

**DIVISION 500****UNDERGROUND CONDUIT CONSTRUCTION AND APPURTENANCES**

<b>ITEM</b>	<b>SUBJECT</b>
501	Underground Conduit Materials
502	Appurtenances
503	Trenchless Installation
504	Open Cut – Backfill
505	Open Cut – General Conduit Installation
506	Open Cut – Water Conduit Installation
507	Open Cut – Wastewater Conduit Installation
508	Open Cut – Storm Water Conduit Installation
509	Crossings

## ITEM 501. UNDERGROUND CONDUIT MATERIALS

### 501.1. GENERAL

All pipe and fittings shall be new.

The CITY shall at all times have free access to the manufacturer's plant while production in progress, and may at any time refuse to accept pipe made when the plant is failing to follow the stipulations of the specifications in regard to workmanship, or failing in provisions to insure a uniform product coming within the permissible variations of the specifications. The CITY may reject pipe if adequate means and methods are not provided so as to insure the manufacture of a product of uniform high quality.

Pipe shall be color coded according to the American Public Works Association Uniform Color Code (i.e. blue for water, green for wastewater or storm drain lines, violet for reclaimed water, etc.) or labeled with labeling tape identifying its specific use. Where feasible, permanent identification of the piping service shall be provided by co-extruding color stripes into the pipe outside surface. The striping shall be of the same material except for the color. For co-extruded markings, IPS sized pipe shall have four equally spaced, longitudinal color stripes and DIPS sized pipe shall have three equally spaced pairs of longitudinal color stripes. The color or marking shall be visible on top of buried pipe when pipe is excavated.

Pipe shall be acceptable by the Underwriters' Laboratories, Inc. or Factory Mutual Research when specifically requested and shall be acceptable by the State Fire Insurance Commission for use in water distribution systems when used for fire protection without penalty. Potable water pipe shall also bear the seal of approval (or "NSF" mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

Installation shall be performed in accordance with relevant portions of Division 500 Underground Conduit Construction and Appurtenances.

**501.1.1 Rejection.** Pipe, joints, fittings, or coatings may be rejected for failure to meet any of the requirements of this specification or for any manufacturing, transportation and/or handling defects that may cause pipe, joints, fittings or coatings to be unsuitable for intended use(s). When approved by the CITY, materials may be retested to establish conformity. All rejected materials shall be plainly marked by the Engineer and shall be replaced by the CONTRACTOR with materials which meets the requirements of these specifications. Such rejected materials shall be removed immediately from the site of the work.

### 501.2. CONCRETE PRESSURE PIPE AND FITTINGS

**501.2.1. General.** These specifications cover the manufacture of concrete pressure pipe designed for internal pressures from a minimum of 20-psi (1.4-kg/cm<sup>2</sup>) to a maximum of 350-psi (24.6-kg/cm<sup>2</sup>). Products shall conform to relevant standards as noted in Table 501.2.1. Standards for Concrete Pressure Pipe and Fittings.

**Table 501.2.1. Standards for Concrete Pressure Pipe and Fittings**

Item Reference No.	AWWA Standard	Description
501.4.5	C301	Prestressed Concrete Pressure Pipe, Steel-Cylinder Type
	C304	Design of Prestressed Concrete Cylinder Pipe
501.4.6	C303	Bar-Wrapped Concrete Cylinder Pipe

Items 501.2.2. through 501.2.4., inclusive, shall apply to each type of pipe in Item 501.2 Concrete Pressure Pipe and Fittings.

The type of pipe to be supplied shall be as shown on the plan and/or in the special provisions for each project.

The manufacturer shall submit a successful experience record in the design and construction of the type of concrete pressure pipe involved. Each type of pipe shall have the complete approval of the Underwriters' Laboratories, Inc., for the manufacture of the pipe specified and diameters required. Pipe shall have NSF61 standard approval for potable water applications.

Upon award of the Contract, the CONTRACTOR shall furnish CITY with shop drawings showing the pipe and fittings to be furnished and shall include a tabulated layout schedule with reference to the stationing of the contract drawings with plan and profile drawings. Such drawings shall be subject to the approval of the CITY and fabrication of pipe and fittings shall not be commenced until such drawings have been approved by the CITY. Such approval by the CITY shall not relieve the CONTRACTOR of any responsibility of providing pipe and/or fittings in accordance with the CITY'S plans and specifications.

No cracks will be permitted in the lining of the pipe, except for minor hairline cracks. Cracks in the vicinity of the spigot of prestressed pipe and those cracks in the vicinity of the circumferential wrappers and outlets shall not be allowed, unless after inspection it is determined that they do not interfere with the performance of the pipe and they are accepted by the manufacturer so as to not void the warranty.

**501.2.2. Fittings and Specials.** The manufacturer shall furnish all fittings and special pieces required for closures, bends, branches, manholes, air valves, blowoffs and connections to mainline valves and other fittings shown on the contract drawings or as set out in the specifications conforming with AWWA C301, AWWA C303, or AWWA C304 as applicable. All openings in the pipe for fittings, manholes, taps, blowoffs, etc. shall have the interior and exterior surfaces of the steel lined and coated with mortar. The lining thickness shall be a minimum of 0.5-inches (12.5mm) for sizes 16-in. (400mm) and smaller, and 0.75-in. (19mm) minimum lining thickness for sizes larger than 16-in. (400mm). The minimum coating thickness shall be 1-in. (25mm). The type of fittings and details covering the design of fittings and specials shall be furnished by the manufacturer and subject to the approval of the CITY. The fittings and specials shall comply in all respects with the requirements of AWWA with modifications as herein set forth.

**501.2.3. Flanged Outlets.** Flanged outlets shall be insulated at all points where external valves, pipe, fittings, etc., are connected to the line. The CONTRACTOR shall furnish an insulating flange kit, flange gaskets, insulating sleeves, and two plastic washers for each bolt approved by the OWNER. Bolts, nuts, and washers for flanged outlet connections shall be carbon steel.

**501.2.4. Tests.** All pipe shall be tested in accordance with applicable specifications and AWWA Standards. In addition to certification of all applicable tests required by governing AWWA Standards, the following tests or certifications of tests may be required.

**501.2.4.1. Steel Cylinder Pipe.** The manufacturer shall submit for approval the specified details of materials and methods of welding it proposes to use before any welding is done.

The manufacturer shall furnish one specimen for tensile tests of welds from each 3,000-ft. (900m) of pipe. If tests indicate the welding is unsatisfactory, additional samples as required shall be furnished. Two test cylinders out of each day's pour of the concrete used, or as required by the CITY, shall be furnished for testing by an independent laboratory. The cost of such a test shall be borne by the CITY. Certified test reports made by the manufacturer shall be acceptable in lieu of the test cylinders, provided such test certificates show that they cover pours from which the purchased pipe is made.

Mill test reports on each heat from which steel cylinders and reinforcing are rolled shall be furnished by the CITY, if required.

Test certificates showing the physical properties of the compound used in the gaskets shall be furnished by the CITY, if required.

**501.2.4.2. Three-Edge Bearing Test.** The manufacturer of concrete cylinder pipe supplied in accordance with the provisions of Item 501.2. Concrete Pressure Pipe and Fittings shall have demonstrated, or

shall demonstrate as may be required, that the pipe when tested in a three-edge bearing test as described in ASTM C497 (C497M) Concrete Pipe, Sections or Tile under a load equivalent to the design ditch load shall not deflect more than 0.1-percent. At the above specified load, there shall be no continuous cracks wider than 0.002-in. (0.7mm) for a length of 12-in. (30mm).

**501.2.4.3. Concrete Cylinder Fittings.** Hydrostatic testing of fittings is not required unless specifically called for in the Project Specifications.

**501.2.5. Prestressed Concrete Cylinder Pipe, AWWA C301.**

**501.2.5.1. General.** The pipe shall comply in all respects with the requirements of AWWA C301 Prestressed Concrete Pressure Pipe, Steel Cylinder Type, for Water and Other Liquids. The pipe may be of two types of prestressed concrete steel cylinder pipe as specified on the plans and/or specifications or special conditions:

- (1) the lined cylinder type with a core composed of a steel cylinder lined with concrete and subsequently wire-wrapped directly on the steel cylinder and coated with the mortar.
- (2) the embedded cylinder type with a core composed of a steel cylinder encased in concrete and subsequently wire-wrapped on the exterior concrete surface and coated with concrete or mortar.

**501.2.5.2. Design Pressures and Stresses.** Design pressure shall be that shown on plans and/or specifications. The size of the high-tensile wire and the spacing and tension under which it is wound shall be such that the conditions required by AWWA C304 Design of Prestressed Concrete Cylinder Pipe are met.

**501.2.6. Bar-Wrapped Concrete Cylinder Pipe, AWWA C303.**

**501.2.6.1. General.** The pipe shall consist of a welded sheet-steel or plate-steel cylinder, manufactured by the spiral or straight seam method with joint rings attached, inside of which a cement mortar lining is centrifugally spun; a mild steel bar spirally wrapped under measured tension on the steel cylinder and protective cement mortar coating applied to the outside of the cylinder and spirally-wrapped rod.

The manufacturer shall furnish pipe in uniform lengths except lengths ordered as specials.

The pipe shall comply in all respects with the requirements of AWWA C303, with the following addition.

**501.2.6.2. Design Pressures and Stresses.** Design pressure shall be that shown on the plans and/or specifications. Steel cylinder and bar reinforcement shall be designed in accordance with AWWA Manual M9, Concrete Pressure Pipe.

**501.3. REINFORCED CONCRETE WASTEWATER PIPE WITH RUBBER GASKET JOINTS**

Concrete pipe shall not be used in wastewater applications

**501.4. REINFORCED CONCRETE CULVERT, STORM DRAIN, PIPE AND BOX SECTION**

This item shall govern reinforced concrete culvert, storm drain, pipe and precast reinforced concrete box sections. Pipe shall be cured in accordance with the applicable ASTM Designations for each type of pipe as referred to below.

**501.4.1. Reinforced Concrete Culvert, Storm Drain, and Pipe.**

**501.4.1.1. General.** Except as applicable to Item 501.6.1.1.1. Alternate Concrete Pipe D-Load Design, circular reinforced concrete pipe shall conform to ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe; arch pipe shall conform to ASTM C506 Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe; elliptical pipe shall conform to ASTM C507 Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe, of the class as designed on the plans subject to the following modifications:

- (1) all pipe shall be machine-made by a process which shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product.
- (2) sizes larger than 60-in. (1524mm) diameter shall be manufactured using two lines of circular reinforcement.
- (3) where Class III pipe of sizes larger than 60-in. (1500mm) diameter are specified, the manufacturer may at its option furnish pipe manufactured with either Wall "B" or Wall "C" minimum thicknesses and the applicable minimum steel area as listed for circular cages in Table II of ASTM C76 (C76M), provided tests strength requirements for Class III pipe are satisfactorily met.

**501.4.1.1.1. Alternate Concrete Pipe D-Load Design.** When bedding is specified in accordance with Item 504.5.2.16. Alternate Embedment for Concrete Pipe, reinforced concrete pipe shall conform to ASTM C1417 (C1417M) Manufacture of Reinforced Concrete Sewer, Storm Drain, and Culvert Pipe for Direct Design. This specification covers the manufacture and acceptance of precast concrete pipe designed to conform to the OWNER's design requirements and to ASCE 15-93, ASTM C655 (C655M) Specification for Reinforced Concrete DLoad Culvert, Storm Drain, and Sewer Pipe, or an equivalent design specification. Conditions of 501.4.1.1. modifications (1) and (2) apply to pipe provided under this specification.

**501.4.1.2. Sizes and Permissible Variations.** Variations in diameter, size, shape, wall thickness, reinforcement, placement of reinforcement, laying length and the permissible underrun of length shall be in accordance with the applicable ASTM specification for each type of pipe as referred to previously.

Where rubber gasket pipe joints are to be used, the design of joints and permissible variations in dimensions shall be in accordance with ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets, Sections 5 and 6.

**501.4.1.3. Joints.** Pipe to be placed along curves shall consist of whatever pipe joint lengths or beveled end joints of pipe or combination thereof that are required to place the pipe on the designated centerline curve with no more than one-half of the tongue length of the pipe exposed from its normal fully closed joint position. The amount of bevel, "drop" or shortening of the pipe joint length by the bevel shall not exceed the amount shown in Table 501.4.1.3.(a) Maximum Bevel or Drop for the pipe sizes indicated.

**Table 501.4.1.3.(a) Maximum Bevel or Drop**

Pipe Diameter	Maximum Amount of Bevel or Drop
From 12-in. (305mm) to 27-in. (685mm), inclusive	3.1875-in. (80mm)
From 30-in. (760mm) to 51-in. (1295mm), inclusive	5-in. (125mm)
From 54-in. (1370mm) to 84-in. (2135mm), inclusive	6-in. (150mm)
From 90-in. (2285mm) to 96-in. (2440mm), inclusive	6.5-in. (165mm)

**501.4.1.3.1. Gaskets.** Unless otherwise specified on the plans or in the special provisions, pipe joints shall be sealed with either of the following types of gaskets; Cold-applied preformed plastic gaskets or Expanded Cellular Rubber Gaskets. Each joint shall require one continuous gasket conforming to the joint shape. Gasket cross-sectional diameters shall be in accordance with the manufacturer's recommendations.

**Cold-Applied Preformed Plastic Gaskets.** Plastic gasket shall be produced from blends of refined hydrocarbon resins and plasticizing compounds reinforced with inert mineral filler and shall contain no solvents, irritating fumes, or obnoxious odors.

The gasket joint sealer shall not depend on oxidizing, evaporating nor chemical action for its adhesive or cohesive strength and shall be supplied in extruded rope-form of suitable cross section. The size of the plastic gasket joint sealer shall be in accordance with the manufacturer's recommendations and sufficient to obtain the squeeze out as described under construction methods. The gasket joint sealer shall be protected by a suitable removable two-piece wrapper. The two-piece wrapper shall be so designed that one-half may be removed longitudinally without disturbing the other half to facilitate application as noted below.

The chemical composition of the gasket joint sealing compound as shipped shall meet the requirements of Table 501.4.1.3.1.(a) Sealing Compound Chemical Composition when tested in accordance with the test methods shown. The gasket joint sealing compound when immersed for 30-days at ambient room temperature separately in 5-percent solution of caustic potash, a mixture of 5-percent hydrochloric acid, a 5-percent solution of sulfuric acid and a saturated H<sub>2</sub>S Solution, shall show no visible deterioration.

**Table 501.4.1.3.1.(a) Sealing Compound Chemical Composition**

Composition	Test Method	Percent by Weight
Bitumen (petroleum plastic content)	ASTM D4 Bitumen Content	50-70
Ash-Inert Mineral Matter	AASHTO T-111	30-50
Volatile Matter at 325°F (163°C)	ASTM D6 Loss on Heating of Oil and Asphaltic Compounds	2.0 Max.

The physical properties of the gasket joint sealing compound as shipped shall meet the requirements of Table 501.4.1.3.1.(b) Sealing Compound Physical Properties when tested in accordance with the test methods shown.

**Table 501.4.1.3.1.(b) Sealing Compound Physical Properties**

Property	ASTM Test Method	Typical Analysis
Specific Gravity at 77°F	D71 Relative Density of Solid Pitch and Asphalt (Displacement Method)	1.20 to 1.35
Ductility at 77°F (cm)	D113 Ductility of Bituminous Materials	5.0 min.
Softening Point at 77°F	D36 Softening Point of Bitumen (Ring-and-Ball Apparatus)	320°F min.
Penetration: 32°F. (300-gms) 60-sec.	D217 Cone Penetration of Lubricating Grease	75 min.
77°F (150-gms) 5-sec.		50 to 120
115°F (150-gms) 5-sec.		150 max.
Flash Point C.O.C.	D92 Flash and Fire Points by Cleveland Open Cup Tester	600°F
Fire Point C.O.C.		625°F

**Expanded Cellular Rubber Gaskets.** Expanded cellular rubber gaskets shall be produced from tubular cross-sections of a blend of nitrile and vinyl polymers meeting the physical requirements of ASTM D1056 Flexible Cellular Materials-Sponge or Expanded Rubber, Class 2C1.

**501.4.1.4. Workmanship and Finish.** Pipe shall be substantially free from fractures, large or deep cracks and surface roughness. The ends of the pipe shall be normal to the walls and centerline of the pipe within the limits of variations allowed as stated previously.

**501.4.1.5. Pipe Marking.** Markings shall be indented on the pipe section or painted thereon with waterproof paint. The following information shall be clearly marked on each section of pipe:

- (1) the class of pipe,
- (2) the date of manufacture,
- (3) the name or trademark of the manufacturer,
- (4) where elliptical reinforcement is used, one end of each section or joint of pipe shall be clearly marked during the process of manufacture or immediately thereafter on the inside and the outside of opposite walls to show the location of the "top" or "bottom" of the pipe as it should be installed.
- (5) "Top" and "bottom" shall be required on pipe, unless pipe has such an external shape that the correct position of the top and bottom is obvious.

**501.4.1.6. Tests.** The acceptability of the pipe in all diameters, strengths and classes shall be determined by such material tests performed as required in ASTM C76 (C76M), C506 or C507; by the results of the three-edge bearing test for the load to produce a 0.01-in. (0.25mm) crack and ultimate load and by absorption tests on selected samples from the wall of the pipe in accordance with ASTM C497 (C497M) Concrete Pipe, Manhole Sections, or Tile; and by inspection of the finished pipe to determine its conformance with the design prescribed in these specifications and its freedom from defects.

Testing rates shall be as follows, except that in no case fewer than two specimens shall be furnished:

- (1) If subjected to three-edge-bearing tests for the 0.01-in. (0.25mm) crack only, testing shall be performed on 0.8-percent of the number of pipe sections of each size included in the order. Pipes that have been tested only to the formation of a 0.01-in. (0.25mm) crack and that meet the 0.01-in. (0.25mm) test load requirements shall be accepted for use.
- (2) If subjected to three-edge-bearing tests for both the 0.01-in. (0.25mm) crack and the ultimate load, testing shall be performed on 0.2-percent of the number of pipe sections of each size included in the order.

As an alternate to the three-edge-bearing test, concrete pipe 60-in. (150cm) in diameter and over may be accepted, at the option of the manufacturer, on the basis of material tests and inspection of the completed product. Acceptability of pipe on this basis shall be determined by the results of material tests as required in ASTM C76, C506 or C507; by crushing tests on cores taken from the barrel of the completed and cured pipe; by absorption tests on samples from the wall of the pipe; and by inspection of the finished pipe, including amount and placement of reinforcement, to determine its conformance with the design prescribed in these specifications and its freedom from defects.

The manufacturer shall furnish facilities and personnel for taking the cores from the pipe barrel and for determining the compressive strength of the samples. When the cores cut from a section of pipe successfully meet the strength requirement, the core-holes shall be plugged and sealed by the manufacturer in a manner such that the pipe section shall meet all of the test requirements of ASTM C76, C506 or C507. Pipe sections, so sealed, shall be accepted for use.

Tested pipe accepted for use shall be marked "TEST" or otherwise appropriately identified. Should any of the test specimens fail to meet the test requirements, two consecutive joints in the same mix series shall be tested and results shall be a basis of accepting or rejecting the pipe of the series.

**501.4.1.7. Rejection of Pipe.** All rejected pipe shall be plainly marked by the Engineer and shall be replaced by the CONTRACTOR with pipe that meets the requirements of these specifications. Such rejected pipe shall be removed immediately from the site of the work.

**501.4.2. Precast Reinforced Concrete Box Sections.** Precast reinforced concrete box sections shall conform to ASTM C789 (C789M) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers, or ASTM C850 (C850M) Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers With Less Than 2 Feet of Cover Subject to Highway Loadings. Two-piece box culverts, if approved by the CITY, must meet or exceed the load requirements of ASTM C789 and ASTM C850. Materials and construction methods, unless otherwise specified, shall conform to the requirements of Item 702.8. Precast and Cast-In-Place Concrete Units.

## **501.5. DUCTILE-IRON PRESSURE PIPE AND FITTINGS**

**501.5.1. General.** Ductile-iron pressure pipe 4-in. through 64-in. shall conform to the American National Standard for Ductile-Iron Pipe Centrifugally Cast for Water or Other Liquids, AWWA C151. Polyethylene encasement for ductile iron pipe systems shall conform to Item 502.8. Polyethylene Wrap for Metal Pipe and Fittings.

**501.5.2. Joints.** All ductile-iron pressure pipe shall be furnished with one of the types of joints indicated in Table 501.5.2.(a) Ductile Iron Pressure Pipe Joint Types and as described in the proposal or bid request.

Bolts and nuts for mechanical joints or flanged ends (if used underground) shall be of a high-strength low-alloy corrosion-resistant steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints, Type 3.

All threaded flanges shall be ductile iron.

**Table 501.5.2.(a) Ductile Iron Pressure Pipe Joint Types**

Type Joint	AWWA Standard
Push-on	AWWA C111 Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
Mechanical Joint	AWWA C111 (same as above)
Flanged Ends	AWWA C110 Ductile-Iron and Gray-Iron Fittings, 3 In.-48 In. (76 mm-1,219 mm), for Water, or AWWA C115 Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges
Grooved Ends	AWWA C606 Grooved and Shouldered Joints

**501.5.3. Coating and Lining.** All ductile-iron pipe shall be bituminous coated outside and cement mortar lined inside with seal coat in accordance with AWWA C104 Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water. Cement mortar lined ductile iron pipe can be used for water and certain wastewater applications, such as non acid-producing gravity wastewater lines and wastewater force mains that unquestionably flow full. Contact pipe manufacture for linings suitable in other applications.

**501.5.4. Fittings.** Fittings shall be of ductile-iron and shall conform to AWWA C110 ANSI Standard for Ductile-Iron and Gray-Iron Fittings, 3-in. Through 48-in. (76mm Through 1,219mm) for Water, or conform to AWWA C153 ANSI Standard for Ductile-Iron Compact Fittings for Water Service, 3-in. through 64-in. (76mm through 1,600mm), unless otherwise specified in the proposal, special specification or in the plans.

All fittings shall be rated for a minimum of 250-psi (2069-kPa) working pressure unless otherwise specified.

Special fittings using end condition combinations of bells, spigots, mechanical, integrally restrained or pushon joints, flanges, or special internally locked joints shall be dimensioned in accordance with AWWA C110 or C153.

Bolts and nuts for mechanical joints or flanged ends shall be of a high-strength, corrosion-resistant low-alloy steel and shall conform to ASTM A325 (Type 3) or shall be stainless steel in accordance with ASTM A304 Carbon and Alloy Steel Bars Subject to End-Quench Hardenability Requirements.

The CITY shall determine whether fittings shall be bituminous coated outside and cement-mortar lined inside with seal coat in accordance with AWWA C104 Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water or whether the interior and exterior surfaces shall be protected consistent with AWWA C116 Standard for Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.

**501.5.5. Tests.** All ductile-iron pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto .

**501.5.6. Markings.** Class, weight, and casting period shall be shown on each pipe.

## **501.6. DUCTILE-IRON PIPE FOR PIPE REHABILITATION**

**501.6.1. General.** This standard establishes criteria for the specification of centrifugally cast, "bell-less", ductile iron pipe sizes 3" through 16" for pressure or gravity applications up to a maximum of 50-feet of head (43-psi) (296-kPa), including the conveyance of sewage, wastewater, storm water, treated water, and raw water, installed by trenchless methods. Ductile-iron pipe for pipe reconstruction, as described in Item 601.9. Pipe Bursting with Rigid Pipe, shall meet the minimum property and testing requirements as specified herein.

Pressure and gravity "bell less" pipe shall be manufactured in accordance with AWWA C151 Standard for Ductile-Iron Pipe, Centrifugally Cast for Water, except as modified herein.

The outside diameter of ductile iron "bell less" pipe shall be in accordance with AWWA C151.

Finished pipe lengths of Rubber gasket coupled "bell less" pipe shall have a standard nominal laying length and shall have a standard manufacturing tolerance for actual laying length equal to  $\pm 0.25$ -in (6mm). Laying length shall be specified per project conditions.



**501.6.2. Joints.** Pressure and gravity “bell less” ductile iron pipe joints shall be sealed with O-ring rubber gaskets installed in a machined tongue and groove type joint. The rubber gasketed joints of gravity service shall be field air pressure tested to 5-psi (35-kPa).

**501.6.3. Coating and Lining.** The candidate pipe for trenchless use may be uncoated or standard asphaltic coating in accordance with AWWA C151. Lining systems for ductile iron “bell less” pipe shall be specified by the CITY based on the corrosiveness of the liquid being conveyed and other service requirements.

**501.6.4. Tests.** All pipe and fittings shall be tested in accordance with the applicable provisions of the specifications relating thereto.

**501.6.5. Markings.** Class, weight, and casting period shall be shown on each pipe.

## **501.7. STEEL PIPE AND FITTINGS**

**501.7.1. General.** Steel pipe, fittings and specials shall conform to the details as shown on the plans or included in the specifications and as specified below.

**501.7.2. Applicable Standard Specifications.** Except as modified or supplemented herein, all steel pipe, fittings and specials shall conform to the applicable requirements of the standard specifications indicated in Table 501.7.2.(a) Standards for Steel Pipe and Fittings.

**Table 501.7.2.(a) Standards for Steel Pipe and Fittings**

<b>Standard</b>	<b>Designation</b>
AWWA C200	Steel Water Pipe—6 In. (150 mm) and Larger
AWWA C203	Coal Tar Protective Coatings and Linings for Steel Water Pipeline — Enamel and Tape — Hot Applied
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. (100 mm) and Larger — Shop Applied
AWWA C206	Field Welding of Steel Water Pipe
AWWA C207	Steel Pipe Flanges for Waterworks Service—Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm)
AWWA C208	Dimensions for Fabricated Steel Water Pipe Fittings
AWWA C209	Cold -Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipe
AWWA C210	Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines
AWWA C214	Tape Coating Systems for the Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings
AWWA C602	Cement-Mortar Lining of Water Pipelines in Place—4 In. (100 mm) and Larger
AWWA C606	Grooved and Shouldered Joints
ASTM A283	Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A139	Electric-Fusion (Arc)-Welded Steel Pipe (NPS 4 and Over)

**501.7.3. Pipe and Fittings Requirements.** Fabricated pipe and fittings shall be made of steel plate conforming to ASTM A283, Grade D, or ASTM A139, Grade B, C, or D in accordance with AWWA C200. Milltype pipe and fittings shall be Grade B conforming to AWWA C200.

Nominal pipe diameter shall be as specified in the plans. Nominal diameters for steel pipe sizes under 24-in. (61cm) are outside diameters and for sizes 24-in. (61cm) and over are inside diameters per AWWA M11 Steel Pipe—A Guide for Design and Installation.

The pipe wall thickness shall be as specified in the plans.

Pipe sections shall be furnished in not less than 20 ft. (6.1 m) lengths except for specials and closures sections as may be required.

**501.7.4. Joints.** Steel pipe and fittings shall be joined with any of the end types as specified below, unless a particular end type is specified. Flange ends shall be used only where specifically noted on drawings. Welded joints shall conform to and be tested in accordance with AWWA C206.

Rubber gasketed joints may be used up to 72-in. (1.8m) in diameter and shall conform to, and be tested in accordance with AWWA C200.

Grooved and shouldered joints shall conform to, and be tested in accordance with AWWA C606.

Mechanically coupled joints shall consist of Dresser Couplings Style 38 or equal or as specified on the drawings.

Flanged joints shall conform to the AWWA C207, Class D. The thickness of flanges shall be as specified in Table 1 or 2 of AWWA C207, or as specified on the drawings.

**501.7.5. Lining and Coating.** Steel pipe and fittings shall be lined in accordance with any of the standards indicated in Table 501.7.5.(a) Lining and Coating for Steel Pipe and Fittings, unless a particular specification is shown on the plans.

The exterior surface of steel pipe and fittings to be installed underground shall be coated in accordance with AWWA C214. If coated in accordance with AWWA C214, then the fittings will be coated in accordance with AWWA C209. The exterior surface of steel pipe and fittings to be installed above ground shall be cleaned, primed and coated, all in accordance with either AWWA C222 or C210.

**Table 501.7.5.(a) Lining and Coating for Steel Pipe and Fittings**

<b>Standard</b>	<b>Topic</b>
AWWA C205	Cement-Mortar Protective Lining and Coating for Steel Water Pipe — 4 In. and Larger — Shop Applied
AWWA C210	Liquid-Epoxy Coating Systems for Interior and Exterior of Steel Water Pipelines
AWWA C222	Polyurethane Coatings for the Interior and Exterior of Steel Water Pipelines and Fittings
AWWA C602	Cement-Mortar Lining of Water Pipeline — 4 In. and Larger — in Place

**501.7.6. Testing.** All steel pipe shall be hydrostatically tested to a pressure that will induce a stress of 75% of the minimum yield strength of the steel in accordance with AWWA C200. Fittings fabricated from hydrostatically tested pipe shall not require shop hydrostatic testing. Welds for fittings that were not previously hydrostatically tested shall require hydrostatic testing, air testing, or other ASTM nondestructive testing.

## **501.8. SEAMLESS COPPER TUBING**

**501.8.1. General.** These specifications pertain only to Type K, annealed (soft) copper water tubing for use with solder, flared, or compression-type fittings. The copper tubing shall conform to ASTM B88 Seamless Copper Water Tube.

**501.8.2. Quality.** The vendor shall be responsible for submission of a laboratory analysis of the products supplied. The manufacturer's own laboratory analysis is acceptable providing that these standards meet the requirements of ASTM B88 (seamless copper water tubing). The certificate of analysis shall state size and type of analysis and results obtained. A statement shall be made and validated that tests confirm compliance with the requirements of this specification.

The CITY reserves the right to conduct or cause to have conducted independent laboratory tests. Where the results of such tests prove the quality requirements have not been met: (1) the costs of tests shall be charged to the vendor's account, and (2) the entire shipment may be rejected on the basis of such tests.

## **501.9. CORRUGATED METAL PIPE OR PIPE ARCH SHAPES**

**501.9.1. General.** This item shall govern the furnishing of corrugated metal pipe for culverts and storm water conduit for the locations and designations as shown on the plans and contract specifications as herein outlined.

Pipe having a design hydraulic head exceeding 5-ft. (1.5m) of water will have helical corrugations and the lock seam shall be either continuously welded or caulked with a neoprene or mastic seal during fabrication. Caulked helical pipe shall be fabricated by applying a uniform bead of neoprene or mastic compound to the lock seam in such a manner that the inner surfaces of the lock seam are free of voids.

Shell Data shall specify diameter, classification (Type), material, gage and corrugation. This information shall be designated on the plans and/or contract specifications.

**501.9.2. Pipe Manufacture.** Corrugated metal pipe or pipe arch shapes shall meet the requirements of ASTM A760 (A760M) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains, ASTM B745 (B745M) Corrugated Aluminum Pipe for Sewers and Drains, or ASTM A742 (742M) Steel Sheet, Metallic Coated and Polymer Precoated for Corrugated Steel Pipe. All pipe shall be manufactured with a minimum of two re-rolled ends.

**501.9.2.1. Steel Pipe.** Galvanized or aluminized steel pipe shall be full circle or arch pipe conforming to AASHTO Designation M36, Type I, Type II or Type III as specified in the plans.

**501.9.2.2. Aluminum Pipe.** Aluminum pipe shall conform to the requirements of AASHTO Designation M196, Type I, Type II or Type III pipe arch as specified on the plans.

Aluminum pipe may be placed bare of any precoating, but any portions of aluminum pipe that are to be in contact with a metal other than aluminum or in contact with concrete containing chlorides, shall be insulated from

this other metal or concrete by a coating of bituminous material or a plastic coating, such as asphalt mastic or polymeric coating. The coating applied to the aluminum pipe or pipe arch to provide an insulation between the aluminum and other metal shall extend a minimum distance of 1 ft. beyond the area of contact.

**501.9.2.3. Precoated Galvanized or Aluminized Steel Pipe.** Pipe shall be full circle or arch pipe conforming to AASHTO Designation M245, Type I, Type II or Type III as specified in the plans.

**501.9.3. Classification (Type).** Corrugated metal pipe shall be classified on the plans and/or specifications with the notations as set forth in ASTM A760 (A760M), ASTM B745 (B745M) and ASTM A742 (A742M) and indicated in Table 501.9.3.(a) Corrugated Metal Pipe Type.

**Table 501.9.3.(a) Corrugated Metal Pipe Type**

Type	Description
Type I	Pipe with a full circular cross section with a singular thickness of corrugated sheet, fabricated with annular or helical corrugations.
Type IA	Pipe with a full circular cross section, with an outer shell of corrugated sheet fabricated with helical corrugations and an inner liner of smooth (uncorrugated) sheet attached to the shell at helical lock seams. Unless otherwise shown on the plans or contract specifications, the inner liner of smooth (uncorrugated) sheets shall be 18-gage, polymer coated per ASTM A762 (A762M) Grade 10/10 or 20-gage, polymer coated per ASTM A762 (A762M) Grade 10/10.
Type IR	Pipe with a full circular cross section, with a single thickness of smooth sheet, fabricated with helical ribs projecting outward.
Type II	Type I pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
Type IIA	Type IA pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
Type IIR	Type IR pipe which has been reformed into a pipe-arch, having an approximately flat bottom.
Type III	Type I pipe which has been perforated to permit the inflow and outflow of water, intended for use as underdrains.
Type IIIA	Pipe shall consist of semi-circular cross section having a smooth bottom with a corrugated top shield which has been perforated, intended for use as deck drains.

**501.9.4. Material.** Corrugated metal pipe or pipe arch shapes shall be fabricated from corrugated sheets conforming to one of the styles indicated in Table 501.9.4.(a) Corrugated Sheets for Pipe or Pipe Arch Shapes.

**Table 501.9.4.(a) Corrugated Sheets for Pipe or Pipe Arch Shapes**

Metal		Standards
GALV	Galvanized Steel	ASTM A760 (A760M) Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ALT2	Aluminized Type 2 Steel	ASTM A760 (A760M) (same as above)
POLY	Polymeric Steel	ASTM A762 (A762M) Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains (Grade 10/10)
ALUM	Aluminum Alloy	ASTM B744 (B744M) Aluminum Alloy Sheet for Corrugated Aluminum Pipe

**501.9.5. Gage.** Where reference is made to gage of metal, the reference is to U.S. Standard Gage for uncoated sheets in ASTM A929 (A929M) Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe. Unless otherwise shown on the plans or contract specifications, minimum gages shall be as required by *TxDOT Standard Specifications for Construction of Highways, Streets and Bridges*, Item 460.4. Selection of Gages.

**501.9.6. Corrugation.** Corrugated configurations shall be governed by dimensional tolerances set forth in ASTM A760 (A760M). The corrugations as shown in Table 501.9.6.(a) Corrugation Configurations shall only be valid with their respective classifications (type).

**Table 501.9.6.(a) Corrugation Configurations**

Type	Configuration
Type 1	2? -in. x ½-in.; 3-in. x 1-in.; 5-in. x 1-in. (68mm x 13mm; 75mm x 25mm; 125mm x 25mm)
Type IA	2? -in. x ½-in.; 3-in. x 1-in. (68mm x 13mm; 75mm x 25mm)
Type IR	¾-in. x ¾-in. x 7½-in.; ¾-in. x 1-in. x 11½-in. (19mm x 19mm x 190mm; 19mm x 25mm x 292mm)
Type II	2? -in. x ½-in.; 3-in. x 1-in.; 5-in. x 1-in. (68mm x 13mm; 75mm x 25mm; 125mm x 25mm)
Type IIA	2? -in. x ½-in.; 3-in. x 1-in. (68mm x 13mm; 75mm x 25mm)
Type IIR	¾-in. x ¾-in. x 7½-in.; ¾-in. x 1-in. x 11½-in. (19mm x 19mm x 190mm; 19mm x 25mm x 292mm)
Type III	2? -in. x ½-in.; 3-in. x 1-in. (68mm x 13mm; 75mm x 25mm)

**501.9.7. Repairs.** All damage incurred in fabrication will be repaired at the fabrication location. Damage incurred during handling and placement will be repaired, inspected and approved by the CITY prior to backfilling the pipe.

**501.9.7.1. Galvanized Steel Pipe.** Damaged spelter coating shall be repaired by thoroughly wire brushing the damaged area and removing all loose, cracked or weld burned spelter coating. The cleaned area shall be painted with a zinc dust-zinc oxide paint conforming to Federal Specifications TT-P-641.

**501.9.7.2. Aluminized Steel Pipe.** Damaged areas of aluminized coating, including saw cut ends and welds, shall be cleaned and repaired by brush coating of aluminized paint to the damaged, cut or welded area to a minimum thickness of 0.005-in. (0.13mm).

**501.9.7.3. Precoated Pipe.** Damaged or cut areas of polymeric coatings shall be repainted by the application of a polymeric coating similar and compatible with the polymeric coating on the pipe and to a minimum 10-mil (0.25mm) thickness.

Damaged areas of bituminous coated galvanized steel shall be repaired by repair of any damaged areas of spelter coatings in accordance with Item 501.9.7.1. Galvanized Steel Pipe before repairing the bituminous coating by applying asphalt mastic to the same thickness as the original coating.

**501.9.8. Pipe Marking.** The following information shall be clearly marked on each section of pipe:

- (1) Date of manufacture of the pipe.
- (2) The name or trademark of the manufacturer of the pipe.
- (3) Gage or thickness of metal.
- (4) Alloy number (aluminum pipe only).

**501.9.9. Couplings.**

**501.9.9.1. Coupling Bands.** Except as may be otherwise required, coupling bands shall be of the same base material(s) as the pipe. Coupling bands shall lap evenly on each of the pipes being connected and shall fit securely into a least one full circumferential corrugation to form a tightly closed joint. Pipe end circumferential corrugations shall be the corrugation width and depth as shown on the plans or as specified by the Engineer.

All pipe shall be field jointed with corrugated locking bands. Coupling bands shall not be more than three nominal sheet thicknesses lighter than the pipe to be connected and in no case thinner than 0.052-in. (1.32mm). The minimum sheet width of the corrugated locking bands shall be as shown in Table 501.9.9.1.(a) Corrugated Locking Band Width for the corrugation which corresponds to the end circumferential corrugations on the pipe being joined.

**Table 501.9.9.1.(a) Corrugated Locking Band Width**

Corrugation	Minimum Band Width
2? -in. x ½-in. (68mm x 13mm)	10½-in. (267mm)
3-in. x 1-in. (75mm x 25mm)	12-in. (305mm)
6-in. x 1-in. (152mm x 25mm)	18-in. (457mm)

When it is necessary to join a new pipe of helical corrugations to an existing pipe which was installed with no circumferential end corrugations, the two pipes shall be field jointed with helically corrugated bands. The width of helically corrugated bands shall conform to the minimum widths in Table 501.9.9.1.(b) Helically Corrugated Band Width.

**Table 501.9.9.1.(b) Helically Corrugated Band Width**

<b>Helical End Corrugation</b>	<b>Minimum Band Width</b>
½-in. (13mm) deep	12-in. (305mm)
1-in. (25mm) deep	14-in. (356mm)

All coupling bands 12-in. (305mm) wide or less shall be drawn together by means of a minimum of two ½-in. (13mm) diameter bolts through angles or bar and strap device suitably welded; coupling bands greater than 12-in. (305mm) wide shall have a minimum of three ½-in. (13mm) diameter bolts.

**501.9.9.2. Bell-and-Spigot Coupling.** Except as may otherwise be required, bell-and-spigot couplings shall be of the same base material as the pipe, and in no case thinner than 0.052-in. (1.32mm).

Couplings shall be bell and spigot type. The bell shall have a corrugation to engage the rerolled annular corrugation in the pipe, with a flare to receive the spigot end of the next section of pipe. The bell shall have factory-welded lap(s) applied after snugging the bell corrugation into the pipe rerolled annular corrugation.

Gaskets, if required, shall be polyisoprene (or similar) with a durometer of 45 ±5. The gasket on the spigot end shall be fluted with two flutes to prevent rolling when assembled in the field and to resist pull out from the bell.

## **501.10. STRUCTURAL PLATE STRUCTURES**

**501.10.1. General.** Structural plate conduit, pipe arch, box culverts and special shapes shall meet the requirements of *TxDOT Standard Specifications for Construction of Highways, Streets and Bridges* Item 461 Structural Plate Structures and be in accordance with ASTM A761 Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches for galvanized steel structures or ASTM B221 Aluminum and Aluminum -Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, for aluminum alloy structures.

**501.10.2. Plates.** Steel plates shall consist of structural units of corrugated galvanized metal. Single plates shall be furnished in standard sizes to permit structure length increments of 2-ft. (0.6m). Aluminum plate shall consist of structural units of corrugated aluminum alloy. For aluminum alloy structures, cut plates shall be furnished on structure ends to permit structure length increments of 1-ft. (0.3m).

Plates shall be formed to provide bolted lap joints. The bolt holes shall be so punched that all plates having like dimensions, curvature, and the same number of bolts per foot of seam shall be interchangeable. Each plate shall be curved to the proper radius so that the cross-sectional dimensions of the finished structure will be as indicated on the plans. Joints shall be staggered so that not more than 3 plates are joined at any one point. Unless otherwise specified, bolt holes along those edges of the plates that will form longitudinal seams in the finished structure shall be:

- (1) staggered in rows 2-inches (5cm) apart, with one row in the valley and one in the crest of the corrugations and not less than 4-bolts-per-foot for galvanized steel structures, or
- (2) in rows 1¾-in. (4.5cm) apart with 2 bolts in each valley and on each crest and not less than 16-bolts-per-3-feet for aluminum alloy structures.

Bolt holes along those edges of the plates that will form circumferential seams in the finished structure shall provide for a bolt spacing of not more than 12-in. (30cm). The minimum distance from center of hole to edge of the plate shall be not less than 1¾-times the diameter of the bolt. The diameter of the bolt holes in the longitudinal seams shall not exceed the diameter of the bolt by more than ¼-in. (6mm). Plates for forming skewed or sloped ends shall be cut so as to give the angle of skew or slope specified. Burned edges shall be free from oxide and burrs and shall present a workmanlike finish and legible identification numerals shall be placed on each plate to designate its proper position in the finished structure.

**501.10.3. Corrugations.** Permissible corrugations of metal plates to be furnished for each structure shall be shown on the plans. Corrugations for steel structures shall have a pitch of 6-in. (150mm) with a tolerance of ¼-in. (6mm) and a depth of 2-in. (50mm) with a tolerance of ⅜-in. (3mm). The radius on the inside of the corrugations shall be at least 1 1/16-in. (26mm) for steel structures. Corrugations for aluminum alloy structures shall have a pitch of 9-in. (229mm) with a tolerance of ⅜-in. (9.5mm) and a depth of 2½-in. (64mm) with a tolerance of ⅜-in. (3mm). The radius of the inside of the corrugation shall be at least 2-in. (50mm) for aluminum alloy structures.

**501.10.4. Gauge Determination and Tolerances.** The gage or minimum thickness of metal plates to be furnished for each structure shall be shown on the plans. The gauge and tolerances of aluminum plates shall conform to those in ASTM B221 Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes. The thickness of galvanized steel plates shall conform to those in ASTM A929/A929M Steel Sheet, Metallic-Coated by the Hot-Dip Process for Corrugated Steel Pipe.

**501.10.5. Metal Headwalls.** The material for metal headwalls shall comply with requirements shown on plans. When required, aluminum alloy inverts, toewalls footings and closure plates shall conform to the material requirements herein. Extruded aluminum transverse stiffeners shall conform to ASTM B221 Aluminum and Aluminum -Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes, Alloy 6061-T6.

**501.10.6. Fasteners.** Fasteners for steel structural plate shapes shall be high strength bolts  $\frac{3}{4}$ -in. (19mm) diameter, hot-dip galvanized, meeting ASTM A449 Quenched and Tempered Steel Bolts and Studs. Nuts shall conform to ASTM A563 Carbon and Alloy Steel Nuts, Grade C. Fasteners for aluminum structural plate shapes shall be  $\frac{3}{4}$ -in. (19mm) diameter, hot-dip galvanized steel, meeting ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength with the zinc coating in accordance with ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware. Nuts shall conform to ASTM A563, Grade A.

Bolt lengths shall be such as to result in at least "full nuts" when tightened in place.

**501.10.7. Anchor Bolts.** Anchor bolts for anchoring the ends of structural plate conduits into concrete headwall, footings or toewalls, as shown on the plans, shall be  $\frac{3}{4}$ -in. (19mm) diameter conforming to ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength with the zinc coating in accordance with ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware. The length, shape and placement of these anchor bolts shall be as shown on the plans or approved by the Engineer.

**501.10.8. Identification.** No plates shall be accepted unless the metal is identified by a stamp on each plate in accordance with AASHTO M167 for Steel Structural Plate or AASHTO M219 for Aluminum Alloy Structural Plates.

**501.10.9. Inspections.** If the Engineer so elects, it may have the material inspected and sampled in the rolling mill or in the shop where fabricated. Engineer may require from the mill the chemical analysis of any plate. The inspection, either in the mill or in the shop, shall be under the directions of the Engineer. The Engineer or its representative shall have free access to the mill or shop for inspection and every facility shall be extended to the Engineer or representative for this purpose. Any material which has been previously rejected at the mill or shop and included in a later lot will be cause for rejection unless it has been satisfactorily repaired.

The CONTRACTOR shall furnish an itemized statement of the number and size of plates in each shipment. From this list a visual inspection shall include an examination of the plates for deficiency in size, radius of curvature specified, and any evidence of poor workmanship as outlined herein. The inspection may include the taking of samples for chemical analysis and determination of weight of spelter coating on steel plates. The plates making up the shipment shall fully meet the requirements of these specifications. Any plates failing to do so will be rejected.

**501.10.10. Rejection.** In addition to the provisions of Item 501.1.1 Rejection, structures shall be rejected on which the spelter coating has been bruised or broken either in the shop or in shipping, or which shows defective workmanship. The requirement applies not only to the individual plates but also to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual culvert plate or in general in any shipment shall constitute sufficient cause for rejection:

- (1) elliptical shaping,
- (2) variation from a straight centerline,
- (3) ragged edges,
- (4) unevenly lined or spaced bolt holes,
- (5) illegible brands,
- (6) bruised, scaled or broken spelter coating,
- (7) dents or bends in the metal itself, or
- (8) uneven laps.

## **501.11. TUNNEL LINER PLATES**

**501.11.1. General.** This specification covers the material, galvanizing, coating, shapes and gauge requirements of tunnel liner plates for use in tunneling under railroads, highways and streets.

**501.11.2. Plates.** The plates shall be fabricated from steel sheets conforming to the requirements of ASTM A1011 Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-

Alloy with Improved Formability. In addition, the flat plates before cold forming shall have mechanical properties indicated in Table 501.11.2.(a) Tunnel Liner Plate Requirements.

**501.11.2.(a) Tunnel Liner Plate Requirements**

Property	Minimum Value
Tensile Strength	42,000-psi (2953-kg/cm <sup>2</sup> )
Yield Strength	28,000-psi (1967-kg/cm <sup>2</sup> )
Elongation, 2-in. (51 mm)	30-percent

**501.11.3. Bolts and Nuts.** Bolts used with lapped seam type (2 flange) liner plates shall be not less than  $\frac{5}{8}$ -in. (15mm) diameter. Bolts shall conform to ASTM A449 Quenched and Tempered Steel Bolts and Studs for plate thickness equal to or greater than 0.209-in. (5mm) and to ASTM A307 Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength for plate thickness less than 0.209-in. (5mm). Nuts shall conform to ASTM A307.

Bolts and nuts used with the four-flanged type shall be not less than  $\frac{1}{2}$ -in. (12mm) for 7-gauge plates and lighter and not less than  $\frac{5}{8}$ -in. (15mm) diameter for plates heavier than 7-gauge. The bolts and nuts shall be quick acting coarse thread and shall conform to ASTM A307, Grade A.

**501.11.4. Fabrication.** The plates shall be new and unused prior to fabrication. All plates shall be punched for bolting on both longitudinal and circumferential seams or joints and shall be so fabricated as to permit complete erection from the inside of the tunnel. All plates shall be of uniform fabrication and those intended for one size tunnel shall be interchangeable.

**501.11.5. Grout Holes.** One-half of the total number of the top plates shall be equipped with 2-in. (50mm) diameter grout holes to facilitate grouting above and around the tunnel liner conduit. All grout holes shall be equipped with screw type galvanized plugs for final watertight closure of the grout holes.

**501.11.6. Galvanizing.** After the plates are formed to shape and after all holes are punched, the plates shall be galvanized on all surfaces by the hot-dip process. A coating of prime western spelter or equal shall be applied in accordance with ASTM A123 Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products. Spelter coating shall be of first-class commercial quality free from injurious defects such as blisters, flux and uncoated spots. All nuts shall be galvanized to conform to ASTM A153 Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

**501.11.7. Bituminous Coating.** The plates shall be given a bituminous coating meeting the current American Railway Engineering & Maintenance of Way Association specification or ASTM A849 Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe. Bituminous protected corrugated metal pipe or plates may be spray-coated in the field with a minimum dry film thickness of 0.05-in. (1.3mm) prior to installation.

**501.11.8. Section Properties.** Section properties shall conform to those specified in AASHTO Standard Design Specifications for Highway Bridges, Section 16, Steel Tunnel Liner Plates.

**501.11.9. Rejection.** Structures on which the spelter coating has been bruised or broken either in the shop or in shipping or which shows defective workmanship shall be rejected. The requirement applies not only to the individual plates but also to the shipment on any contract as a whole. Among others, the following defects are specified as constituting poor workmanship, and the presence of any or all of them in any individual liner plate or in general in any shipment shall constitute sufficient cause for rejection:

- (1) uneven laps,
- (2) elliptical shaping,
- (3) variation from a straight centerline,
- (4) ragged edges,
- (5) unevenly lined or spaced bolt holes,
- (6) illegible brands,
- (7) bruised, scaled or broken spelter coating, or
- (8) dents or bends in the metal itself.

## **501.12. POLYVINYL CHLORIDE (PVC) WATER PIPE**

**501.12.1. General.** Unplasticized polyvinyl chloride (PVC) water pipe shall meet the requirements of AWWA Standard for Polyvinyl Chloride (PVC) Pressure Pipe, 4 In. through 12 In., For Water, AWWA C900 with cast-iron outside dimensions or AWWA C905 Polyvinyl Chloride (PVC) Water Transmission Pipe, Nominal Diameter 14 in. through 48 in., with cast-iron outside dimensions. Laying lengths shall be 20-ft  $\pm$  1-in. (6m  $\pm$  2.5cm).

**501.12.2. Approvals.** PVC water pipe shall be approved by the Underwriters' Laboratories and shall be accepted by the State Fire Insurance Commission for use in water distribution systems in cities and towns of

Texas. PVC water pipe shall also bear the seal of approval (or “NSF” mark) of the National Sanitation Foundation Testing Laboratory for potable water pipe.

**501.12.3. Dimension Ratio.** PVC water pipe shall meet the dimension ratios (DR's) and physical dimensions as shown in AWWA C900 or C905. The pressure classification refers to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations. DR 21 is a non-standard product in pipe sizes 18-, 20- and 24-inch. 42- and 48-in pipe DRs of 41 and 51 shall not be used for water applications.

**501.12.4. Joints.** PVC water pipe shall be furnished with gasketed joints. Lubricant used for pipe and fittings assembly shall be nontoxic, water soluble approved by AWWA & NSF rating and shall have no detrimental effect to either gasket or pipe.

**501.12.5. Fittings.** Fittings for PVC water pipe shall conform to one of the standards Table 501.12.5.(a) PVC Water Pipe Fittings Standards unless otherwise specified. Fittings joints shall be push-on, integrally restrained, or mechanical. Bolts and nuts for mechanical and integrally restrained fittings joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to ASTM A325 High Strength Bolts for Standard Steel Joints (Type 3) or shall be stainless steel in accordance with ASTM A304.

**Table 501.12.5.(a) PVC Water Pipe Fittings Standards**

<b>Standard</b>	<b>Topic</b>
AWWA C110 (ANSI A21.10)	Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In. (76 mm Through 1,219 mm) for Water
AWWA C153	ANSI Standard for Ductile-Iron Compact Fittings for Water Service
AWWA C907	Polyvinyl Chloride (PVC) Pressure Fittings for Water—4 In. Through 8 In. (100 mm Through 200 mm)
AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe, and Fabricated Fittings, 4 In. Through 12 In. (100 mm Through 300 mm) for Water Distribution
AWWA C905	Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In. Through 48 In. (350 mm Through 1,200 mm), for Water Transmission and Distribution

### **501.13. POLYVINYL CHLORIDE (PVC) PRESSURE-RATED PIPE (SDR SERIES)**

**501.13.1. General.** PVC pressure-rated pipe shall conform to the current ASTM D2241, Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

**501.13.2. Material.** The pipe shall be made of PVC plastic having cell classifications of 12454, 12454 or 14333.

**501.13.3. Joints.** Joint tightness shall be tested in accordance with ASTM D3139, Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.

**501.13.4. Testing.** All pipe shall meet ASTM requirements for sustained pressure test, accelerated regression test, burst pressure, flattening and impact resistance.

### **501.14. MOLECULARLY ORIENTED POLYVINYL CHLORIDE (PVCO) WATER PIPE**

**501.14.1. General.** Unplasticized (PVCO) Water pipe shall meet the requirements of AWWA Standard C909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. – 12 In. (100 mm-300 mm), for Water Distribution. Laying length shall be 20ft ± 1 inch (6m ± 2.5cm).

**501.14.2. Material.** PVCO water pipe starting stock shall be made from ASTM D1784 cell class 12454 material, having an Hydrostatic Design Basis (HDB) of 4000-psi (281-kg/cm<sup>2</sup>). When orientation is achieved, PVCO pipe will have an HDB of 7100-psi (500-kg/cm<sup>2</sup>). The pressure classifications refer to the maximum hydrostatic pressure to which the pipe shall be subject in normal operations.

**501.14.3. Dimensions.** Dimensions shall conform to the requirements in AWWA C909.

**501.14.4. Joints.** PVCO water pipe shall be furnished with gasketed joints, meeting ASTM D3139 Joints for Plastic Pressure Pipes using Elastomeric Seals. Lubricant used for pipe and fittings assembly shall be nontoxic and shall have no detrimental effect to either gasket or pipe. Solvent cement shall not be used with PVCO pipe.

**501.14.5. Fittings.** Fittings for PVCO water pipe shall conform to American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In., For Water and Other Liquids, AWWA Standard C110 (ANSI A21.10) or AWWA C907 for Polyvinyl Chloride (PVC) Pressure Fittings for Water, 4 In. through 8 In., or AWWA C153 ANSI Standard for Ductile-Iron Compact Fittings for Water Service unless otherwise specified. Fittings joints shall be push-on or mechanical joints. Bolts and nuts for mechanical joints shall be of a high-strength, corrosion-resistant, low-alloy steel and shall conform to High Strength Bolts for Standard Steel Joints, ASTM A325 (Type 3) or stainless steel in accordance with ASTM A304.



**501.15. POLYVINYL CHLORIDE (PVC) WASTEWATER PIPE & FITTINGS WITH DIMENSION CONTROL**

**501.15.1. General.** PVC Wastewater Pipe and Fittings shall conform to ASTM D3034 Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings for 4 in. through 15 in. diameter and ASTM F679 Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings for greater than 15 in. diameter.

**501.15.2. Material.** The pipe shall be made of PVC plastic having cell classification of 12454, 12454 or 12364, and fittings shall be made of PVC plastic having cell classifications of 12454, 12454 or 13343 as defined in ASTM D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. Pipe type shall be determined by size as shown in Table 501.15.2.(a) PVC Wastewater Pipe Type.

**501.15.2.(a) PVC Wastewater Pipe Type**

Pipe Size (diameter)	Type	Standard
4-in. through 15-in. (10cm - 38cm), inclusive	PSM SDR-35 or SDR-26	ASTM D3034
greater than 15-in. (38cm)	T-1 A or T-2 B	ASTM F679

**501.15.3. Dimensions.** Dimensions shall conform to requirements of ASTM D3034 or F679.

**501.15.4. Testing.** All pipe shall meet ASTM requirements for flattening, impact resistance, stiffness, joint tightness and extrusion quality as specified in ASTM D3034 or F679.

**501.16. POLYVINYL CHLORIDE (PVC) PROFILE GRAVITY WASTEWATER PIPE AND FITTINGS – FOR DIRECT BURY AND SLIPLINING APPLICATIONS**

**501.16.1. General.** This specification designates requirements for PVC plastic gravity wastewater pipe for the conveyance of domestic wastewater with various modified wall profiles and performance requirements.

**501.16.2. Stiffness.** Minimum pipe stiffness at five percent deflection shall be 46-psi (3.2-kg/cm<sup>2</sup>) for wastewater conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

**501.16.3. Pipe Classification.** Pipe as indicated on the plans shall conform to one of the standards in Table 501.16.3. PVC Profile Gravity Pipe Standards.

**Table 501.16.3. PVC Profile Gravity Pipe Standards**

Standard	Topic	Notes
ASTM F789	Type PS-46 PVC Plastic Gravity Flow Sewer Pipe and Fittings, size 4 in. to 18 in.	Pipe conforming to ASTM F789 shall be joint compatible to ASTM D3034 pipe joint dimensions
ASTM F794	PVC Ribbed Gravity Sewer Pipe and Fitting Based on Controlled Inside Diameter, sizes 4 in. through 48 in.	--
ASTM F949	PVC Corrugated Sewer Pipe with Smooth Interior and Fittings, sizes 4 in. through 36 in. (46 psi pipe stiffness) or sizes 8 in. through 15 in. (115 psi pipe stiffness)	--
ASTM F1803	PVC Closed Profile Gravity Pipe and Fittings Based on Controlled Inside Diameter, sizes 18 in. through 60 in.	--

**501.16.4. Joints.** Joint tightness shall be tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

**501.16.5. Testing.** Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

**501.17. PVC COMPOSITE PIPE FOR WASTEWATER CONDUITS**

**501.17.1. General.** PVC composite pipe shall conform to ASTM D2680 Acrylonitrile-Butadiene-Styrene (ABS) and Poly(Vinyl Chloride) (PVC) Composite Sewer Piping for 8 in. through 15 in diameter. Acrylonitrile-Butadiene-Styrene (ABS) shall not be allowed.

**501.17.2. Joints, Couplings and Fittings.** Wyes or tees with saddle shall be provided as indicated on the plans. Adapters to other types of pipe shall be supplied as indicated on the plans.

**501.17.2.1. Chemically Welded Joints.** If the pipe is plane ended with couplings, the pipe shall be delivered prebelled. Sufficient primer and solvent cement shall be provided. The solvent cement shall conform to ASTM D2564 Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.

**501.17.2.2. O-Ring Joints.** If the pipe is prebelled with an enlarged coupling, an O-Ring shall be provided for each joint. The physical properties of the gasket shall be at least equal to the requirements of ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets.

**501.17.3. Tests.** The pipe stiffness at five-percent vertical deflection shall be at best equal to or exceed 200-lb./in. (3612-g/cm) of deflection for each diameter as determined by ASTM D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading. The physical test may be the 3-Edge Bearing Method under applicable ASTM Designation if preferred.

#### **501.18. POLYVINYL CHLORIDE (PVC) CORRUGATED STORM WATER PIPE WITH A SMOOTH INTERIOR AND FITTINGS**

**501.18.1. General.** PVC Corrugated storm water pipe and PVC Perforated Corrugated drainpipe shall conform to ASTM F949 Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings (4"-36").

**501.18.2. Material.** The storm water conduit/drainpipe shall be of PVC compound having a minimum cell classification of 12454 in accordance with ASTM D1784 Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds. The fittings shall be made of PVC compound having a cell classification of 12454 or 13343 as defined in ASTM D1784.

**501.18.3. Stiffness.** Constant minimum pipe stiffness at five-percent deflection shall be 46-psi (3.2-kg/cm<sup>2</sup>) for storm conduit as specified for all sizes when calculated in accordance with ASTM D2412 Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

**501.18.4. Joints.** Joints shall be an integral bell-gasketed joint. When the joint is assembled, it shall prevent misalignment of adjacent pipes and form either a soil tight joint (2-psi hydrostatic test per AASHTO Standard Specification for Highway Bridges, Section 26.4.2.4) or a watertight joint (10.8-psi test per ASTM D3212 Standard Specification for Joints for Drain and Sewer Plastic Pipes using Flexible Elastomeric Seals) as required.

**501.18.5. Testing.** Pipe shall be tested for flattening, impact resistance and extrusion quality as specified in the applicable ASTM Designations.

#### **501.19. SOLID WALL POLYETHYLENE PLASTIC PIPE FOR WATER, WASTEWATER, AND PIPE REHABILITATION**

**501.19.1. General.** Pipe and fittings shall conform to the material and physical properties as described in ASTM F714 Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter, unless otherwise specified herein or in the special specifications. Standard Lengths shall be 40-ft (12m) or 50-ft (15m) for straight pipe. Coiled pipe may be obtained in reels of 500-ft (152m), 1000-ft (305m) or 1500-ft (457m) depending on outside diameter and Dimension Ratio (DR) requested.

Solid wall high density polyethylene pipe (HDPE) for pressure water pipe shall meet the requirements of AWWA C901 Polyethylene (PE) Pressure Pipe and Tubing, ½ In. (13 mm) Through 3 In. (76 mm), for Water Service or AWWA C906 Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,575 mm), for Water Distribution.

**501.19.2. Material.** Pipe and fittings shall be made of high density, high molecular weight polyethylene pipe PE3408 material, polyethylene resin which conforms to Polyethylene Plastics Molding and Extrusion Materials, meeting the requirements of Type III, Grade P33, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials. The polyethylene plastic shall meet the Cell Classification requirements of 345464C or 345464E as defined in ASTM D3350. Pipe for non-pressure applications shall have a light colored interior, unless otherwise specified in the plans, contract documents or purchase request.

**501.19.3. Dimensions.** The polyethylene (PE) pipe shall meet the dimension ratios and outside diameter, wall thickness and tolerances as provided in the reference specifications of manufacture as listed in Table 501.19.3.(a) Solid Wall PE Pipe Dimension Standards. Diameters and wall thickness other than those shown in the standards may be used if specifically called for in the plans, contract documents or purchase request, and if they are mutually agreed upon by the manufacturer and CITY.

**Table 501.19.3.(a) Solid Wall PE Pipe Dimension Standards.**

<b>Standard</b>	<b>Topic</b>
AWWA C901	Polyethylene (PE) Pressure Pipe and Tubing, ½ in Through 3 in for Water Service
AWWA C906	Polyethylene (PE) Pressure Pipe and Fittings, 4in through 63in for Water Distribution and Transmission
ASTM D2239	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Controlled Inside Diameter
ASTM D2737	Polyethylene (PE) Plastic Tubing
ASTM D3035	Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter
ASTM F714	Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter

**501.19.4. Joints.** Dependent upon installation requirements, site location, and weather conditions, joining shall be performed within or outside the excavation.

Sections of polyethylene pipe and fittings shall be joined by the butt fusion process, unless one of the alternate methods is approved by the CITY. The butt (heat) fusion method shall be performed in accordance with the pipe manufacturer's recommendations. Electrofusion fittings may be used. Mechanical joint adapters, flanges, unions, grooved-couplers, transition fittings, and some mechanical couplings may be used to mechanically connect PE pipe/tubing and fittings. Extrusion welding or hot gas welding of PE shall not be used for pressure pipe application or fabrications where shear or structural strength is important.

**501.19.4.1. Alternate Methods.** When approved by the CITY, pipe may be joined to one another and to polyethylene fittings by electrofusion or socket thermal fusion joints in accordance with ASTM D2657 Heat Joining of Polyolefin Pipe and Fittings, ASTM F1290 Electrofusion Joining of Polyolefin Pipe and Fittings, and as recommended by the pipe manufacturer.

**501.19.5. Tests and Requirements.** Tests for compliance with this specification shall be made as specified herein and according to the applicable ASTM or AWWA Standard(s). All polyethylene pipe shall be tested for brittleness, joint separation, quality and ring stiffness as specified in the applicable ASTM or AWWA Standard(s). A certification of compliance with this specification shall be furnished by the manufacturer for all material furnished under this specification. In addition, the CITY may, at its own expense, witness inspection and test of the materials.

**501.19.5.1. Tensile Properties.** The tensile strength, yield strength, elongation and elastic modulus of the material shall be determined in accordance with Tensile Properties for Plastics, ASTM D638 (D 638M).

**501.19.5.2. Hydrostatic Properties.** The long term hydrostatic strength rating shall be listed in the name of the pipe and fittings manufacturer in PPI (Plastic Pipe Institute) TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Pipe and Fittings compounds, with a standard grade HDB rating of 1600-psi (112-kg/cm<sup>2</sup>) at 73°F (23°C).

**501.19.5.3. Melt Index.** The melt index of the polyethylene plastic, as determined in accordance with ASTM D1238 Flow Rates of Thermoplastics by Extrusion Plastometer, shall meet the requirements as specified in ASTM D3350 Cell Classification of 4.

**501.19.5.4. Density.** The density of the polyethylene plastic, as determined in accordance with ASTM D1505 Density of Plastics by the Density - Gradient Technique shall have specific base resin densities meeting the requirements as specified in ASTM D3350 Cell Classification 3.

**501.19.5.5. Environmental Stress Cracking Resistance.** The environmental stress cracking resistance (ESCR) of the material shall meet the requirements as specified in ASTM D3350 Cell Classification of 6 using ASTM F1473 (PENT) or meet a Cell Classification of 4 according to ASTM D1693.

**501.19.5.6. Wastewater Pipe Stiffness.** Minimum pipe stiffness at five-percent deflection shall be 46-psi (3.2-kg/cm<sup>2</sup>) for all sizes of gravity and pressure wastewater conduits as specified in Section XI "Deflection Control In Unpressurized Polyethylene Piping Systems," Table X1.1 "Pipe Stiffness Ranges for Specified Materials" and DR's of ASTM F714.

## **501.20. POLYETHYLENE (PE) LARGE DIAMETER WASTEWATER PIPE WITH MODIFIED WALL PROFILES AND PERFORMANCE STANDARDS**

**501.20.1. General.** High Density Polyethylene gravity wastewater pipe and fittings in nominal sizes 18-in. through 120-in. (46cm – 305cm) with integral bell joints shall conform to current ASTM F894 Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

**501.20.2. Materials.** The pipe and fittings shall be made of high density, high molecular weight polyethylene pipe material meeting the requirements of Type III, Class C, Category 5, Grade P34, as defined in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials with a minimum cell classification of 345444C.

**501.20.3. Stiffness.** Minimum pipe stiffness at five-percent deflection shall be 10-psi (0.7-kg/cm<sup>2</sup>) for wastewater as specified for all sizes when calculated according to Appendix XI, "Relation of RSC To Pipe Properties and Pipe Stiffness" of ASTM F894.

**501.20.4. Joints.** Joint tightness shall be tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

**501.20.5. Testing.** Pipe shall be tested for flattening, quality and ring stiffness as specified in the applicable ASTM Designations.

## **501.21. POLYETHYLENE (PE) CORRUGATED DRAINAGE TUBING AND CORRUGATED SMOOTH LINED STORM WATER PIPE AND FITTINGS**

**501.21.1. General.** High Density Corrugated and Corrugated Smooth Lined Polyethylene storm water tube/pipe and fittings shall conform to current AASHTO Designations as follows: AASHTO M-252, Corrugated Polyethylene Drainage Tubing (3"-10" (75 mm – 250 mm)) or AASHTO M-294, Corrugated Polyethylene Pipe (12"- 48" (300 mm-1200 mm)). Profile wall HDPE pipe shall conform to ASTM F894 Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe.

**501.21.2. Materials.** The tube/pipe and fittings shall be made of virgin polyethylene which conforms with the requirements of cell class 335400C as defined and described in ASTM D3350 Polyethylene Plastics Pipe and Fittings Materials.

**501.21.3. Stiffness.** Minimum tube/pipe stiffness at 5-percent deflection shall be 50-psi (3.5-kg/cm<sup>2</sup>) for 3-in. through 10-in. (76mm – 254mm) diameters and as outlined in Section 7.4 of AASHTO M-294 for other diameters. Profile wall HDPE pipe shall have minimum RSC Class equal to 40.

**501.21.4. Joints.** Joint integrity shall be tested in accordance with ASTM F667 Large Diameter Corrugated Polyethylene Pipe and Fittings, Section 9.6 for PE corrugated pipe up to 24" or AASHTO M-294 and M-252 for smooth-lined corrugated pipe. Profile wall HDPE pipe joints shall be made and tested in accordance with ASTM D3212 Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.

**501.21.5. Testing.** All polyethylene tubing/piping shall be tested for elongation, brittleness, joint separation, quality and ring stiffness as specified in the applicable AASHTO M-294, AASHTO M-252 or ASTM F894, as applicable.

## **501.22. FIBERGLASS (GLASS-FIBER-REINFORCED THERMOSETTING-RESIN) WASTEWATER PIPE**

**501.22.1. General.** This specification designates requirements for fiberglass glass-fiber reinforced thermosetting-resin pipe (RTRP) sizes from 8-in. to 144-in. (20cm – 366cm) for the conveyance of wastewater. Pipe for gravity application shall conform to ASTM D3262 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe. Pipe for force main applications shall conform to or ASTM D3754 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer and Industrial Pressure Pipe. If ASTM D3754 pipe is selected, its actual outside diameter shall be in accordance with AWWA C950 Fiberglass Pressure Pipe.

**501.22.2. Stiffness.** Minimum pipe stiffness at 5-percent deflection shall be 46-psi (3.2-kg/cm<sup>2</sup>) for gravity and pressure wastewater conduit and 36-psi (2.5-kg/cm<sup>2</sup>) for gravity sliplining applications as specified for all sizes when calculated in accordance with ASTM D2412 Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.

**501.22.3. Joints.** Joint tightness shall be tested in accordance with ASTM D4161 for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals.

**501.22.4. Fittings.** Fittings shall conform to ASTM D5685 Fiberglass (Glass-Fiber-Reinforced Thermosetting-Resin) Pressure Pipe Fittings or D3840 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Fittings for Nonpressure Applications.

**501.22.5. Testing.** Pipe shall be tested for inside and outside diameter, wall thickness, squareness of pipe ends, chemical requirements, stiffness, beam strength as specified in the respective ASTM D3681 Test Method for Chemical Resistance of "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe in a Deflected Condition, ASTM D2412 Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading, and ASTM D3262 Standard Specification for "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe.

## ITEM 502. APPURTENANCES

### 502.1. MANHOLES

**502.1.1. Manhole Materials.** Manholes shall be fabricated in different configurations to meet the specific needs required in the water or wastewater or storm water system.

**502.1.1.1. Precast Reinforced Concrete Manhole Sections.** These specifications cover precast reinforced concrete manhole sections, which shall conform to ASTM C478 (C478M) Precast Reinforced Concrete Manhole Sections, with the following additions:

- (1) All pipe shall be machine made by a process that shall provide for uniform placement of zero slump concrete in the form and compaction by mechanical devices which shall assure a dense concrete in the finished product, except that reducer cones may be wet-cast.
- (2) Aggregates for the concrete shall comply with requirements of ASTM C33 Concrete Aggregates, with the additional requirement that the aggregate shall have a minimum of 50-percent of calcium carbonate equivalent.
- (3) Minimum wall thickness for the manhole risers shall be as listed under Wall "B" in the "Class Tables" of ASTM C76 (C76M) Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
- (4) Unless otherwise noted, manhole steps shall not be furnished. If required, the steps shall be of the noncorrosive plastic or rubber coated steel type, with a clear cleat space of 10 in. (25.4 cm) minimum that shall support a concentrated load of 300 pounds (136.2 kg), and be in accordance with applicable OSHA specifications.
- (5) Resilient connectors between reinforced concrete manhole structures and pipes shall meet the requirements of ASTM C923 Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes and Laterals or ASTM C443 Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets. The resilient connector shall provide an airtight seal that eliminates infiltration and exfiltration.

**502.1.1.1.1. Joints.** Joints shall conform to the joint specification ASTM C478 Precast Reinforced Concrete Manhole Sections (C478M). All joints shall have rubber gaskets. Rubber gaskets shall meet the requirements of Item 501.5.4.1. Rubber Gaskets.

**502.1.1.1.2. Coatings and Linings.** At the discretion of the CITY coatings and linings called for in specifications or as shown on the plans shall meet the requirements as specified and shall be installed or applied by a certified applicator with minimum three years experience. All warranties shall be provided by the product manufacturer.

Manholes shall be tested in accordance to CITY standards prior to surface preparation to produce the required level of cleanliness, which must be achieved either by high pressure water blasting rated at minimum of 5,000 psi at 4 gpm or dry abrasive using slag grit. All specified surface preparation shall be performed in accordance with the latest version of the SSPC, NACE and ICRI. Concrete surfaces shall be abraded to produce a minimum surface profile. All interior surfaces must be thoroughly cleaned before application of coating. It is the responsibility of the contractor and job inspector to inspect and report unacceptable concrete substrate surface conditions to the CITY prior to the commencement of surface preparation activities. Unacceptable surface conditions are defined as the presence of cracked surfaces or concrete deteriorated to a depth of greater than 1-inch or otherwise unable to withstand surface preparation as specified herein.

All surfaces that show exposed structural steel, spalling greater than 3/4-inches deep or cracks greater than 3/8-inches wide, shall be patched using a quick setting, high strength cement mortar.

The epoxy coating shall be sprayed on uniformly in two separate layers of achieve a total minimum thickness of 125 mils. Two distinct separate colors shall be used to differentiate the first and second coat and allowing, in accordance with manufacturers specifications, curing time between coating application.

**502.1.1.1.3. Rejection.** Manhole sections shall be subject to rejection on account of failure to conform to any of the requirements specified herein or having defects as follows:

- (1) Variations in any dimensions exceeding the permissible variation prescribed.
- (2) A piece broken out of the bell, spigot, tongue or groove in such size that the watertightness of the joint should be impaired.
- (3) Any shattering or flaking of concrete or other conditions indicating an improper concrete mix.
- (4) Lack of uniformity in placement steel which might preclude all joints being typical of those tested.
- (5) Cracks sufficient to impair the strength, durability, or serviceability of the pipe.
- (6) Joint sections with spalls, cracks, fractures, or other imperfections that could adversely affect the performance of the joint.

**502.1.1.2. Fiberglass Manholes.** Allowable when proposed by design engineer and accepted by the City of Temple.

**502.1.2. Grade Adjustment Risers.** Casting may be raised or final grade adjustment of access covers and frame assemblies made using Grade Adjustment Risers. Grade Adjustment Risers shall be concrete with wire reinforcement.

Installed grade adjustment risers and riser assemblies shall fit within the existing casting without interference, cause no binding to the manhole lid and shall be immobile and watertight. Manhole lids shall have bearing on all of the surface of inner ring(s).

**502.1.2.1. Precast Concrete Grade Adjustment Riser.** Precast Concrete adjustment risers shall be precast, reinforced concrete meeting requirements of ASTM C478 Precast Reinforced Concrete Manhole Sections.

**502.1.2.2. Cover Adjustment Riser.** Cover riser rings shall only be used for resurfacing, rehabilitation or reconstruction activities on existing facilities.

**502.1.2.2.1. Steel.** Inner cover riser ring shall be of domestic steel meeting the requirements of ASTM A36 carbon structural steel. It shall be  $\frac{3}{4}$ " X riser height. Intermediate and outer rings shall be one of the combinations indicated in Table 502.1.2.3.1.(a) Cover Adjustment Risers, as specified by the CITY.

**Table 502.1.2.2.1.(a) Cover Adjustment Risers**

Intermediate ring	Outer ring	Type
none	ASTM A36 steel $\frac{1}{2}$ " thick	solid
ASTM A36 12-gauge steel	$\frac{1}{2}$ " x $\frac{1}{2}$ " surrounding intermediate ring at finished elevation	solid
None	ASTM A36 steel $\frac{1}{2}$ " thick	Adjustable <sup>1</sup>
ASTM A36 12-gauge steel	$\frac{1}{2}$ " x $\frac{1}{2}$ " surrounding intermediate ring at finished elevation	Adjustable <sup>1</sup>

1. Adjustment devices for adjustable steel risers shall be fabricated from stainless steel, have a positive lock, and be in line with the lower bearing bar. It shall be capable of adjustment  $\frac{3}{8}$ " from nominal.

Rings shall be fabricated to  $\pm \frac{1}{16}$ " concentricity. The outer riser ring shall have an inside diameter no greater than  $\frac{3}{16}$ " larger than the outside diameter of the manhole lid. All materials shall be bituminous asphalt coated.

Certified welders shall securely weld rings in accordance with American Welding Society D1.5 Bridge Code to prevent differential movement between rings under traffic loads.

**502.1.2.2.2. Iron.** Gray iron adjustment cover risers shall be manufactured from iron conforming to ASTM A48 Gray Iron Castings, Class 35B, in accordance with AASHTO M306. Ductile iron adjustment risers shall be manufactured from iron conforming to ASTM A536 Ductile Iron Castings, Grade 70-50-05.

**502.1.3. Manhole Frame and Cover.** Manhole Frame (Ring) and cover shall meet the requirements as shown on detail drawings.

**502.1.4. Manhole Construction.** TCEQ/EPA regulations shall take precedence in the case of conflict between these specifications and TCEQ regulations. Construction shall be in accordance with City of Temple standard details.

The CONTRACTOR shall furnish all appropriate equipment and access required for inspection.

## **502.2. WASTEWATER MAIN CLEANOUTS**

Cleanouts shall be constructed in accordance with the City of Temple specifications.

**502.2.1. Typical Cleanout.** Typical cleanout requirements are in the City of Temple standard details.

### 502.3. FIRE HYDRANTS

**502.3.1. Materials.** Fire hydrants which are to be installed as shown on the plans or to be furnished for general installation shall be dry-barrel traffic model that conform to AWWA C502 Standard for Dry-Barrel Fire Hydrants, except for changes and/or additions specified as follows or as shown on the plans or in the contract specifications. All hydrant components covered by NSF-61 must comply with NSF-61 requirements.

#### **502.3.1.1. Supplementary Details Specified.**

The type of shut-off shall be compression type with the flow.

The valve action shall provide positive shut-off at minimum closing torque. Wedge action closing gates shall not be permitted, and the scissors type main valves shall not be permitted.

Inlet connection shall be mechanical joint and shall be for a 6-in. pipe with minimum main valve opening of 5¼-in.

Delivery classification: number and size of pumper and hose nozzles shall be as shown on the plans and contract specifications.

Bury length: ground to bottom of connecting pipe shall be 4-feet (1.2m) or as specified by the CITY.

Diameter outlet connections: hose and pumper nozzle threads shall be of the size and type shown on the plans.

Gaskets shall be furnished on all nozzle caps and shall be long life, black rubber meeting ASTM D2000, Classification System for Rubber Products in Automotive Applications, or equal.

Unless otherwise specified in the special provisions or in the plans, the operating and nozzle cap nuts shall be tapered pentagon nuts with faces not less than 1-in. (2.5cm) high.

Drain valve and outlet: hydrants shall be equipped with a minimum of two drainholes and provided with an automatic and positively operating noncorrodible drain or drip valve so as to drain the hydrant completely when the main valve is shut.

Direction to open is to be specified in the plans and contract specifications. Number of turns to open shall be in accordance with AWWA Standard C502.

The outside of the hydrant above the finished ground line shall be factory painted with one coat of red primer. After shop priming, a finish coat of Flynt Aluminum paint shall be applied to the barrel only leaving the top bonnet primer colored.

**502.3.1.2. Breakable Type Hydrants.** Breakable or Sleeve Type Couplings. The barrel of the hydrant between the base and the nozzle section must be made in two parts connected by a swivel flange or breakable flange which shall permit facing of the nozzles in any desired direction in increments of 45° or less. The complete hydrant shall be of such design that when the hydrant barrel is broken through traffic collision or otherwise, it may be replaced without disturbing the base of the hydrant.

The materials used for gaskets between the upper and lower barrels and the base and nozzle section shall be compounded to conform to ASTM D2000 or an equal material that shall have CITY approval prior to substitution unless otherwise specified in the plans.

Provision shall be made in the design of the stem to disconnect the stem from the hydrant parts above the standpipe break point in the event of traffic accidents. Design of the coupling shall be such that when the coupling is broken, no parts shall come loose and fall into the hydrant barrel, and the break shall not occur through the pins or bolts holding the coupling to the stem.

### 502.4. FITTINGS

#### **502.4.1. Brass Stops, Cocks, and Fittings for Waterworks Service.**

**502.4.1.1. General.** Stops, cocks and other fittings furnished under these specifications shall be in accordance with AWWA C800 (ASTM B-62 and ASTM B-584 and UNS C83600-85-5-5) "Standards for Underground Service Line Valves and Fittings" of the sizes and type specified. Cast solder fittings shall conform to alloy 83-4-6-7, ASTM B-584 "Practice for Copper Alloy Sand Castings". All stops, cocks and fittings shall be full port throughout the sizes specified.

**502.4.1.2. Physicals.** Any pipe, fitting, solder or flux used in the installation or repair of any public water system shall be lead-free. For purposes of this section, "lead-free" means solders and flux containing not more than 0.2-percent lead; and pipes and pipe fittings containing not more than 8.0-percent lead.

Brass used shall have a tensile strength (as determined from test bars) of not less than 30,000-psi (206,820-kPa) when tested as prescribed by ASTM B208 Practice for Preparing Tension Test Specimens for Copper-Base Alloys for Sand, Permanent Mold, Centrifugal, and Continuous Castings (Fig. 5).

Stops, cocks and fittings shall be tested and designed for working pressures as per the requirements of AWWA C800

Stops and cocks containing brass parts shall be shipped prelubricated with a light fluid lubricant between key and body. Lubricant shall remain fluid indefinitely, either in storage or in service.

**502.4.1.3. Design Features of Stops and Cocks.** Seating surfaces of the ground key type shall be tapered and shall be accurately fitted together by turning the key and reaming the body. Seating surfaces shall be lapped together using suitable abrasives to insure accurate fit. The large end to the tapered surface of the key shall be reduced in diameter for a distance that shall bring the largest end of the seating surface of the key into the largest diameter of the seating surface of the body, and the taper seat in the body shall be relieved on the small end, so that the small end of the key may extend through to prevent wearing of a shoulder and to facilitate proper seating of the key. The stem end of the key, key nut and washer shall be so designed that if the key nut is tightened to failure point, the stem of the key shall not fracture. The nut and the stem shall withstand a torque on the nut of at least three-times the necessary effort to properly seat the key without failure in any manner.

The ball stop shall have a full-size round-way opening with straight-through flow, teflon coated bronze ball with a minimum of 0.5-mil (0.0005-in.) (0.01 mm) thickness coating. The stop must be so constructed that it may be disassembled and the ball removed without special tools.

Plug type stop shall have full size round way opening with straight-through flow. Seating surfaces shall be brass (or teflon coated brass) to rubber O-rings, providing positive pressure seal without mechanical means. The stop must be so constructed that the plug may be removed without special tools. Rubber O-rings should conform to requirements of ASTM D2000 Classification System for Rubber Products in Automotive Applications and test method shall conform to ASTM D1414 for Test Methods for Rubber O-Rings.

Inlet and outlet threads, of the types specified, shall conform to the applicable tables of AWWA Standard C300 Reinforced Concrete Pressure Pipe, Steel-Cylinder Type, and inlet threads shall be protected in shipment by a plastic coating or other equally satisfactory means. If used, coupling nuts shall have a bearing skirt machined to fit the outside diameter of the pipe for a length at least equal to the outside of the pipe.

Corporation stops shall be so designed as to rotate about the axis of the flow passageway within a circle of rotation small enough to properly clear the inside of any standard tapping machine of appropriate size. The inlet threads shall be male AWWA tapered threads and the outlet shall be female pipe threads, male iron pipe threads or copper tube size (CTS) compression nut with a stainless steel set screw.

Brass Meter Stops 1-in. in size shall have a 1-in. swivel meter nut connection on the outlet end with an AWWA meter thread reducing bushing reduced to ¾-in. meter thread unless otherwise noted on the plans or specified by the CITY. The inlet side shall be 1-in Copper Tube Size (CTS) compression with stainless steel set screw. The outlet side of 1 ½ -in. and 2-in. brass meter stops shall be female iron pipe or AWWA meter flange. The inlet side of 1 ½ -in. and 2-in. brass meter stops shall be female iron pipe threads, male iron pipe threads or CTS compression nut with stainless steel set screw. All brass meter stops shall be full port ball style meter stops and shall be straight pattern (no angle stops will be accepted).

Brass Curb Stops 1-in., 1 ½ -in. and 2-in. shall be full port ball style with female iron pipe threads on the outlet and CTS compression nut with stainless steel set screw on the inlet or any combination thereof.

**502.4.1.4. Design Features of Fittings.** All castings shall be smooth, free from burrs, scales, sand holes and defects of every nature which would make them unfit for the use for which they are intended. Nuts shall be smooth cast and shall have symmetrical hexagonal wrench flats.

Solder-joint fittings shall be smooth cast. Inside surfaces of solder-joint ends shall be machined smooth to proper inside diameter.

All thread fittings, of all types, shall be protected in shipment by a plastic coating or other equally satisfactory means.

Compression fittings shall have a Buna-N or equivalent beveled gasket and an anti-friction ring. Compression nut shall have:

- (1) for PE tubing or copper tubing, a stainless steel set screw to bite into and lock on the tubing.
- (2) for iron pipe, a stainless steel set screw to bite in and lock on the pipe.



**502.4.1.5. Tests.** All brass stops, cocks and fittings included in this section shall be tested in accordance with the applicable provisions of the specifications relating thereto.

**502.4.1.6. Rejection.** Brass stops, cocks, and fittings may be rejected for failure to meet any of the requirements of this specification.

**502.4.2. All Other Fittings.** All other fittings shall conform to respective provisions of Item 501. Underground Conduit Materials, listed according to conduit type. In water pipe, Ductile Iron or Ductile Iron Compact fittings shall consist of standard crosses, tees, bends, reducers, sleeves, plugs, blind flanges, etc. Fittings for reinforced concrete pressure pipe, steel cylinder type, shall consist of special crosses, tees, bends, reducers, dished plugs, closure sections, flanged outlets, blind flanges, bored flanges, etc.

## **502.5. VALVES**

### **502.5.1. Metal Seated Gate Valves for Ordinary Waterworks Service**

**502.5.1.1. General Description.** All gate valves 3-in. (7.6cm) through 48-in. (122cm) shall conform to AWWA Standards C500 Metal-Seated Gate Valves for Water Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard 61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 48-in. (122cm) shall be a special consideration. The CITY shall hydrostatically test all gate valves larger than 48-in. (122cm) for a reasonable period after receipt of a specified test pressure.

All gate valves shall be iron body, bronze mounted, double disc, parallel seat, nonrising stem, internal wedging type. Valves must embody the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and tracks for gates.

**502.5.1.2. Bonnet Bolting.** Body bolts, studs and nuts shall be 304 stainless steel. Drilled and tapped bodies for use with headless bolts will not be acceptable.

**502.5.1.3. Ends.** Valves shall have flanged or mechanical -joint ends, or any combination of these as may be specified.

Mechanical -joint ends shall conform to AWWA C111 (ANSI A21.11) American National Standard for Rubber-Gasket Joints for Ductile-Iron and Gray-Iron Pressure Pipe and Fittings. Flanged ends shall conform to AWWA C111 (ANSI A21.11). Flanged ends shall conform to AWWA C110 (ANSI A21.10) American National Standard for Gray-Iron and Ductile-Iron Fittings, 3 In. through 48 In. for Water and Other Liquids, Class 125-lb. (862-kPa). Bolts and nuts for mechanical joints shall be of a high-strength, low-alloy corrosion-resistant steel conforming to ASTM A325 (A325M) High-Strength Bolts for Structural Steel Joints (Type 3). All mechanical -joint glands shall be ductile iron.

**502.5.1.4. Gates and Rings.** Gates and rings shall conform to AWWA Standards C500 except as follows: All gates above 4-in. (10cm) shall be cast iron with bronze-gate rings, and 4-in. (10cm) gates may be solid bronze. Gates 3-in. (7.6cm) and smaller shall be solid bronze.

**502.5.1.5. Wedging Device.** Wedging devices shall conform to the requirements of AWWA C500, except as follows: Gate valves 4-in. (10cm) and smaller shall have solid bronze wedges. Wedges for valves above 4-in. (10cm) may be solid bronze or cast-iron with an integral bronze nut. Wedging surfaces may be bronze, monel, or stainless steel cast integral with the wedge. Stem nuts or wedging surfaces that are attached with fasteners are not acceptable. Wedging surfaces on valves up to 16-in. (41cm) shall be bronze-, monel-, or stainless-steel-to-iron. Wedging surfaces on valves 16-in. (41cm) and larger shall be bronze-to-bronze, monel-to-monel, or stainless-to-stainless. Other moving surfaces integral to the wedging action shall be bronze to iron.

**502.5.1.6. Rollers and Tracks and Scrapers for Horizontal Valves.** Rollers and tracks and scrapers for horizontal valves shall conform to AWWA Standards C500, with the following exception: Babbit tracks shall not be acceptable.

**502.5.1.7. Valve Stems and Nuts.** Stem and nuts shall be in accordance with AWWA Standards C500, except as follows: Stem shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as

specified. Upset stems on valves larger than 16-in. (41cm) shall not be permitted under these specifications. Upset stems shall conform to the requirements of AWWA C500.

**502.5.1.8. Stuffing Boxes.** Stuffing boxes shall conform to the requirements of AWWA Standards C500 with the following exceptions: All valves 2-in. (5cm) through 16-in. (41cm) shall be equipped with double O-rings, provided arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double O-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards. Stuffing box bolts and nuts shall be 304 stainless steel.

**502.5.1.9. Follower Glands and Gland Bolts and Nuts.** Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C500 with the following exceptions: Gland flanges or followers that are a separate part may be cast iron or bronze. Glands for valves over 12-in. (31cm) in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

**502.5.1.10. Hand Wheels and Operating Nuts.** All valves 2-in. (5cm) in diameter and above shall be nut operated unless otherwise ordered. All operating nuts shall be ductile iron or cast iron. Handwheels shall be furnished only when called for on plans or in the contract specifications. All valves shall open by turning counterclockwise.

**502.5.1.11. Gearing.** Gearing shall be in accordance with AWWA C500. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. (46cm) in diameter and larger.

**502.5.1.12. Gear Cases.** Gear cases shall be furnished on all geared valves. All geared valves shall be equipped with extended type gear cases, with cast iron side plates. Stuffing boxes shall be located on top of the bonnet and shall be outside the gear case. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be cast iron.

**502.5.1.13. By-Pass Valves.** By-pass valves shall conform to the requirements of AWWA C500 with the following exceptions: By-pass valves are required on all 18-in. (46cm) valves and larger AWWA C500 valves. Properties, construction and design requirements herein specified are applicable to by-pass valves, except stems on by-pass valves over 4-in. (10cm) shall have the same physical qualities as for 30-in. (76cm) and larger.

**502.5.1.14. Cast Iron.** All gray cast iron shall conform to the requirements of ASTM A126 Gray Iron Castings for Valves, Flanges, and Pipe Fittings, Class B or ductile iron shall conform to ASTM A536 Ductile Iron Castings.

**502.5.1.15. Horizontal Valves.** All valves over 16-in. (41cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

**502.5.1.16. Valves for Installation in Vertical Pipeline.** Valves 14-in. (36cm) and larger AWWA C500 valves ordered for installation in vertical pipeline shall be equipped with disc face tracks and wedge springs to prevent pre-wedging. Valves 4 in. (10.2 cm) through 12 in. (30.5 cm) shall be double disc, square-bottom valves.

**502.5.1.17. Tapping Valves.** Tapping valves shall conform to the requirements of AWWA C500, and the other requirements of this section with the following exceptions: Tapping valves shall have oversize seat rings to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gates. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange recess to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

**502.5.1.18. Tests and Inspection.** All valves shall be tested by the manufacturer in accordance with AWWA C500. Any leaking at the test pressure through any casting or between the bronze ring and the cast iron body shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

## **502.5.2. Resilient-Seated Gate Valves for Ordinary Waterworks Service.**

**502.5.2.1. General Description.** All gate valves 2-in. (5.08cm) through 36-in. (91cm) shall conform to AWWA Standards C515 for Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service, or C509 for Resilient-Seated Gate Valves for Water-Supply Service, except for changes or specified alternatives as detailed in this specification or as shown on the plans and contract documents. Materials must comply with NSF Standard

61 – Drinking Water System Components – Health Effects. Tests and design data may be as designated on the plans and contract specifications.

Gate valves larger than 36-in. (91cm) shall be a special consideration. The CITY shall hydrostatically test all gate valves larger than 36-in. (91cm) for a reasonable period after receipt.

All gate valves shall be iron body, resilient seated, nonrising bronze stem and bronze stem nut. Valves must have the resilient seat bonded and vulcanized to the wedge and employ the best workmanship and finish. Valve design shall provide minimum torque designs effectively reducing friction and drag through thrust collar design and guide tracks for the gate.

**502.5.2.2. Bonnet Bolting.** Bonnet Bolting shall conform to Item 502.6.1.2. Bonnet Bolting.

**502.5.2.3. Ends.** Ends shall conform to Item 502.6.1.3. Ends.

**502.5.2.4. Gate.** Gate shall be encapsulated with an elastomer that meets all requirements of AWWA C515 or C509. The bonding of the rubber to the gate shall meet the requirements of ASTM D429, Test Method A or Method B. Gates 3-in. (7.6cm) and smaller shall be rubber encapsulated bronze.

**502.5.2.5. Valve Stems and Nuts.** Stem and nuts shall be in accordance with AWWA Standards C515 or C509 except as follows: Stem nuts shall be of a nongalling, high-grade brass or bronze and shall have threads of sufficient length to develop the full strength of the stem. Stems as received shall meet the minimum strengths as specified. Upset stems on valves larger than 16-in. (41 cm) shall not be permitted under these specifications.

**502.5.2.6. Stuffing Boxes.** Stuffing boxes shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Arrangement is made for replacement under pressure of the upper O-ring when the valve is fully open. All geared valves shall be equipped with double o-rings in the main stuffing box. All horizontal valves shall have attached stuffing boxes as per the above AWWA Standards.

**502.5.2.7. Follower Glands and Gland Bolts and Nuts.** Glands, gland bolts and nuts shall conform to the requirements of AWWA Standards C515 or C509 with the following exceptions: Gland flanges or followers, if used, that are a separate part may be cast iron or bronze. Glands for valves over 12-in. (30cm) in diameter shall be solid bronze or cast-iron bronze bushed. Gland bolts and nuts shall be either bronze or Type 302 stainless steel. For either choice both bolts and nuts shall be of the same material.

**502.5.2.8. Hand Wheels and Operating Nuts.** Hand wheels and operating nuts shall conform to Item 502.6.1.10.

**502.5.2.9. Gearing.** Gearing shall be in accordance with AWWA Standards C515 or C509. Spur or bevel gearing as called for on the plans or as applicable shall be provided on all valves 18-in. (46cm) in diameter and larger.

**502.5.2.10. Gear Cases.** Gear cases shall be furnished on all geared valves. Gear cases shall be lubricated and enclosed with oil seal or O-ring at all shaft openings to prevent the entrance of water which may be in the manhole. Valves equipped with ball or roller type thrust bearings inside the grease case shall have all shaft openings sealed with double O-rings. Gear cases shall be gray iron or ductile iron.

**502.5.2.11. By-Pass Valves.** By-pass valves are not required on resilient seated gate valves.

**502.5.2.12. Cast Iron.** Cast iron shall conform to Item 502.6.1.14.

**502.5.2.13. Horizontal Valves.** Valves for horizontal installation shall be equipped with wedge guide caps or inserts to guide and support the wedge during travel. All valves over 16-in. (41cm) in diameter shall be designated for horizontal installation in a horizontal pipeline unless shown otherwise on the plans. All other valves shall be vertical.

**502.5.2.14. Valves for Installation in Vertical Pipeline.** All resilient seated gate valves shall be suitable for horizontal mounting in a vertical pipeline without special modifications.

**502.5.2.15. Tapping Valves.** Tapping valves shall conform to the requirements of AWWA Standards C515 or C509 and the other requirements of this section with the following exceptions: Tapping valves shall have a port opening to permit entry of standard tapping machine cutters. In the open position, valve gates shall be clear of the ports so that the cutter shall pass through without making contact with the gate. Valves shall have an inlet flange conforming to AWWA C110 (ANSI A21.10) Class 125, with a machined projection to mate with tapping sleeve outlet flange to assure correct alignment. This alignment ring shall comply with MSS Standard SP-60 Connecting Flange Joint Between Tapping Sleeves and Tapping Valves. Valves shall have standard mechanical joint outlet and shall fit any standard tapping machine.

**502.5.2.16. Tests and Inspection.** All valves shall be tested by the manufacturer in accordance with AWWA Standards C515 or C509. Any leaking at the test pressure through any casting shall cause the said casting to be rejected. No plugging or patching to stop any leakage shall be allowed.

When requested at any time, notarized certificates of material and test compliance for these valves shall be provided. Such reports furnished shall be identified by purchase order or contract. The material shall also be identified as to location within the valve and specification or composition.

**502.5.3. Air Valves.**

**502.5.3.1. General.** Unless otherwise indicated in the plans or contract specifications, air valves shall meet the requirements of AWWA C512 Air Release, Air/Vacuum and Combination Air Valves for Water Works Service with exceptions specified herein. Only wastewater air valves shall be used for wastewater applications.

**502.5.3.2. Description.** Air valves shall be of two types as follows:

- (1) An air valve called for on the plans shall mean an air and vacuum valve of the ball type designed to permit the escape of air from a pipeline when the line is being filled and to permit air to enter the pipeline when the line is being emptied.
- (2) A combination air valve called for on the plans shall mean a combination air and vacuum and air release valve designed to fulfill the functions of air and vacuum valve and also designed to permit the escape of air accumulated in the line at the high point when the line is under pressure while in operation. Air valves 3-in. (7.6cm) and smaller shall be self-contained in one unit. Air valves larger than 3-in. (7.6cm) may be a combination of two valves.

**502.5.3.3. Material.** The valves shall be stainless steel or iron body, stainless steel, brass or bronze fulcrum levers and links, stainless steel ball floats and pins, steel flange bolts and nuts, Buna-N synthetic rubber seats or equal against bronze or stainless steel, and brass for other parts.

**502.5.3.4. Inlets and Outlets.** Inlets shall be threaded for 2-in. (5cm) and smaller and flanged for 3-in. (7.6cm) and larger. Outlets shall be threaded through 4-in. (10cm).

**502.5.3.5. Operating Pressure and Testing.** The valves shall be designed to operate under an operating pressure of 200-psi (1380-kPa) and shall be tested to 1½ times that pressure.

**502.5.4. Brass Wheel Valves.**

**502.5.4.1. General.** Valves furnished under this specification shall be wedge disc, non-rising stem gate valves with screwed ends. They shall be equipped with bronze hand wheels and nuts and shall have bronze packing gland followers. They shall be of all brass and/or bronze construction.

**502.5.4.2. Pressure Rating.** Valves shall be rated for 125-psi (862-kPa) saturated steam working pressure and 200-psi (1,380-kPa) for liquids and gases up to 150°F (65.6°C).

**502.5.4.3. Tests.** Each valve furnished under these specifications shall be tested at a hydrostatic pressure of 250-psi (1,724-kPa) with the valve open. Under this test the valve shall not show any indication of leakage at the packing or anywhere on the body. Each valve shall also be tested at hydrostatic pressure of 250-psi (1,724-kPa) applied to one end only with the valve closed. There shall be no indication of leakage by the gate or through the packing under this test.

**502.5.4.4. Direction to Open.** Valve shall open by turning the handwheel counterclockwise.

**502.5.4.5. Material Specifications.** The materials used in the manufacture of these valves shall equal or exceed the specifications shown in Table 502.6.4.5.(a) Brass Wheel Valve Materials.

**Table 502.5.4.5.(a) Brass Wheel Valve Materials**

Part	Material	Designation/Specification
Packing	Teflon impregnated asbestos or approved equal	
Body	Bronze	ASTM B62 Standard Specification for Composition Bronze or Ounce Metal Castings
Bonnet	Bronze	ASTM B62
Gates	Bronze	ASTM B62
Handwheel	Bronze	ASTM B62
Handwheel Nut	Bronze	ASTM B62
Gland & Packing Nut	Brass	ASTM B16/B16M Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines
Stem	Bronze	ASTM B62, 50,000-psi (344,700-kPa) minimum tensile strength

**502.5.4.6. Stem.** Stem shall be completely free of visible flaw, and matching shall be smooth and free of defect. A back seating surface shall be provided on the wedge or on the lifting nut to seat tightly against the bonnet when the valve is open to seal the packing gland against line pressure so that the valve may be repacked against line pressure.

**502.5.4.7. Screwed Ends.** Valve ends shall be threaded internally with American National Taper pipe threads. Thread shall be clean, smooth, true to form and concentric with the axis of the valve. Variations in alignment of thread shall not exceed  $\frac{1}{16}$ -in. -per-foot (0.5-cm-per-m). Thread shall be chamfered approximately to the major diameter of the thread at the face of the valve at an angle approximately  $45^\circ$  with the axis of the thread for the purpose of easy entrance in making a joint and for protection of the thread.

**502.5.4.8. Valve Body.** The body of the valve shall offer sufficient support to the gate while it is moving to keep the gate wedge in place and to accurately align the gate on the body seat. The waterway opening shall be equal to or greater than the nominal pipe size.

**502.5.4.9. Gate.** The gate shall be of wedge design and may be furnished either solid or two-piece. Two-piece or "split" disc gates shall be equipped with lifting nut. Gate faces shall be accurately machined and fitted into the valve body in such a manner that the center of the gate circle is very slightly above the center of the seat circle when the valve is tightly closed.

**502.5.4.10. Workmanship.** All valve parts shall be true to form, free from injurious defects and shall be seated and finished in a workmanlike manner. Casting shall be free from blow holes, porosity, hard spots, excessive shrinkage, cracks or other injurious defects. They shall be smooth and well cleaned both inside and outside, and all fins and similar roughness shall be removed. Castings shall not be repaired, plugged, brazed or burned in.

**502.5.4.11. Packaging.** Valve shall be closed for shipment and wrapped or packaged in accordance with best commercial practice as necessary for mechanical protection and ease in handling.

#### **502.5.5. Butterfly Valves.**

**502.5.5.1. General.** Butterfly valves and actuators shall conform to AWWA C504 Rubber-Seated Butterfly Valves and to these specifications:

- (1) Type of body shall be short body, flanged.
- (2) Body material shall be cast iron or ductile iron.
- (3) Class shall be as specified on the plans or contract specifications.
- (4) Shafts shall be Type 304 or 316 stainless steel.
- (5) Flange holes shall be drilled full size.
- (6) Valve seats shall be natural rubber or Buna-N and polished stainless steel, Type 304 or 316,  $90^\circ$  seating angle only, with a  $360^\circ$  uninterrupted seating surface.
- (7) Shaft seals shall be standard split-V packing or double O-ring seal cartridges.
- (8) Discs shall be ductile iron, cast iron, or fabricated steel.
- (9) Operating nuts shall be ductile iron.

**502.5.5.2. Submittals.** The following shall be furnished to the CITY/ENGINEER. Incomplete data shall be cause for rejection of bid.

- (1) Weights and drawings in accordance with AWWA C504.
- (2) Guaranteed delivery time after receipt of purchase order.
- (3) Number of turns of handwheel required to close valve.
- (4) The required actuator torque ( $T_o$ ) in foot-pounds for each butterfly valve based on the specified operating conditions of pressure and flows.
- (5) Seating-unseating torque ( $T_o$ ) in foot-pounds required for each butterfly valve.
- (6) Rated torque capability of each butterfly valve actuator.

The following data shall be furnished if not previously available to the CITY/ENGINEER:

- (7) Experience: evidence of at least five years satisfactory experience building butterfly valves to AWWA Standards.
- (8) Torque tests in accordance with rubber seated butterfly valves AWWA C504.
- (9) Proof of design tests in accordance with AWWA C504.

**502.5.5.3. Ends.** Valves shall have flanged ends. Flanged ends shall conform to AWWA C110 (ANSI A 21.10), Class 250-lb. (112.5-kg).

#### **502.5.5.4. Actuators.**

##### **502.5.5.4.1. Manual Actuators:**

**Location.** All actuators shall be located at the right end of a horizontal shaft with the input shaft vertical and upward looking in the direction of flow, unless otherwise noted.

**Closure.** The valve shall close by turning the input shaft clockwise. All handwheels shall turn clockwise to close the valve. All operators shall be equipped with a disc position indicator with each valve. The indicator shall be highly visible, clearly showing the legends "Open" and "Closed" at the ends of a  $90^\circ$  arc, with a pointer to show the disc position (Closed —  $0^\circ$  and Open —  $90^\circ$ ). The arc shall be graduated in degrees.

**Type.** All manual actuators shall be totally enclosed worm gear type and traveling-nut type. All manual worm gear type actuators shall be Limitorque, Type HBC or approved equal.

**Sizing.** Each valve actuator shall be sized for the maximum valve torque requirements based on the operating pressures and flow rates as specified.

**502.5.5.4.2. Electric Motor Actuator.** Each electric actuator shall conform to AWWA C504 and shall be of sufficient size to open and close the valve against maximum differential pressure and maximum required torque conditions when voltage at motor terminals is 90-percent of nominal voltage and shall have totally enclosed worm gear reducer with spur gear attached. Limit switches shall be of the four train gear with switches adjustable to operate at any point in the opening or closing cycle of the valve.

Limit switches and torque switches shall be located in a special compartment that is an integral part of the actuator and shall be readily accessible. Each limit switch shall have two normal closed contacts. Limit switch gearing shall be in step at all times whether in power or manual operation. Limit switch gearing shall be stainless steel or high-grade bronze. Two torque switches shall be furnished, one for opening direction and one for closing direction. The torque switches shall be connected in series so that they will operate regardless of the phasing of the power.

Torque and thrust loads in both closing and opening directions shall be limited by torque switches. Each torque switch shall be provided with a micrometer adjustment and reference setting indicator. The adjustment shall permit a variation of approximately 40-percent in torque setting. Switches shall have a rating of not less than 6-amperes at 120-volts-a.c. and 2.2-amperes at 115-d.c. The torque switches shall be in series with the opening and closing coils of the starter.

The torque switches shall be factory adjusted by the manufacture for this application.

A handwheel for manual operation shall be provided. Motor shall not rotate when handwheel is in use. A fused motor shall not interfere with manual operation. For valve control, furnish for each valve a reversing starter in watertight enclosure that is integral with the actuator housing. Furnish a push-button station NEMA-4 with red and green indicating lights separate from the valve actuator. Space heaters shall be provided to protect the motor, reversing starter and limit switch compartments from moisture condensation. Valve control wiring diagrams shall be furnished with submittal data.

Valve actuators shall conform to latest revision of AWWA C504 and shall be designed to hold the valve in any intermediate position between fully opened and fully closed without creeping and fluttering.

**502.5.5.4.3. Other Actuators.** Other types of actuators shall conform to AWWA C504.

**502.5.5.5. Shipment and Storage Requirements.** Electric motor actuated valves shall be shipped to bonded covered warehouse storage to be designated by the CITY. Valves shall be stored indoors and shall have space heaters energized. Full face flange protectors of waterproof plywood shall be at least one-inch (2.5cm) thick.

**502.5.5.6. Tests.** All butterfly valves shall be tested by the manufacturer in accordance with AWWA C504. Test results shall be furnished to the CITY.

**502.5.6. Line Valve Installation.** At locations shown on the plans, CONTRACTOR shall furnish and install valves of the type and size indicated. Valve vaults shall be furnished as provided in the special contract documents and constructed in accordance with Item 702.4.9.8. Vaults and applicable Division 4000 Standard Drawings.

**502.5.6.1. Gate Valves.** Valves shall be carefully handled and lowered into position in such a manner as to prevent damage to any part of the valve. The valve shall be placed in the proper position and held securely until all connections have been made. Where valves are to be placed in a concrete structure, the floor shall be completed before installing the valve. The valve shall be securely blocked so that its weight is carried by the floor rather than being supported by connected piping. See also Standard Drawing 4050.

**502.5.6.2. Air Release Valves.** The term "air release valve" as used in this section shall apply to the installation of both air release valve and combination air and vacuum release valves. Vaults shall be furnished as an integral part of either air release valve or combination air and vacuum release valve installation.

Air valves shall be installed in the manner shown in Standard Drawings 4090 – 4100B and on the appurtenance sheet unless otherwise indicated on the plans. The proper valve and fitting sizes shall be installed on mains in accordance with the schedule in Table 502.6.6.2.(a) Air Release Valve Sizing unless otherwise specified.

**Table 502.5.6.2.(a) Air Release Valve Sizing**

I.D. of Main		Size of Valve and Fitting	
Inches	Centimeter equivalent	Inches	Centimeter equivalent
16 and smaller	41 and smaller	1	2.5
18 through 36	46 through 91	2	5.1
42 and larger	107 and larger	3	7.6

Matching taps shall be provided for and made in accordance with Item 502.10. Connections to Conduit for Service. Fittings required for mounting air valves shall be as specified in Item 502.5. Fittings. All fittings shall be tight, leak free and plumbed true to the required position.

**502.5.7. Rejection.** Any valve may be rejected for failure to meet its respective requirements of this specification or referenced specifications.

#### **502.6. PREFORMED FLEXIBLE CONDUIT JOINT SEALANT**

**502.6.1. General.** This specification covers a cold-applied preformed flexible butyl rubber or plastic sealing compound for sealing interior and/or exterior space on concrete sewer pipe and manhole sections, where infiltration or exfiltration is a factor in the design.

**502.6.2. Applicable Standards.** Except as modified or supplemented herein, all preformed flexible joint sealants shall conform to the applicable requirements of the standard specifications listed in Table 502.7.2.(a) Conduit Joint Sealant Standards.

**Table 502.6.2.(a) Conduit Joint Sealant Standards**

Publisher	Standard
Federal Specification	SS - S - 210A(1) Sealing Compound, Preformed Plastic, For Expansion Joints
American Association for State Highway and Transportation Officials (AASHTO)	M198

**502.6.3. Basis of Acceptance.** The acceptability of the preformed flexible joint sealant shall be determined by the results of physical tests, by inspection and by approval of its experience record.

**502.6.4. Material.** The joint sealer shall be supplied in either extruded rope form of suitable cross-sectional area or flat tape form and shall be sized as recommended by the manufacturer and approved by the Engineer. The joint sealer shall be protected by a suitable removable wrapper. The joint sealer shall not in any way depend on oxidation, evaporation, or any other chemical action for either its adhesive properties or cohesive strength. The joint sealer shall remain totally flexible without shrinking, hardening, or oxidizing regardless of the length of time it is exposed to the elements.

The manufacturer shall furnish an affidavit attesting to the successful use of the product as a preformed flexible joint sealant on concrete pipe and manhole sections for a period of at least 5-years.

If requested by the CITY, the CONTRACTOR shall provide results of above specified tests to insure product compliance with these specifications or shall supply an affidavit of compliance from the manufacturer insuring compliance with these specifications.

**502.6.5. Installation of Joint Sealant.** All surfaces to be in contact with the joint sealant shall be thoroughly cleaned of dirt, sand, mud or other foreign matter. The protective paper wrapper shall remain on the joint sealant until immediately prior to placement of the pipe in the trench. After removal of the protective paper wrapper, the joint sealant shall be kept clean.

Backfilling of pipe laid with this joint sealer may proceed after the joint has been inspected by the CITY.

**502.6.7. Rejection.** The preformed flexible joint sealant may be rejected for failure to meet any of the requirements of this specification.

## **502.7. POLYETHYLENE WRAP FOR METAL PIPE AND FITTINGS**

These specifications cover 8 mil black polyethylene film used as a wrap to protect cast iron, ductile iron and other metals in a corrosive soil environment.

**502.7.1. Material.** Unless otherwise specified, encasement material, sizing, and marking shall conform to ANSI/AWWA C105/A21.5-99 or latest revision Polyethylene Encasement for Ductile-Iron Pipe Systems.

**502.7.2. Installation.** Unless otherwise specified, encasement installation shall conform to AWWA C105/A21.5-99. Polyethylene wrapping of pipe, fittings or hydrants shall precede blocking or restraint.

Fittings such as bends and reducers shall be wrapped similarly to pipe. Specials such as but not limited to hydrants and crosses shall be wrapped by splitting, tucking and overlapping the polyethylene tube, then closing the field-made splices with the required tape. All seams shall be folded twice prior to taping in accordance with AWWA C105/A21.5-99.

Hydrants shall be encased with the polyethylene tubing slipped over the hydrant and extended to a point 2-in. to 3-in. (5cm – 7.5cm) above the ground line. The wrap shall be excluded from the drain region to allow normal drain function of the hydrant.

**502.7.3. Rejection.** Failure to meet any of the specifications contained in this section shall be cause for rejection of the materials.

## **502.8. CORROSION-RESISTANT COATINGS AND LINERS FOR WASTEWATER CONDUIT AND APPURTENANCES**

**502.8.1. General.** Coatings and liners are used as a protective barrier attached to the interior walls of concrete, ductile iron, or steel pipe or manhole sections, special concrete appurtenances for protection against the corrosive chemical elements which may occur in certain domestic wastewater environments and for protection against certain corrosive wastes from industry.

All work for and in connection with the installation of the coatings and linings, including interlocking liner plates and epoxy lining in concrete pipe and the field sealing and welding of joints, shall be done in strict conformity with all applicable specifications, instructions and recommendations of the manufacturer.

**502.8.2. Basis of Acceptance.** The acceptability of the protective material and its attachment to the pipe or appurtenance shall be determined by the results of tests, by inspection and by approval of its experience record. The tests are designed to prove, demonstrate and insure:

- (1) whether or not the protective material is the same as used in the tests,
- (2) surface continuity and lack of holidays,
- (3) adhesion,
- (4) resistance to temperature changes,
- (5) resistance to abrasion,
- (6) resistance to fire, and
- (7) chemical resistance.

The inspection at the manufacturing plant or in the field is to determine:

- (8) whether or not the protective material is the same as used in the tests,
- (9) that it is attached in the same manner, and as uniformly, as it is attached to the concrete in the tests,
- (10) that the joint areas are adequately protected.

The experience record of the protective material attached to the pipe or appurtenances must be acceptable.

To qualify the material and the attachment of the material to the pipe or appurtenances for acceptance, all tests must be met or certified for the specific protection intended, all conditions to be evaluated by inspection must be met, and the experience record must be submitted and approved.

**502.8.3. Testing Requirements.** Unless otherwise specified, the manufacturer of the protective material is responsible for meeting the testing, inspection standards and experience records as described herein, except in



the case of a pipe manufacture electing to procure the protective material and applying the material as the pipe is manufactured. In such a case the pipe manufacturer would be responsible.

The test results shall be certified by a recognized testing laboratory acceptable to the CITY and do not necessarily have to be made on each project.

The inspection results shall be attested to in writing by a licensed Professional Engineer or witnessed by the Engineer representing the CITY. The experience record shall be documented with dates, locations, actual number of feet (m) of protected conduit in the ground, length of time in the ground, the nature of the environment against which the conduit is being protected and the names and addresses of responsible references who shall verify the facts in the experience record.

#### **502.8.4. Physical Requirements.**

**502.8.4.1. Chemical Resistance.** The CITY may designate which of the solutions mentioned may be used or may designate others.

The chemical resistance test shall be made as follows:

- (1) The specimens, approximately 5-in. long, 2¼-in. wide and 1-in. thick (125 mm x 56 mm x 25 mm), shall be cut from the pipe. The protective material shall be attached to these test specimens in the same manner as it would be attached to the pipe. The protective material shall be to manufacturer's specified minimum thickness. If curing is required, the protective material shall be cured to the manufacturer's recommendations.
- (2) The protective material on the prepared test specimens shall be tested for indentation hardness in accordance with the requirements of ASTM D2240 Test Method for Rubber Property—Durometer Hardness and the hardness recorded.
- (3) The prepared test specimens shall then be placed in wide mouth glass containers half submerged in the following solutions:
  - 5% sulphuric acid
  - 5% hydrochloric acid
  - 3% salt (NaCl) water
  - 1 % phenol
  - 5% alum
  - 5% phosphoric acid
  - 10% biodegradable detergent
  - 100% motor oil
- (4) The containers shall be closed and held at 100°F (37.7°C) for six-months.
- (5) After six months the specimens shall be taken from the containers and tested again for indentation hardness in accordance with the requirements of ASTM D2240. The test durometer hardness shall be made in both the area exposed to the liquid and in the area exposed to the vapor above the liquid. There shall be no loss of indentation hardness either in the area below the liquid or in the area above the liquid.

**502.8.4.2. Surface Continuity and Holidays.** Voids or holidays shall be cause for rejection. The surface continuity and holiday test shall be made as follows:

- (1) An electrical holiday detector, capable of producing and maintaining a voltage equal to 800 times the square root of the specified minimum protective thickness expressed in mils, shall be used to determine the complete continuity of the protective surface.
- (2) The electrical holiday detector shall be used on a full size piece the protective material taken from a production run.

#### **502.8.4.3. Adhesion to the Pipe or Appurtenances.**

**502.8.4.3.1. Adhesion to Concrete.** Where the protective material adheres directly to the concrete, adhesion test shall be made as follows:

- (1) Make a test specimen by drilling a core hole through the protective material and the pile to produce a core sample 1-in. (2.5cm) in diameter by ¾-in. (1.9cm) or more in depth. (This hole may be repaired and the pipe from which the sample was taken may be used.)
- (2) Check the protective material for thickness.
- (3) Cement the test specimens onto a solid wooden block at least 2-in. x 2-in. x 1-in. (5cm x 5cm x 2.5cm) in thickness so that the protective material is cemented onto the wooden block.
- (4) Allow sufficient time for the cement to set.
- (5) Support the wooden block so that the test specimen is on its underside and hang a 40-pound (18-kg) weight on the test specimen. This can be done using an ordinary wooden clamp.
- (6) This test should be made at an ambient temperature of between 60°F and 90°F (15°C - 32°C).

- (7) The protective material shall adhere to the material for a minimum of two-hours.

**502.8.4.3.2. Anchored to Concrete.** Where the protective material is anchored to the concrete by fins embedded or dovetailed into the concrete adhesion test shall be made as follows:

- (1) Using a large enough square footage ( $m^2$ ) of the protective material to be a representative sample, the fins shall not be capable of being pulled out of the material, usually concrete, nor the protective material torn away from the embedded fins using less than a pull equal to 50-psi (3.6-kg/ $m^2$ ).
- (2) For the adhesion test, either Item 502.9.4.3. Adhesion to the Pipe or Appurtenances or paragraph (1) above shall be used, but not both.

**502.8.4.4. Resistance to Temperature Changes.** The test for resistance to temperature changes for those materials that adhere directly to the concrete shall be made in accordance with the latest ASTM Method when required by the CITY.

**502.8.4.5. Resistance to Abrasion.** The test for resistance to abrasion shall be made as follows:

- (1) A 1-foot (30cm) length of pipe which has been lined with the protective material shall be suitably capped and arranged on rollers so that it can be revolved at high speeds. A door shall be left in one end so that access can be had to the interiors of the test section.
- (2) A slurry shall be made composed of six-pounds (2700-grams) of gravel and three-pounds (1360-grams) of water, and it shall be placed inside the test section and the test section shall be rotated so that the protective material has peripheral speed of four-feet-per-second (122-cm-per-second). After 1,500,000 revolutions, the protective material shall not show visible signs of wear or abrasion.

**502.8.4.6. Resistance to Fire.** The protective material, if plastic, shall be tested for resistance to fire by meeting the requirements of ASTM D635 Test Method for Rate of Burning and/or Extent and Time of Burning of Self-Supporting Plastics in a Horizontal Position. The material shall be self-extinguishing or nonburning according to ASTM D635.

**502.8.5. Appurtenance Protection.** Adequate protection shall be provided at the ends of joints.

All special shapes such as tees and wyes, branches, slants and curves shall be protected with the protective material, and they shall be given the same degree of protection provided to the production run of pipe. Lift holes, if called for on the plans or in the specifications, shall be sealed with epoxy or sealant recommended by the coating or liner manufacturer that shall pass the tests as set out in this Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances.

**502.8.6. Inspection.** The tests required under the physical test requirements section of this specification need only be made once on any one project. Each length of pipe or special may be subject to visual inspection during manufacture, transportation or laying by the OWNER in order to cull and reject pipe as specified in Item 502.9.8. Rejection.

**502.8.7. Repair of Coatings and Liners.** Where the protective material is damaged or where the adhesion of the protective material to the concrete is damaged, repairs may be made at the discretion of the CITY.

**502.8.8. Rejection.** The protective material shall be rejected if:

- (1) Any tests described under physical test requirements are not met,
- (2) The manufacturing method of applying, adhering and curing the protective material differs from that used on the test samples,
- (3) The protective material thickness as used on the test samples exceeds the minimum specified in the manufacturer's specification by more than five-percent, or
- (4) It cannot be adequately repaired in the field.

## **502.9. CONNECTIONS TO WATER CONDUITS FOR SERVICE**

**502.9.1. Definitions.** "Service" shall be defined as a service line to an individual customer. "Bullheads" shall be defined as an individual service line with branches at the end to serve two or more customers.

### **502.9.2. Materials.**

**502.9.2.1. Water Service Saddles-General.** All Water Service Saddles shall be designed for tapping water conduit piping under normal operating pressures and shall be designed for 150-psi working pressure. All Service Saddles shall be sealed against the pipe with a Buna-N or EPDM Chloramine resistant gasket and shall have a heavy style hub tapped with CC (AWWA) corporation stop threads. Service Saddles shall be shaped so as to provide approximately 180 degree coverage around the pipe.

**502.9.2.1.1. Saddle/Straps.** Single band saddles for conduit piping under 4 inches shall be of material conforming to ASTM B62 Bronze or, shall be constructed of a Ductile Iron body meeting ASTM A536 with fusion bonded Epoxy or Plastic coating and a 14 gauge 18-8 type 304 stainless steel strap with antiseize coated stainless steel nuts. Double band saddles for conduit piping 4 inches or larger shall be of material conforming to ASTM B62 Bronze with two Bronze straps, or Ductile Iron body meeting ASTM A536 with fusion bonded Epoxy or Plastic coating with two 14 gauge 18-8 type 304 stainless steel straps with anti-seize coated stainless steel nuts. Straps shall be flat on one side to fit uniformly against the wall of the pipe. No hinged type saddles shall be allowed on any size main.

**502.9.2.1.2. Markings.** Saddles shall be distinctly and permanently marked showing manufacturers name and minimum/maximum O.D. ranges.

**502.9.2.1.3. Rejection.** All Water Service Saddles furnished under these specifications shall be subject to the inspection and approval of the City of Temple. If any products are found not to conform to the specifications, the lot or any portion thereof may be rejected.

**502.9.2.2. Tapping Valves.** Tapping valves shall conform to the requirements of Item 502.6.1.15.

**502.9.2.3. Tapping Sleeves.** The material for tapping sleeve bodies shall be cast iron or ductile iron in accordance with AWWA C110 (ANSI 21.10) or ASTM A285 Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength, Grade C carbon steel, in two sections or halves to be bolted together with high-strength, corrosion-resistant, low-alloy steel bolts conforming to AWWA C111 (ANSI A21.11). Branch outlet of tapping sleeves shall be flanged with a machined projection or recess to mate with tapping valve inlet flange to assure correct alignment.

Cast-iron and ductile-iron tapping sleeves shall be mechanical joint, or as specified, with dimensions to secure proper fit on the type and class of pipe on which they are to be used. Bolts, nuts and glands for mechanical joint ends shall conform to the requirements of Item 502.6.1.3. Ends.

Steel sleeves shall be restricted to use on pipe sizes 12-in. (31cm) and larger and subject to the following additional specifications:

- (1) Flange shall conform to AWWA Standard C207 for Steel Pipe Flanges for Waterworks Service — Sizes 4 In. through 144 in. Class D, ANSI 150 lb. (68.0 kg) drilling. Gasket shall be affixed around the recess of the tap opening in such a manner as to preclude rolling or binding during installation.
- (2) All steel sleeves shall be fusion bonded epoxy coated to an average of 12-mil (0.012-in.) (0.3mm) thickness. Finished epoxy coat shall be free of laminations and blisters, shall not peel and shall remain pliable and resistant to impact.
- (3) Steel sleeves shall be provided with a ¾-in. (19mm) NPT test opening so that test can be made prior to tapping. Opening shall be provided with a ¾-in. (19mm) bronze plug.

**502.9.2.4. Residential Meter Boxes.** The meter box shall be constructed for impact strength and corrosion resistance. The meter box shall not be constructed of a material known to degrade in wet, acidic or alkaline soil. Materials specified by the City includes, precast polymer concrete and HDPE plastic boxes with cast or ductile iron hinged lid.

Cast iron shall meet ASTM A48 Gray Iron Castings, Class 30B. Ductile iron shall meet ASTM A536 Ductile Iron Castings. Plastic boxes shall be black on the exterior, white on the interior for better illumination and shall be UV stabilized.

All meter box covers shall be solid, made of gray cast iron conforming to ASTM A48 Class 30B or ductile iron conforming to ASTM A536 and shall bear the manufacturer's ID and product number.

The City will furnish and install meter boxes at the time the meter is set for an additional fee to the permittees set by City.

**502.9.3. Water Conduit Connections.** This section and Item 506.6. Connections to Existing Water Conduits shall govern for the construction of connections to water conduits.

**502.9.3.1. Taps and Tap Assemblies in Water Conduit.** Taps and/or tap assemblies of the specified size shall be installed in locations as detailed and indicated on the plans or as specified.

**502.9.3.1.1. Taps.** Taps for transmission of water or air from the main into system service accessories can be either of two types as follows:

- (1) Standard internal pipe threaded holes in wall of water mains. These taps may be either manufactured into the pipe or installed in the field.
- (2) Tap installations that are made by clamping a service saddle equipped with a sealed threaded port on the periphery of the main and then drilling through the pipe wall to complete each service port. Taps may be made either on an uncharged system or into a main under pressure.

**502.9.3.1.2. Tap Assemblies.** The tap assembly shall consist of a corporation stop and an iron to copper connection attached to a hard copper (Type K) tubing terminating approximately 1-ft. (30cm) below ground surface with a brass gate valve as shown and detailed on the plans to serve as additional air release.

When tap assemblies are an integral part of an air valve installation, measurement and payment shall be in accordance with Item 502.6. Valves.

Tap assemblies may be required by the project plans and specifications adjacent to gate valve installations. Tap assemblies so required shall be installed in the water main on either side of the valve. Payment for the tap assemblies shall be included in the unit price bid for furnishing and installing the gate valve complete in place.

When taps are required for flushing, chlorination and/or testing, the CONTRACTOR shall locate the taps in accordance with Standard Drawing 4110 or other detail drawings, plans or in locations directed by the CITY. No separate payment shall be made for taps required for testing, flushing, and/or chlorination.

Upon completion of the testing and purification, the CONTRACTOR shall return to the job site, remove the blow-off down to the corporation stop, backfill leaving the corporation stop in place, and replace all pavement. The CONTRACTOR'S removal of the blow-off shall include all labor, materials, tools, equipment and incidentals necessary to complete the work, including excavation, backfill and disposal of surplus materials without additional compensation.

**502.9.3.1.3. Tapping Sleeves.** Steel sleeves shall not be used for taps greater than 75-percent of the pipe diameter. Use of steel sleeves for "size-on-size" taps is prohibited.

Care shall be taken to protect all coatings, gaskets and flange surfaces of all tapping sleeves during transport and storage.

**502.9.3.1.4. Tapping Ductile Iron Pipe.** No direct taps. Taps shall only be done by using an approved tapping sleeve or saddle. See Section 502.10.2.1 Water Service Saddles.

**502.9.3.1.5. Tapping Concrete Pipe.** Tap location shall be provided to the pipe manufacturer, when available, and taps shall be made by the manufacturer during the fabrication phase of the pipe when locations are so furnished. Taps fabricated during manufacture with a diameter less than or equal to 2-in. (5cm) shall be provided with brass or bronze insert bushings. Taps greater than 2-in. (5cm) shall be provided as flanged outlets with flange to thread insulator adapter kits. When taps are required to be made in the field, the taps shall be made in accordance with the pipe manufacturer's recommended procedures and to the satisfaction of the CITY.

**502.9.3.1.6. Tapping Asbestos or Asbestos Cement Pipe.** If asbestos pipe is found contact City Utility Department.

**502.9.3.1.7. Tapping PVC Pipe.** Service taps in AWWA C900 PVC pressure pipe shall be made with a shell cutter assembly and the coupon removed for tap sizes relative to pipe class and diameter.

No direct taps. Taps shall only be done by using an approved tapping sleeve or saddle.

**502.9.3.2. Procedures for Transferring Service.** The CONTRACTOR will inform the customer that the service is being transferred.

**502.9.3.2.1. Short Service.** A water service shall be classified as a "Short Service" if the existing service line to the water meter is on the same side of the street as the new main and requires the existing service line to be replaced to complete the installation as indicated on the plans and specified herein. A curb stop will be installed on the end of the service line.

**502.9.3.2.2. Long Service.** A water service shall be classified as a "Long Service" if the existing service line to the meter is on the opposite side of the street as the new main and requires a new service line to be installed under the street to complete the installation as indicated on the plans and specified herein. Splices in service lines shall not be permitted.

All new services will be flushed according to TCEQ Standards. The main will then be hydrostatically tested and disinfected. After a good sample is received, the CONTRACTOR will then begin transferring the services.

**502.9.4. Wastewater Conduit Connections.** This section shall govern for new construction of connections to wastewater conduits and for connections of wastewater pipe to existing wastewater conduits or wastewater appurtenances as shown on the plans or as directed by the Engineer. Details of standard construction shall be shown on the plans.

The end of each new wastewater service connection shall be marked with a 2" x 2" x 3' stake painted green and heavy gauge foil backed polyethylene tape, 6-inches (15cm) in width with a minimum thickness of 0.004-inches. The tape should be green in color on which has been printed "Caution Buried Wastewater Line Below" in continuous print. The tape should have a minimum tensile strength of 1700-psi (120-kg/cm<sup>2</sup>) lengthwise and 1200-psi (85-kg/cm<sup>2</sup>) crosswise. The tape shall extend from the end of the capped service pipe and shall be wrapped around the green painted stake to the top of the stake.

**502.9.4.1. Service Connection Piping.** Service pipe shall be of the same material as the main wastewater conduit unless otherwise specified on the plans or in the contract or approved by the CITY. Connections shall be made to prevent the occurrence of bi-metallic corrosion or any other corrosion that can result by joining incompatible materials.

Wastewater service connections shall be defined as a service line connecting the customer's wastewater system at the property line or utility easement to the main wastewater conduit and shall consist of the service wye and fittings as shown on the plans, the necessary Class B or Class PB (as specified by the CITY) concrete cradle or crushed stone for the service wye, the service pipe necessary to extend the line from the main wastewater conduit to the customer's property line and a cap placed in the end of the service line.

Services for single-family residences shall normally be one 4-inch lateral for single services and one 6 inch lateral branching off to two 4 inch laterals for double services. Standard laterals shall consist of a standard wye bend(s) and fittings along with the necessary pipe as shown on the plans or directed by the CITY. Larger laterals shall consist of a manhole and the necessary minimum 6-inch (15cm) pipe as shown on the plans or directed by the CITY. If the CONTRACTOR is required to connect or reconnect the service line to the customer's wastewater system, the connection shall be as shown on the plans. If the CONTRACTOR is not required to connect to the customer's wastewater system, the service line shall be plugged and sealed.

Extra depth service connections shall be installed when the wastewater main is at a depth greater than that necessary to serve the abutting property. The service is identical to a standard connection except that pipe risers will be installed at a maximum 45-degree angle into the trench walls to connect the combination tee wye and 45-degree bend to the service pipe. Where possible, a minimum slope of 1/4-in.-per-foot (equivalent to a 2% slope) will be maintained. Where the wastewater main is located in the street and the abutting property slopes to the street, the wastewater service shall normally have a minimum depth of 5-feet below the top of the curb at the point where it passes beneath the curb. Where abutting property slopes away from the wastewater main, service connections shall be placed at a depth adequate to serve the normally expected use of the property.

Where water and wastewater service connections cross, they shall be treated in accordance with TCEQ regulations.

**502.9.4.2. Cleanouts.** Service line cleanouts shall conform to Standard City of Temple details and specifications. If service line cleanouts are required, they shall be installed at the property line. When specified in the special provisions or in the plans, a test tee shall be installed at the end of the service line (located in the parkway), with the branch in a vertical position.

## **502.10. STRUCTURES**

**502.10.1. Description.** This section shall govern for the construction of all miscellaneous structures such as junctions, transitions, and utility supports, and for the construction of appurtenances such as deep-cut connections, wyes, stoppers and bulkheads, and such other miscellaneous structures or appurtenances which may be shown on the plans. Construction shall conform with any applicable provisions of Division 700. Structures.

Unless otherwise specified on the plans, all storm sewer structures such as junctions, transitions, manholes, cleanouts, wyes, elbows, tees, stoppers and such other miscellaneous structures or appurtenances which may be shown on the plans shall be made of the same base metal and coating (metallic or otherwise) as the pipe on which it is connected. All such structures or appurtenances field fabricated or otherwise will be repaired in accordance with Item 502.9.7. Repair of Coatings and Liners or Item 804.3.5. Repair of Damaged Zinc Coating, as applicable.

In general there shall not be a pay item for pipe support when a temporary part of conduit installation, but the contract prices for the new or re-laid pipe, shall be the total compensation for the furnishing of all labor, tools, materials, equipment and incidentals necessary to complete the work including excavation, installation and removal of the temporary piping, construction of piers, stripping of forms, disposal of surplus materials, in accordance with the plans and specifications. Where a pay item is included, the contract price shall be the additional compensation for all excavation, labor, tools, and materials over and above the bid price for furnishing and installing the conduit.

**502.10.2. Permanent Concrete Structures.** The construction of reinforced concrete structures, including junctions, transitions, vaults, piers and beam supports, and such other similar structures as may be covered by this specification, shall be performed in accordance with the requirements of Item 702. Concrete Structures, applicable Division 1000-5000 Standard Drawings, and the following additional requirements. Unless otherwise specified, all concrete shall have an average compressive strength at 28-days equal or greater than 3000-psi (210-kg/cm<sup>2</sup>). Excavation shall be made to the required depth and of sufficient width to construct the work to grade, form and dimensions. All soft and yielding materials shall be removed and replaced with acceptable materials. The subgrade shall be moistened to a minimum depth of 2-in. (5cm) before placing concrete. All formed surfaces of the concrete exposed to public view shall be given a textured finish as shown on the plans. All other formed surfaces shall be given the "Type 1 Finish," as described in Item 702.4.14. Finishing Exposed Surfaces. Corrosion protection shall be applied as may be called for on the plans or the proposal and shall be measured for payment and paid for at the contract price as detailed in Item 502.9. Corrosion-Resistant Coatings and Liners for Wastewater Conduit and Appurtenances.

**502.10.3. Miscellaneous Pipe Structures.** Riprap and miscellaneous pipe structures that may be necessary shall be designed in detail on the plans.

**502.10.4. Connections to Existing Structures.** The bottom of the existing structure shall be mortared or concreted, if necessary, to eliminate any drainage pockets by the new connection in general accord with details for the new structure as shown on the plans. Where conduit is connected into old structures that are to remain in service, any damage to the structure resulting from the work of making the connection shall be restored by the CONTRACTOR to the satisfaction of the Engineer.

**ITEM 503. TRENCHLESS INSTALLATION**

**RESERVED**

## ITEM 504. OPEN CUT – BACKFILL

**5.04 Open Cut - Backfill**

**Trench backfill must be in compliance with the following:**

**504.1 Backfill Material**

**504.1.1** Trench excavation material may be used as backfill material subject to the following:

- (1) Backfill requirements, established by the project engineer, are noted on the construction plans.
- (2) Excavated rock exceeding 2" in diameter may not be used. Such material must be sufficiently graded to fill all voids & bind together.
- (3) Groundwater, encountered in any excavation, must be reported to the project engineer for establishing backfill criteria.

**504.2 Compaction Equipment**

**504.2.1** Authorized compaction equipment and related maximum loose lift:

Equipment	Maximum Loose Lift
Vibratory Rammer	6"
Compaction Wheel for Rubber-Tired Backhoe	18" – 24"
Compaction Wheel for Excavator (Wheel type must be appropriate for specific site conditions)	24" – 30"
Motorized Sheep's Foot Vibratory Roller (22 – 25hp)	18" – 24"
Pneumatic or Hydraulic "Pogo Stick" Tamper	4"

**504.2.2** Use of any alternative compaction equipment and related maximum loose lift must receive prior approval of the Project Engineer or the City Engineer.

**504.3 Onsite Construction Representative**

The Onsite Construction Representative is the authorized person responsible for project quality control.

**504.4 Density Testing**

- 1) Random testing will be made and scheduled at the discretion of the Onsite Representative.
- 2) Contractors will not be required to suspend construction, pending testing or test results.
- 3) Failed Tests: Additional testing, at contractor's expense, may be made. Any portion of work, that does not meet Project Specifications, must be removed; reworked and retested (to the point of the last acceptable test) at contractor's expense.
- 4) The contractor must provide adequate trench protection for testing.



**ITEM 505. OPEN CUT - GENERAL CONDUIT INSTALLATION**

**RESERVED**

**ITEM 506. OPEN CUT – WATER CONDUIT INSTALLATION**

**RESERVED**

**ITEM 507. OPEN CUT – WASTEWATER CONDUIT INSTALLATION**

**RESERVED**

**ITEM 508. OPEN CUT – STORM WATER CONDUIT INSTALLATION**

**RESERVED**

**ITEM 509. CROSSINGS**

**RESERVED**