed weld.

   On welds, do not deposit more than 1/4-in. of metal on each pass. Thoroughly clean the weld by wire brushing and hammering on each individual pass including the final one, to remove dirt, slag, or flux.

Do not perform welding under any weather condition that would impair the strength of the weld, such as wet surface, rain or snow, dust or high winds, unless the work is properly protected.

If using tack welds, ensure they are of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welds during the welding operation.

Remove dirt, scale, and other foreign matter from the inside of piping before tying in sections, fittings, or valves.

Provide a minimum overlap of 4 in. of butt strap over the adjacent piece on butt strap closures.

Employ an approved independent certified testing laboratory, to perform weld tests and associated work to accommodate testing on the entire job. Include the cost of such testing in the contract unit bid price for the water main. Furnish copies of test reports to the Engineer for review. Ensure testing is by X-ray methods for butt welds and is performed for every joint weld. If a defective weld is revealed, assume the cost of repairing and retesting the repaired weld. The Engineer has the full and final decision as to the suitability of welds tested. If any interior or exterior coating or lining is damaged during the welding process, repair it and return it to its original state as approved, in conformance with applicable AWWA standards.

Provide cylindrical corrosion barriers (CCBs) for epoxy-lined steel pipe smaller than 24-in. in diameter. Furnish CCBs manufactured by CCB International, Inc., or approved equal. CCBs are not required if the minimum wall thickness is 1/2 in. or greater.

In addition to the welding requirements contained in this specification, conform to the protection fitting manufacturer’s installation recommendations.

Provide the services of a technical representative of the manufacturer available on site at beginning of pipe laying operations. Ensure this representative is able to train welders and advise regarding installation and general construction methods. Employ only welders with at least 12 months experience installing protection fittings.

**4. Flanged Joints for Steel Pipe.** Before installing bolts, accurately center the flange joints and align them to prevent mechanical pre-stressing of flanges, pipe, and appurtenances. Align bolt holes to straddle the vertical, horizontal, or north-south, centerline. The maximum inclination of the flange face from the true alignment is 3/64 in. per foot.

Use full-face gaskets for flanged joints. Provide 1/8-in. thick cloth inserted rubber gasket material. Cut the gaskets at the factory to the proper dimensions.

Unless otherwise noted, provide insulation kits at connections to the existing water system or at locations to isolate one type of cathodic system from another type; between water line, access manhole piping, and other major openings in the water line; or as shown on the plans.

For isolating flange joints 30 in. in diameter and greater, and at butterfly valve flanges, provide a Pyrox G-10 with nitrite seal, Type E LineBacker gasket as manufactured by Pipeline Seal and Insulator, Inc., or approved equal, conforming to ANSI A 21.11 mechanical joint gaskets. For isolating flange joints 24 in. in diameter and smaller, provide a Phenolic PSI with nitrite seal, Type E LineBacker gasket as manufactured by Pipeline Seal and Insulator, Inc., or approved equal, conforming to ANSI A 21.11 mechanical joint gaskets.

Use galvanized or black nuts and bolts to match the flange material. Use cadmium-plated steel nuts and bolts underground. Tighten the bolts progressively to prevent unbalanced stress. Consistently maintain approximately same distance between the two flanges at all points around the flanges. Tighten the bolts alternately (180 degrees apart) until they are evenly tight. Draw the bolts right to ensure properly seating the gaskets. Provide Denso, or approved equal, petroleum-based tape wrapping system for nuts and bolts.

Pay particular attention to procedures used in tightening and torquing flanged joints. Improper methods may result in leakage and require corrective measures. Follow recommended industry standards and guidelines as set forth by the various fabricators and manufacturers.

5. **Flanged Joints For Use On Ductile-Iron Pipe.** See the requirements of Section 3.H.4., “Flanged Joints for Steel Pipe,” of this specification.

**I. Thrust Restraint.** Provide adequate temporary blocking of fittings when making connections to the distribution system and during hydrostatic tests. Provide enough anchorage and blocking to resist stresses and forces encountered while tapping the existing waterline. For new waterlines 16 in. in diameter and larger, provide restraining joints as specified in this section. Provide restrained joint lengths as shown on the plans or as directed. For existing waterlines and waterlines less than 16 in. in diameter, restrain pipe joints with concrete thrust blocks or provide joints as specified in this section.

The length of the restrained joints shown on the plans, assumes that hydrostatic testing will begin upstream and proceed downstream with respect to the normal flow of the water in the pipe. If installation or testing of the pipe differs from this assumption, submit for approval a revised method of restraining the pipe joints upstream and downstream of the device used to test against (i.e., block valve, blind flange, or dished head plug).

**J. Electrical Continuity Bonds.**

1. **General.** Attach the bond wires at the required locations using the Thermite welding process.

2. **Thermite Welding Methods.** Perform Thermite welding of bond wires to the piping in the following manner:

Ensure the pipe to which the wires will be attached is clean and dry. Use a grinding wheel to remove coating, mill scale, oxide, grease, and dirt from an area approximately 3 in. square. Grind the surface to bright metal.

Remove approximately 1 in. of insulation from each end of the wires to be Thermite welded to the structure, exposing clean, oxide-free copper for welding.

Select the proper size Thermite weld mold as recommended by the manufacturer. Place the wire between the graphite mold and the prepared metal surface. For No. 12 AWG size wires, use a copper sleeve crimped over the wire. Place the metal disk in the bottom of the mold. Place the Thermite weld charge in the mold. Squeeze the bottom of the cartridge to spread ignition powder over the charge.

Close the mold cover and ignite the starting powder with a flint gun. After the exothermic reaction, remove the Thermite weld mold and gently strike the weld with a hammer to remove the weld slag. Pull on the wire to assure a secure connection. If the weld is not secure or the wire breaks, repeat the procedure with a new wire. If the weld is secure, coat bare metal and weld metal with a coal-tar compound. If a polyurethane dielectric coating has been used, use a compatible polyurethane coating.

**K. Backfilling.**

**1. General.** Backfill trenches in accordance with the requirements of Item 400, "Excavation and Backfill for Structures," except for measurement and payment.

Begin backfilling and cleaning up each section of main, i.e., from valve to valve, immediately upon the completing the hydrostatic test, unless otherwise permitted by Engineer, and continue until obtaining a final and complete clean-up of the section. Any portion of the trench that is left open in excess of that required to facilitate hydrostatic testing may be ordered closed by the Engineer.

Use surplus excavated materials in the embankments or dispose of them as directed.

**2. Backfilling Pipe for Water Mains.**

**a. Open Cut.** After the pipe joints are made up and inspected, backfill the trenches with excavated materials or any other backfill material covered by this specification, as approved. Backfill the portion from the spring line of the pipe (or from 6 in. on top of pipe if sand bedding is used) to the top of the trench in maximum lifts of 9 in. loose measurement (provided the trench is not located in sidewalks, roadways, roadway shoulders, driveways, etc. that are being used for automobile or pedestrian traffic). Mechanically compact the backfill material using vibratory equipment, or any other acceptable equipment, so that no settlement occurs. Compact to a density of at least 95% of the maximum dry density, as determined in accordance with Tex-114-E. The Engineer reserves the right to perform compaction tests on an as-needed basis. Compaction by water tamping is prohibited.

Do not allow dirt, clods, or trench sides to fall or rest against the pipe before completing the embedment or backfill.

The allowable materials for backfill are listed in Section 2.O., "Backfill Material," of this specification.

Continue backfilling and compacting in this manner to the minimum elevation shown in the excavation and backfill diagram.

**b. Boring or Augering Pits.** Backfill boring or augering pits with bank run sand up to 1 ft. from the top of the natural ground. For the final 12 in., use backfill consisting of 10 in. of native soil in the bottom and 2 in. of bank run sand just below the grass.

Backfill the portion from the spring line of the pipe to the top of the pit in lifts not exceeding 9 in. (loose measurement). Mechanically compact the backfill by using vibratory equipment, or any other acceptable equipment, so that no settlement occurs. Compact the material to a density of at least 95% of the maximum dry density at optimum moisture content as determined in accordance with Tex-113-E or Tex-114-E. The Utility Owner may perform compaction tests on an as-needed basis. Compaction by water tamping is prohibited.

Do not allow dirt, clods, or auger pit sides to fall or rest against the pipe before completing the embedment or backfill.

The only allowable material for backfill in boring or augering pits is bank run sand, described in Section 2.O., "Backfill Material," of this specification.

**L. Valves and Fire Hydrants.** Ensure each valve and fire hydrant is completely closed when placed in the pipe line.

Install valves and hydrants in accordance with AWWA C600, except where modified by this specification. Provide drainage at the base of the hydrant in accordance with AWWA C600.

Set each hydrant at the location and grade indicated by the stakes, and plumb, brace, and install in accordance with AWWA's requirements for fire hydrant installation. If the barrel of a hydrant is to pass through a concrete slab, fit a piece of 1-in. thick pre-formed bituminous expansion joint material closely around the section of the barrel passing through the concrete.

Locate the nozzle centerline a minimum of 18 in. above the finish grade.

Place 12-in. x 12-in. yellow indicators (plastic, sheet metal, plywood, or other approved material) on pumper nozzles of new or relocated fire hydrants installed on new mains not in service. Remove indicators after the new main is tested and approved.

**M. Tapping Sleeves and Valves.**

**1. General.** Install tapping sleeves and valves at the locations and using the sizes shown on the plans. Thoroughly clean the tapping sleeve, tapping valve, and pipe in conformance with the manufacturer's instructions before installing.

Hydrostatically test the installed tapping sleeve to 150 psig for a minimum of 15 minutes. Inspect the sleeve for leaks, and remedy any leaks before the tapping operation.

When tapping concrete pressure pipe, size on size, use a shell cutter one standard size smaller than that of the water line being tapped. Do not use Large End Bell (LEB) increases with a next size tap except for existing asbestos-cement pipe.

2. **Installation.** Verify the outside diameter of the pipe to be tapped before ordering the sleeve. Tighten the bolts in the proper sequence to avoid placing undue stress on the pipe. Align the tapping valve properly and attach it to the tapping sleeve. Insert the insulation sleeve into the flange holes of the tapping valve and pipe. Insert the sleeve on pipe side of tapping valve. Do not damage insulation sleeves during the bolt tightening process.

   Make the tap with a sharp shell cutter using the following criteria: For 12-in. and smaller taps use a minimum cutter diameter 1/2 in. less than the nominal tap size. For 16-in. and larger taps, use the manufacturer's recommended cutter diameter.

   Withdraw the coupon and flush the cuttings from the newly-made tap. For 12-in. and smaller taps, wrap the completed tapping sleeve and valve in accordance with this specification.

   For 16-in. and larger taps, apply Denso or approved equal, petroleum-based tape wrapping system around the completed tapping sleeve and valve. Place the concrete thrust block behind the tapping sleeve (not over the tapping sleeve and valve).

   Arrange for the mandatory inspection of the installation before backfilling. Completion of the inspection is not required before backfilling. Backfill in accordance with this specification and as shown on the plans.

   If Asbestos-Cement (AC) Pipe is encountered, follow the Safety Practice outlined in the Asbestos-Cement Pipe Producers Association publication, "Recommended Work Practices for A/C Pipe," and make them "Mandatory Practices" for this project.

**N. Boxes for Valves.** Cut the cast-iron or ductile-iron pipe to the proper length, then assemble and brace the box as approved. Construct manholes over the operators of butterfly valves for sizes 30 in. and larger.

Concrete for valve box placement: For locations in new concrete pavement, use the same strength and mix design as that of new pavement. For other locations, use Class "A" Concrete, conforming to the requirements of Item 421, "Hydraulic Cement Concrete."

Install valve box and riser piping plumbed in a vertical position. Provide 6-in. telescoping freeboard space between the riser pipe top butt end and the interior contact flange of the valve box, for vertical movement damping. Ensure the riser (bell end of pipe) rests on the valve flange, or provide a suitable foot piece to support the riser pipe.

Set, align, and adjust the valve box so that the lid is level with the final grade.

Paint the covers of new valve boxes in "Fluorescent Orange" when installed. After completion and approval by the Engineer, repaint the covers in "Black." This work is incidental to this Item.

**O. Wet Connections.** Make the wet connections, as directed, in such a manner and at such hours to minimize inconvenience to the public. When the existing mains have been cut or a plug removed for a connection, pursue the work of making the connection without interruption until complete.

If the Contractor proceeds with a wet connection without a complete shut-off, there will be no extra compensation for damages or extra work resulting from the incomplete shut-off.

The Utility Owner will operate gate valves in the existing system and in sections of completed mains that have been placed in service. Notify the Utility Owner at least 48 hours in advance of making connections.

Wet connections that are 2 in. or smaller are sometimes referred to on the plans as 2-in. standard connections or gooseneck connections.

Items that may be necessary to complete these types of wet connections include corporation cock, saddle, copper tubing, brass fittings, and 2-in. valves. Do not use these connections on or consider them as part of a 2-in. service line.

The Utility Owner will handle, at no cost to the Contractor, operations involving opening and closing valves for wet connections.

**P. Polyethylene Film Wrap.** Except as noted on the plans, wrap ductile-iron pipe (including fittings and other appurtenances), with a polyethylene film. Also wrap fire hydrant barrels.

Remove lumps of clay, mud, cinders, etc., on the pipe surface before installing the polyethylene encasement. Prevent soil or embedment material from becoming trapped between the pipe and the polyethylene. Fit the polyethylene film to the contour of the pipe to affect a snug, but not tight fit; encase with minimum space between the polyethylene and the pipe. Provide enough slack in contouring to prevent stretching the polyethylene where it bridges irregular surfaces, such as bell-spigot interfaces, bolted joints, or fittings, and to prevent damage to the polyethylene due backfilling operations. Secure overlaps and ends with adhesive tape to hold polyethylene encasement in place until backfilling operations are complete.

For installations below the water table and in areas subject to tidal actions, seal both ends of the polyethylene tube with adhesive tape at the joint overlap.

Repairs: Repair any cuts, tears, punctures, or damage to the polyethylene with adhesive tape or with a short length of polyethylene sheet or cut open tube, wrapped around the pipe to cover the damaged area, and secured in place.

Openings in Encasement: Provide openings for branches, service taps, blowoffs, air valves, and similar appurtenances by making an X-shaped cut in the polyethylene and temporarily folding back the film. After the appurtenance is installed, tape the slack securely to the appurtenance and repair the cut, as well as other damaged areas in the polyethylene, with tape. Service taps may also be made directly through the polyethylene. Repair any resulting damaged areas as described above.

Junctions between Wrapped and Unwrapped Pipe: Where polyethylene-wrapped pipe joins an adjacent pipe that is not wrapped, extend polyethylene wrap to cover the adjacent pipe for distance of at least 3 ft. Secure the end with circumferential turns of tape. Wrap service lines of dissimilar metals with polyethylene or suitable dielectric tape for a minimum clear distance of 3 ft. away from cast-iron or ductile-iron pipe.

1. **Tubular Type Wrap.** When the polyethylene film is supplied in tubular form, install it on the pipe before placing the pipe in the trench and in the following manner:

   Elevate the spigot end of the pipe, brush mud and debris from the pipe, and slip a length of film (approximately 2 ft. longer than the joint of pipe) over the joint of the pipe. Wrap the film tightly around the spigot end, leaving about 1 ft. extending beyond the end of the pipe, and tape the edge down lightly with polyethylene tape.

   When lifting the joint of pipe for placing in the trench, remove any remaining mud, clay, or debris. Insert the spigot end into the bell end of the joint previously placed, push home, and release the pipe into the trench. Pick up the pipe joint at the bell, slide the film to a point back of the bell, and prepare a bell hole.

   When laying the next joint, pull the film beyond the bell to overlap the film attached to the spigot of the new pipe joint. Wrap the film by folding it longitudinally and tape it securely in place to prevent damage during backfill. Do not tape the end that is slipped over the last bell but bind it with twine or other approved material.

   At each corporation, draw the loose material up around the corporation base and seal it with tape to insulate the 2 dissimilar metals.

   Wrap fittings and fire hydrant leads, and tape or bind the wrap with heavy twine. Wrap fittings, such as bends and reducers, similarly to the method outlined above. Wrap specials, such as valves, tees, crosses, etc., by splitting, tucking, and overlapping the polyethylene tube, then closing the field-made splices with the required tape. Material to cover the valves may be acquired from excess overlapping polyethylene tubing on adjacent pipe joints. Draw the polyethylene tubing over the bell of the pipe on either side and insulate with field-made seams as described above. Completely wrap fittings and specials that require concrete blocking, before placing concrete.

2. **Sheet Type Wrap.** Apply sheet type wrap around the pipe either before or after positioning the pipe in the trench. Install “above ground” in a manner similar to that described above for tubular installation. Install “in trench” in a manner similar to that described below:

   Cut the polyethylene sheet to a length approximately 2 ft. longer than the pipe section. Center the length to provide a 1 ft. overlap on each adjacent pipe section, bunching it until it clears the pipe ends. Wrap the polyethylene around the pipe so that it circumferentially overlaps the top quadrant of the pipe. Secure the cut edge of the polyethylene sheet at intervals of approximately 3 ft.

Lower the wrapped pipe into the trench and make up the pipe joint with the preceding section of pipe. Make shallow bell holes at joints to facilitate installation of the polyethylene. After completing the joint, make the overlap and secure the ends.

Repair cuts, tears, punctures, or other damage to the polyethylene. Proceed with installing the next section of pipe in the same manner.

3. **Boring or Augering Section Installation.** Use cast-iron or ductile-iron pipe with a polyurethane coating as specified in this Item.

Provide a final seal against the intrusion of the backfill material by completely encasing the tapping sleeve with sheet vinyl of 8-mil thickness. Apply tape to secure this wrapping, using Polyken No. 900, Scotch Wrap No. 50, or approved equal, manufactured for this purpose.

**Q. Disinfecting Mains and Testing for Leakage.**

1. **Disinfecting Mains.** The Utility Owner will furnish water for disinfecting and flushing without charge to the Contractor.

Furnish the necessary taps, risers, and jumpers of such sizes and materials as are specified by the Engineer, and install the subject material in the locations designated. Normally, each valve section of main will require two 3/4-in. taps; however, on larger mains the Engineer may order that 1-1/2 in. or 2-in. taps and risers be used.

Furnish and install the necessary temporary blind flanges, sleeves, plugs, etc., as required to disinfect and pressure test the new mains.

Use fire hydrants as blow-offs to flush newly constructed waterlines 8-in. diameter and above.

After laying and backfilling the pipe, disinfect the newly laid pipe. Unless otherwise shown on the plans, the Utility Owner will furnish and pay for the labor and materials necessary for the initial application of the disinfecting agent. Slowly fill each valves section of pipe with water and expel the air from the pipe. Furnish and install taps at the points of highest elevation, if required to accomplish this. After filling the main with water and expelling the air, charge the pipe with the disinfecting agent and allow it to stand for 24 hours. Unless otherwise shown on the plans, the Utility Owner will then flush the main with water. After flushing, draw samples from the main and test for 2 consecutive days at a valid, approved testing facility. After samples are drawn and the test results pass, proceed with the pressure test and any necessary repairs. If the samples do not pass, re-disinfect the pipe until the samples taken are passed by the certified and approved testing facility. Unless otherwise shown on the plans, in the event that more than one disinfection of the main (or portion of the main) is required, the additional disinfection will be charged to the Contractor at rates established by the Utility Owner.

After disinfecting and flushing water lines, bacteriological tests will be performed by the Utility Owner or testing laboratory.

When test results indicate a need for additional disinfection of water lines based on Texas Department of Health requirements, assist Utility Owner with additional disinfection operations.

2. **Testing for Leakage.** Following the first disinfection test, subject the newly laid pipes to a hydrostatic pressure of 125 psi, unless otherwise shown on the plans. Where practicable, test pipe lines in lengths between line valves or plugs, of at most 1,500 ft. unless otherwise approved. Perform the pressure test by means of a pump connected to the pipe in a manner satisfactory to the Engineer. Furnish, install, and operate the necessary connections, pump, meter, and gauges. Before running the pressure test, ensure the meter is tested, sealed, and approved (at the Contractor's expense) by an approved, certified testing facility. Ensure the minimum duration of the test is 8 hours. If a large quantity of water is required to maintain pressure during the test, discontinue testing until the cause of the water loss is identified and corrected.

   Observe the following general regulations during each leakage test for cast-iron, ductile-iron, and PVC pipe:

   Except for welded steel pipe in which no leakage is permitted, ensure that pipe lines, when subjected to the specified pressure test, do not show leakage in excess of 3.19 gal. per inch of diameter, per mile, in 24 hrs.

   Repair portions of the pipe showing visible leaks regardless of the total leakage shown by the pressure test. Remove and replace cracked or defective pipes, fittings, valves, or hydrants discovered by means of this pressure test with sound material. If the main is opened for any reason, re-disinfect it until satisfactory samples are obtained. Also, pressure tests it until the requirements of this specification are met.

   Immediately upon completing disinfection and pressure testing, remove all taps, risers, and blow-offs, then backfill the remainder of the trench in accordance with the requirements of this specification.

   Perform leakage testing at no additional cost to the Department.

**R. Using Completed Sections of Mains.** The Utility Owner may use and operate portions of the water mains that are disinfected and pass the leakage test. Unless otherwise shown on the plans, operate the valves in such completed sections only with the express permission of the Utility Owner.

The use of the mains is not construed as acceptance of them and does not relieve the Contractor's responsibility for fulfilling the conditions of the contract, unless the mains are damaged due to negligence on the part of the Utility Owner.

**S. Lowering Mains.** When lowering a main, perform the initial excavation in such a manner to permit the mains to rest on a number of dirt benches. If soil conditions are unsatisfactory for dirt benches, use wooden blocks to support the mains. Then attach the pipe by using ropes, cable, or chains to overhead supports; remove the dirt benches or wooden blocks, and slowly and evenly lower the pipe into position. After lowering the mains, repair each damaged joint as directed.

**T. Copper Service Line Construction.** The use of Hays-Seal and Mueller Company catalog numbers to describe various fittings is not intended to be proprietary, but merely to indicate clearly the respective types of fittings to be furnished.

**1. Installing Service Lines.** For curb and gutter streets, lay copper service lines with a minimum 30 in. of cover from top of curb to the top of the service line. For crowned streets with open ditches, lay copper service lines with a minimum 30 in. of cover at the crown and with a minimum 18 in. of cover from the flow line of the ditch to the top of the service line. Ensure service line locations are clear of proposed paving and underground work.

Exercise caution to keep the lines free of dirt and foreign matter at all times. Assemble copper lines in an entirely slack position and free of kinks. Use service lines consisting of one continuous run of copper tubing where possible. Do not use bends greater than that originally found in the coil of tubing as packaged.

For 1-1/2 in. and 2-in. copper tubing shipped in straight lengths, use the following bend criteria:

For 2-in. copper tubing, a maximum of one 45-degree bend may be accomplished in a 4-ft. section; for 1-1/2 in. copper tubing, a maximum of one 45-degree bend in a 3-ft. section. No kinks, dents, flats, or crimps will be permitted.

Locate meters, in general, 1 ft. into the street right of way. Where this is not applicable, locate meters approximately 1 ft. from the sidewalk on the curb side. If the present meter location conflicts with proposed driveway turnouts or other proposed street improvements, shift the meter to miss the obstruction and re-connect it to the customer's service line. Reset meters at positions such that the top of the meter is 4 in. to 6 in. below the finished grade.

Where the plans call for salvaging and relocating the meter, meter box, and curb stop, remove these materials with care, thoroughly clean them, and submit them for inspection by the Engineer, before installing them in the new location. If the plans call for relocating the meter (other than at some point along the existing service line), a new service line will be required.

Where it is necessary to cross a paved street, push the service line under the paving through a pre-drilled and prepared opening. Use only full lengths of copper tubing, taking care not to damage the tubing when pulling it through the prepared hole.

A compression type union is only permitted when a full 40-ft. (60-ft. for 3/4-in. to 1-in.) length of tubing cannot completely span underneath the pavement. Do not use compression type unions under the paved street.

**2. Installing Corporation Stops.** Tap the main at a location such that a straight line passing through the meter and the corporation stop will be at 90 degrees to the main. Locate taps in the upper portion of the main within 45 degrees of the pipe spring line. Perform the cutting operation with an approved sharp shell cutter tool.

Install taps for service lines conforming to the requirements of Table 12. Space taps a minimum of 2 ft. apart.

**Table 12**
**Service Tap Requirements for Service Lines**

| Water Main Type and Diameter | Service Size Diameter | | | |
|---|---|---|---|---|
| | 3/4 in. | 1 in. | 1-1/2 in. | 2 in. |
| 4 in. Cast-Iron or Ductile-Iron | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 4 in. Asbestos-Cement | WBSS | WBSS | DSS, WBSS | DSS, WBSS |
| 4 in. PVC(AWWA C900) | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 6 in. and 8 in. Cast-Iron or Ductile-Iron | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 6 in. and 8 in. Asbestos-Cement | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 6 in. and 8 in. Cast-Iron or Ductile-Iron | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 6 in. and 8 in. PVC (AWWA C900) | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 12 in. Cast-Iron or Ductile-Iron | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 12 in. Asbestos-Cement | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 12 in. PVC (AWWA C900) | DSS, WBSS | DSS, WBSS | DSS, WBSS | DSS, WBSS |
| 16 in. and up Cast-Iron or Ductile-Iron | DWBSS | DWBSS | DWBSS | DWBSS |
| 16 in. and up Asbestos-Cement | DWBSS | DWBSS | DWBSS | DWBSS |
| 16 in. and up PVC (AWWA C900) | DWBSS | DWBSS | DWBSS | DWBSS |
| DSS – Dual Strap Saddles<br>WBSS – Wide Band Strap Saddles<br>DWBSS – Dual Wide Band Strap Saddles | | | | |

3. **Installing Curb Stops.** Set curb stops or angle stops only at the outer end of the service line just ahead of the meter. Secure the opening in the curb stop to prevent unwanted material from entering. Use eighth bend or quarter bend couplings to accomplish close quarter turns in the service line.

In 3/4-in. and 1-in. services, install a meter coupling or swivel nut meter spud curb stop, ahead of the meter. Also install a straight meter coupling on the outlet end of the meter. Install a new curb stop when the service line is extended.

4. **Sequence of Work.** Open the trench for the proposed service line or prepare the jacking and receiving pits.

   Install the corporation stop in a workmanlike manner using the proper equipment.

   Install the copper service line and connect it to the corporation stop.

   Install the curb stop on the meter end of the service line.

   With the curb stop open, and before connecting the service line to the meter, open the corporations stop and flush the service line adequately. Close the curb stop, leaving the corporation stop in the full open position.

   Check the service line for apparent leaks. Repair leaks before proceeding.

   Connect the service line to the meter and, if necessary, adjust the meter location. Use care to ensure that the inlet side of the meter is connected to the water service line. Momentarily open the curb stop to verify proper registration of the meter.

   Backfill the excavations, tamping the backfill material in place to the density of the soil in the adjacent trench walls.

   If relocating the meter, relocate the meter box so that it is centered over the meter with the top of the lid flush with the finished grade. When the meter must be located in driveways or sidewalks furnish and install an approved traffic type meter box with a cast-iron lid.

**U. Cutting and Plugging Water Mains.** Where the plans call for abandoning water mains, adhere to the following general procedure:

After constructing, disinfecting, testing, and placing the replacement main in service, and services are transferred to the replacement main, locate the main to be abandoned, trace it back to the feeder main, and at this point cut and plug it at the tee. Normally, installing a plug, clamp, and a concrete thrust block does this. In cases of 1-1/2 in. or 2-in. corporation cock or tapping sleeve and valve (TS&V) connections, remove the valve and install a cap or plug at the tee. Ensure the line to be abandoned is not valves off at the nearest valve, nor cut and plugged other than at the supply main.

Adequately plug the ends or openings in abandoned mains or cap them in an approved manner and replace excavation, backfill, and any street surfaces, to the Engineer's satisfaction. Perform this work in accordance with Sections 3.A., "Excavation" and 3.K., "Backfilling," of this specification.

Remove surface identification, i.e., valve boxes and fire hydrants. Where valve boxes are in improved streets (other than shell), pouring valve boxes full of concrete with the cap permanently removed is permitted.

Do not remove plugs during the months of peak water demands, June, July, and August, unless otherwise approved.

**V. Service Lines of Public Utilities.** Where any pipe or conduit of a public utility corporation crosses the water main trench, support such pipe or conduit in a manner satisfactory to the Engineer.

If the Contractor considers it necessary for a utility company to relocate their utility lines or other improvements, notify the Engineer in advance.

If the Engineer considers it imperative to make the change, the Engineer will make the necessary arrangements with the utility company.

**W. Relocating Meter Vaults.** Salvage existing valves, meters, and strainers from inside the vault and return them to the Utility Owner, or as designated on the plans.

Install pipe, valves, service lines, and other appurtenances in accordance with the pertinent Sections of this specification or as directed.

In general, install the type of meter vault shown on the plans or as approved.

**1. Precast Concrete Vault.** Construct and furnish the precast concrete vault as shown on the plans.

Set the precast concrete vault level on a minimum 3-in. bed of sand in an excavation and bring it to grade. Then install piping and backfill with sand around the vault.

**2. Cast-in-Place Concrete Vault.** Construct the cast-in-place concrete vault as shown on the plans. Key the walls to the floor slab and form to the dimensions shown on the plans. Provide a minimum wall thickness of 4 in. Cast the walls monolithically. One cold joint is allowed when the vault depth exceeds 12 ft. Set the frame for the cover while the concrete is still green.

**3. Frame and Cover.** Construct the frame and cover as shown on the plans.

In grass areas, set the frame and cover 2 in. to 3 in. above the natural ground or finished grade and parallel to it (the maximum allowable angle from horizontal is 20 degrees). Slope the backfill away from the meter.

In sidewalk areas, set the frame and cover 1/2 in. to 1 in. above the adjacent concrete and parallel to it. Slope the replacement concrete away from the meter to meet the adjacent concrete.

**4. Inspections.** The following inspections will be made jointly by the Engineer and representatives of the Utility Owner:

**a. Site Location Inspection.** Perform this to obtain the required approval of the proposed meter location before starting work.

**b. Final Inspection.** Perform this after the backfill is in place, the cover is installed, the cleanup is completed, and the surface is restored.

**X. Adjusting Existing Surface Structures.**

**1. Valve Boxes.** Salvage and reuse the valve box. Remove and replace the 6-in. ductile-iron riser pipe with a suitable length for the depth of cover required to establish the adjusted elevation to accommodate the actual finished grade.

Reinstall the valve box and riser piping plumbed in a vertical position. Provide a minimum of 6-in. telescoping freeboard space between the riser pipe top butt end and the interior contact flange of the valve box, for vertical movement damping.

After setting, aligning, and adjusting the valve box so that the top lid is level with the final grade, place a 24-in. by 24-in. by 8-in. thick concrete block around the valve box. Center the valve box horizontally within the concrete box.

**2. Meter Boxes.** Salvage and reuse meter boxes when possible. Reinstall them in conformance with the manufacturer's recommendations. Repair any damage sustained by the meter box during relocation or service transfer, at no expense to the Department.

If the existing meter box requires replacement, the Contractor may obtain a new box from the Utility Owner by providing adequate documentation of the existing and proposed locations.

**3. Meter Vaults.** Adjust meter vaults in conformance with the details shown on the plans. Salvage and reuse access covers.

**Y. Relocating Water Meters and Boxes.** Salvage, clean, inspect, and install existing curb stops, meters, unions, and meter boxes at the new locations in conformance with specifications in this section. When the meter and box is relocated, move it the minimum distance to enable access for new connections. Repair any damage sustained by the meter box during relocation or service transfer, at no expense to the Department.

If unable to salvage the existing boxes, the Contractor may obtain new boxes from the Utility Owner by providing proper documentation of the existing and proposed locations of the meter.

When approved, the Contractor may relocate meter boxes located adjacent to existing pavement, if this operation facilitates construction or decreases the costs. Obtain written approval of the Engineer and perform this work, including excavation, piping, meter box relocation, removal and replacement of paving, etc., at no cost to the Department.

**Z. Installing Split Casing.** Notify the Utility Owner at least 48 hours in advance of any work planned involving existing water lines. Do not, at any one time, expose more than 20 ft. of water lines to be encased.

Place 6-in. x 6-in. x 1-1/4-in. neoprene pads between the split casing sections and the top and bottom of the water lines spacing them at approximately 6 ft. or as directed.

Ensure the completed and shaped trench to receive the casing is of wide enough to provide free working space for satisfactorily installing the casing and backfilling under and around the casing.

Hold the split casing in place for welding by using hinges, coupling bands, or any other acceptable method.

Use a casing diameter not less that the outside dimension of the pipe at is longest dimension plus 4 in.

Perform welds conforming to the requirements of AWWA Standard C 206. Provide welds capable of developing the full strength of the pipe throughout the joint and casing split.

Seal the ends of the encasement pipe with casing and seals in accordance with Section 2.B.1., "Steel Carrier Pipe," to prevent the entrance of the excessive ground water.

**AA. Modifications for Cathodic Protection.**

1. **General.** Provide cathodic protection systems in accordance with Special Specification Item, "Cathodic Protection Systems for Large Diameter Water Main," as specified in this Item, and as shown on the plans.

   References to steel pipe apply to tape-coated welded steel pipe. If damage occurs to the pipe coatings during the welding process, refurbish the affected area to its original condition.

2. **Bonded Joints.** Where rubber gasket bell and spigots are provided, provide for bonded joints by either welding a strap or clip between the bell and the spigot of each joint, or by providing a Thermite-welded cable between the bell and the spigot of each joint. Provide pipes, whether installed in a tunnel or open cut, with bonded joints, except where providing insulating flanges. Where welding joints for thrust restraint, no additional bonding is required.

   Bonding Strap or Clip: Provide a strap or clip for bonding the bell to the spigot, that is free of foreign material that could increase the contact resistance between the wire and the strap or clip.

   Unless otherwise noted, provide insulation kits at connections to the existing water system, at locations to isolate one type of cathodic system from another type, between the water main and extra piping, or as shown on the plans.

**BB. Removing and Salvaging Fire Hydrants and Water Meters.** Deliver removed and salvaged fire hydrants and water meters to the Utility Owner at the location shown on the plans, or as directed.

**CC. Installing the Nonmetallic Pipe Detection System.** Install the nonmetallic pipe detection system concurrently with placing the proposed pipe. Install as specified by the manufacturer and as approved.

**DD. Removing Water Mains and Removing Water Mains with Casing.** Remove water mains and water mains with casing in accordance with Item 100, "Preparing Right of Way" or as shown on the plans. This includes removing and disposing of pipe and appurtenances as shown on the plans or as directed. Perform related excavation and backfilling, as required, at no additional cost the Department.

**4. Measurement.** This Item will be measured as follows:

**A. Water Main Pipe and Steel Casing** will be measured by the foot, of the various sizes and types specified. Water mains and casing will be measured along the axis of the pipe and no deductions will be made for valves or fittings. Reducers will be classed as pipe of the size of the larger end.

Unless otherwise shown on the plans, Fire Hydrant Branches (Leads) will be measured by the foot, of the various types and installation methods specified, along the axis of each branch (lead) from the hydrant to the end of the branch (lead). No deductions will be made for valves or fittings.

**B. Split Steel Casing** will be measured by the foot, of the various sizes shown on the plans.

**C. Fiberglass Reinforced Plastic (FRP) Pipe for Casing** will be measured by the foot, of the various sizes shown on the plans.

**D. Jacking, Tunneling, Boring, or Augering** for water mains and steel casing will be measured by the foot, of the sizes, types, and wall thickness (applicable only for casing) specified.

Jacking, Tunneling, Boring, or Augering for fire hydrant branches (leads) will be measured by the foot, of the various types specified.

**E. New Copper Service Lines** will be measured by each service line installed.

Short Side service line refers to service connections made to meters located on the same side of the street as the supply main is located. Long Side service line refers to service connections made to meters located on the opposite side of the street from the supply main, or from the center of the street, where the supply main is located in the center of the street.

**F. Gate Valves, Tapping Sleeves and Valves, and Butterfly Valves** will be measured by each assembly installed, of the various sizes specified, except that gate valves 20 in. in diameter and smaller, are subsidiary to the water lines.

**G. Fire Hydrants** will be measured by each assembly installed, including a 6-in. gate valve and box, regardless of depth. It is the Contractor's responsibility to install the fire hydrant assembly such that it meets the standard installation requirements of this specification and the manufacturer's specifications.

Fire Hydrant Branches (Leads) will be measured as indicated in Sections 4.A. and 4.D.

**H. Meters and Vaults** will be measured by each assembly constructed.

**I. Air Release and Vacuum Relief Valves** will be measured by each assembly, of the various sizes, with the valve box installed.

**J. Pressure Reducing Stations** will be measured by the lump sum unit constructed.

**K. Blow Off Valves** will be measured by each assembly, of the various sizes and types, with the valve box installed.

**L.** **Removing Fire Hydrants** will be measured by each assembly removed and disposed of properly.

**M.** **Removing Water Valves and Boxes** will be measured by each assembly removed and disposed of properly.

**N.** **Removing and Relocating Meters and Boxes** will be measured by each assembly removed, cleaned, and installed at the new location.

**O.** **Removing Meters and Vaults** will be measured by each assembly removed and disposed of properly.

**P.** **Removing and Salvaging Water Meters** will be measured by each assembly removed and salvaged.

**Q.** **Removing and Salvaging Fire Hydrants** will be measured by each assembly removed and salvaged.

**R.** **Removing and Relocating Water Meters and Meter Vaults** will be measured by each assembly removed and relocated.

**S.** **Adjusting Meter Vaults** will be measured by each assembly adjusted.

**T.** **Adjusting Meter Boxes** will be measured by each assembly adjusted.

**U.** **Lowering Water Mains** will be measured by the foot, of the sizes and types of pipe lowered.

**V.** **Cutting and Plugging Water Mains** will be measured by each location a water main is cut and plugged, of the sizes indicated.

**W.** **Removing Pressure Reducing Stations** will be measured by each complete pressure reducing station removed.

**X.** **Wet Connections** will be measured by each connection, of the sizes specified.

**Y.** **Extra Hand Excavation or Extra Machine Excavation** will be measured by the cubic yard in its original position. Excavation performed by manual labor at the locations specifically designated by the Engineer, and which is not included under or subsidiary to other bid items contained in this specification, is considered Extra Hand Excavation or Extra Machine Excavation.

**5.** **Payment.** The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit prices bid for the items of work described below. These prices are full compensation for furnishing, hauling, placing, and installing the materials; for inspecting and testing; and for other materials, labor, equipment, tools, and incidentals.

**A.** Payment for water main pipe, and steel casing will be made at the unit prices bid for "Water Main Pipe (Cast-Iron)," "Water Main Pipe (Steel)," "Water Main Pipe (Ductile-Iron)," "Water Main Pipe (Copper)," "Water Main Pipe (Polyvinyl Chloride)(PVC)," and "Casing (Steel)," of the various sizes and types specified, installed by the open-cut method.

Payment for fire hydrant branches (leads) will be made at the unit price bid for "Fire Hydrant Branch (Lead)(6 in.)" installed by the open-cut method.

Unless otherwise shown on the plans or specifications, excavating, disposing of unsuitable excavated material, backfilling, and the material for backfill, for the complete installation of the water main system, are subsidiary to this bid Item.

**B.** Payment for split steel casing will be made at the unit price bid for "Split Steel Casing," of the various sizes specified, installed by the open cut method.

**C.** Payment for Fiberglass Reinforced Plastic (FRP) Pipe for Casing will be made at the unit price bit for "Fiberglass Reinforced Plastic (FRP) Pipe for Casing" of the various sizes specified.

**D.** Payment for jacking, tunneling, boring, or augering water main will be made at the unit price bid for "Jacking, Tunneling, Boring, or Augering (Water Main)," of the sizes and types specified. This price includes furnishing the pipe.

Payment for jacking, tunneling, boring, or augering fire hydrant branches (leads) will be made at the unit price bid for "Jacking, Tunneling, Boring, or Augering Fire Hydrant Branch (Lead)(6 in.)," of the types and installation method specified. This price includes furnishing the pipe.

Payment for jacking, tunneling, boring, or augering steel casing will be made at the unit price bid for "Jacking, Tunneling, Boring, or Augering Casing (Steel)," of the sizes, types, and wall thickness (applicable only if exceeding minimum thickness, shown in Section 2.B.2, "Steel Casing Pipe," of this specification) specified. This price includes the casing. Water mains and fire hydrant branches (leads) placed in the casing will be paid for by the appropriate bid item.

Excavating, backfilling, backfill material, and disposing of unsuitable excavated material for jacking, tunneling, boring, or augering pits are subsidiary to these bid items.

**E.** Payment for copper service lines will be made at the unit price bid for "Service Line (Short Side 5/8 in. to 1 in.)," "Service Line (Long Side 5/8 in. to 1 in.)," "Service Line (Short Side 1-1/2 in. to 2 in.)" and "Service Line (Long Side 1-1/2 in. to 2 in.)," installed. This price is full compensation for labor, materials, excavation, and backfill required to install the facility, including connection to the customer's service line.

**F.** Payment for gate valves (larger than 20 in. in diameter), tapping sleeves and valves, and butterfly valves will be made at the unit price bid for "Gate Valve," "Tapping Sleeve and Valve," and "Butterfly Valve," of the various sizes specified, with the valve box installed.

**G.** Payment for fire hydrants will be made at the unit price bid for "Fire Hydrant Assembly," including 6-in. gate valve and box, installed regardless of barrel depth.

Any adjustment required either in the flow line of the water main or to the barrel length of the fire hydrant is subsidiary to this bid Item.

**H.** Payment for meters and vaults will be made at the unit price bid for "Meter and Vault" constructed.

**I.** Payment for air release and vacuum relief valves will be made at the unit price bid for "Air Release and Vacuum Relief Valve," of the various sizes specified, with the valve box installed.

**J.** Payment for pressure reducing stations will be made at the unit price bid for "Pressure Reducing Station." This price is full compensation for performing the necessary excavation, backfill, finish grading, constructing the concrete structure, and furnishing and installing station appurtenances addressed under Article 2., "Materials," of this specification.

**K.** Payment for blow off valves with boxes will be made at the unit price bid for "Blow Off Valve" of the various sizes and types specified, with the valve box installed.

**L.** Payment for removing fire hydrants will be made at the unit price bid for "Removing Fire Hydrant." This price includes removing valves from the existing location, disposing of the valves, and plugging at the tee. Excavation and backfill required for removing fire hydrants are subsidiary to this bid Item.

**M.** Payment for removing water valves and boxes will be made at the unit price bid for "Removing Water Valve and Box." Excavation and backfill required for removing water valves and boxes are subsidiary to this bid Item.

**N.** Payment for removing and relocating meters and boxes will be made at the unit price bid for "Removing and Relocating Meter and Box."

**O.** Payment for removing meters and vaults will be made at the unit price bid for "Removing Meter and Vault." This includes salvaging the meter strainers and valves and delivering them to their owner at the location shown on the plans or as directed.

**P.** Payment for removing and salvaging water meters will be made at the unit price bid for "Removing and Salvaging Water Meter." This price includes removing salvaged water meters from the existing locations and delivering them to the owner. Excavation, backfill, and finish grading required for removing the water meters are subsidiary to this bid Item.

**Q.** Payment for removing and salvaging fire hydrants will be made at the unit price bid for "Removing and Salvaging Fire Hydrant." The salvaging of fire hydrants will be a cash reimbursement to the owner by the Contractor where the fire hydrants will become the property of the Contractor or the Contractor will deliver the fire hydrants to the Utility Owner at the location shown on the plans. Excavation, backfill, and finish grading required for removing fire hydrants are subsidiary to this bid Item.

**R.** Payment for removing and relocating water meters and meter vaults will be made at the unit price for "Removing and Relocating Water Meter and Meter Vault."

**S.** Payment for adjusting meter vaults will be made at the unit price bid for "Adjusting Meter Vault." This price is full compensation for furnishing the required materials, including backfill as required, excavation, tools, labor, equipment, and incidentals.

**T.** Payment for adjusting meter boxes will be made at the unit price for "Adjusting Meter Box."

**U.** Payment for lowering water mains will be made at the unit price bid for "Lowering Water Mains," of the sizes and types of pipe lowered. This price is full compensation for lowering and adjusting pipes, as well as any connected valves, boxes, and service lines. Excavation and backfill required for lowering water mains are subsidiary to this bid Item.

**V.** Payment for cutting and plugging water mains will be made at the unit price bid for "Cut and Plug Water Main," of the sizes indicated. This price is full compensation for performing excavation, backfill, finish grading, and other incidental items required to abandon or cut and plug the water main as set forth this specification. Where grout is required, as shown on the plans, it is subsidiary to this bid Item.

**W.** Payment for removing pressure reducing stations will be made at the unit price bid for "Removing Pressure Reducing Station." This price is full compensation for performing the necessary excavation, backfill, finish grading, pipe removal, structure removal, and for tools, equipment, and incidentals.

**X.** Payment for wet connections will be made at the unit price bid for "Wet Connections," of the sizes specified.

**Y.** Payment for extra hand excavation or extra machine excavation will be made at the unit price bid for "Extra Hand Excavation" or "Extra Machine Excavation." This price is full compensation for labor, hand tools, machines, dewatering, and handling and properly disposing of any excess excavated material not suitable for bedding or backfill for this project.

Trench excavation protection or temporary special shoring for trenches greater than 5 ft. in depth, or sloping the sides of these trenches to preclude collapse, will be measured and paid for as required by Item 402, "Trench Excavation Protection" or Item 403, "Temporary Special Shoring."

Furnishing and placing bedding material is subsidiary to the various bid items.

Providing fittings, including necessary concrete thrust blocking, pipe clamps, nipples, pipe coatings, and lubricants, etc. is subsidiary to the water mains in which they are installed.

In addition, providing fittings required due to plan changes or alterations in line and grade, is subsidiary to the water mains in which they are installed.

Furnishing and installing taps, risers, jumpers, blind flanges, cast-iron sleeves, plugs, reducers etc., as required to disinfect and pressure test the new mains is subsidiary to the various bid items. In addition, necessary excavation and backfill, site grading, and maintenance until completion of pressure testing are subsidiary to the various bid items.

Unless otherwise shown on the plans, the work performed and materials furnished to support the pipes or conduits of public utilities are subsidiary to the various bid items.

Furnishing and installing the nonmetallic pipe detection system, as well as the labor and materials necessary for the system, is subsidiary to the various bid items. In addition, ensure that the detection system is complete, operational, and satisfactory to the Utility Owner.

Adjusting valve boxes is subsidiary to the various bid items.