

**DIVISION II
CONSTRUCTION AND MATERIAL SPECIFICATIONS
SECTION 2900 WATERLINES**

APPROVED AND ADOPTED THIS 15th DAY OF FEBRUARY, 2017

**KANSAS CITY METROPOLITAN CHAPTER
OF THE AMERICAN PUBLIC WORKS ASSOCIATION**

TABLE OF CONTENTS

SECTION 2901 GENERAL	1
2901.1 Scope	1
2901.2 Referenced Standards.....	1
2901.3 Cleanup	2
SECTION 2902 MATERIALS	2
2902.1 Scope	2
2902.2 Pipe and Fittings.....	2
2902.3 Valves and Valve Boxes	7
2902.4 Fire Hydrants	9
2902.5 Specials	10
2902.6 Bedding Material.....	11
2902.7 Location Wire and Tape	11
2902.8 Concrete	11
2902.9 Casing Pipe	11
SECTION 2903 CONSTRUCTION	13
2903.1 Grading and Excavation	13
2903.2 Installation	16
2903.3 Jointing	20
2903.4 Connection to Existing Mains	21
2903.5 Polyethylene Encasements	22
2903.6 Setting Valves, Fittings and Hydrants.....	22
2903.7 Thrust Restraint.....	23
2903.8 Embedment and Backfilling	23
2903.9 Disinfection and Testing	23
2903.10 Surface Restoration.....	25
SECTION 2904 WATER MAINS NEAR SEWERS	25
2904.1 Horizontal Separation	25
2904.2 Vertical Separation	25
2904.3 Sewer Manholes and Inlets	25
SECTION 2905 MEASUREMENT AND PAYMENTS	25
2905.1 Methods of Measurement.....	26
2905.2 Basis of Payment.....	26

(Minor updates on page 5 – underlined – May 31, 2017)

SECTION 2901 GENERAL

2901.1 Scope

This section governs the furnishing of all labor, materials, and equipment necessary for the complete installation of waterlines, fittings, valves, valve boxes, fire hydrants, and other appurtenances as shown on the Plans and in accordance with the Standard Drawings, the specifications, and the Special Provisions.

2901.2 Referenced Standards

The following standards are referenced directly in this section. The latest version of these standards shall be used. If conflicting standards are referenced, the more stringent standard shall apply.

APWA

Section 2100	Grading and Site Preparation
Section 2150	Erosion and Sediment Control
Section 2200	Paving
Section 2300	Incidental Construction
Section 2400	Seeding and Sodding

ASTM

A 36	Standard Specification for Carbon Structural Steel
A 126	Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings
A 276	Standard Specification for Stainless Steel Bars and Shapes
A 307	Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
A 536	Standard Specification for Ductile Iron Castings
A 564	Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
A 1011	Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
C 33	Standard Specification for Concrete Aggregates
C 150	Standard Specification for Portland Cement
C 478	Standard Specification for Circular Precast Reinforced Concrete Manhole Sections
D 1784	Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds
D 2241	Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series)
D 3139	Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals
D 4976	Standard Specification for Polyethylene Plastics Molding and Extrusion Materials
F 477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe

ANSI/AWWA

C 104/A21.4	Cement-Mortar Lining for Ductile-Iron Pipe and Fittings
C 105/A21.5	American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems
C 110/A21.10	American National Standard for Ductile-Iron and Gray-Iron Fittings, 3 In. Through 48 In.
C 111/A21.11	American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings
C 115/A21.15	American National Standard for Flanged Ductile-Iron Pipe with Threaded Flanges
C 116/A21.16	American National Standard for
C 151/A21.51	American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water

AWWA

C 207	Steel Pipe Flanges for Waterworks Service – Sizes 4 In. Through 144 In.
C 509	Resilient-Seated Gate Valves for Water Supply Service

- C 515 Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service
- C 550 Protective Interior Coatings for Valves and Hydrants
- C 600 Installation of Ductile Iron Water Mains and Their Appurtenances
- C 900 Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In. Through 60 In.
- C 909 Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 In. and Larger

MCIB Mid-West Concrete Industry Board Concrete Specifications - Concrete Pavement
 The current editions of the "Bulletins" and Approved Sections of the "Standard Concrete Specifications" issued by the Mid-West Concrete Industry Board, Inc. (MCIB) are made a part hereof by reference. However, when the provisions of this Specification differ from the provisions of such "Bulletins" and "Sections" the provisions of this Specification shall govern. Reference December 2000 Specifications if most recent version does not contain specified mix designs.

KCMMB Kansas City Metro Materials Board Specifications

2901.3 Cleanup

Cleanup shall follow the work progressively. The Contractor shall remove from the project site all rubbish, equipment, tools, surplus or discarded materials, and temporary construction items.

Streets to be opened to local traffic at the end of the day's operation shall be cleaned of dirt or mud. All equipment and material stockpiles shall be secured for safe passage of vehicles and pedestrians.

SECTION 2902 MATERIALS

2902.1 Scope

This section governs materials for waterlines, including fittings, valves, valve boxes, fire hydrants, and appurtenances.

2902.2 Pipe and Fittings

A. Ductile-Iron

1. Pipe: Unless indicated otherwise on the construction plans, all ductile iron pipe 6-inch and larger shall be Class 50; 4-inch pipe shall be Class 51 complete with all accessories and conforming to ANSI A21.51, AWWA C151, ASTM A 536, and Grade 64-42-10.
2. Joints: Unless otherwise specified, shall be of the push-on type conforming to ANSI A21.11/AWWA C111, except gaskets shall be neoprene or synthetic rubber. Natural rubber will not be acceptable. Gaskets shall be certified as suitable for chlorinated potable water in accordance with ANSI/NSF61.
3. Restrained Joints
 - a. Restrained push-on joints for ductile iron pipe and fitting shall be American "Flex-Ring" or "Fast Grip"; Clow "Super-Lock"; U.S. Pipe "TR Flex" or "Field Lok"; or Griffin "Snap-Lok".
 - b. Restrained Mechanical Joints shall be EBAA Iron "Mega-Lug" or Ford Uni-Flange. "Mega-Lug" shall not be used on plain end fittings.
 - c. Restrained joint fittings shall be One Bolt.

4. Fittings
 - a. All ductile-iron fittings shall be complete with all accessories and shall conform to ANSI A21.10/AWWA C110, 350 psi pressure rating.
 - b. Fitting joints shall be Mechanical Joint (MJ), Flange Joint (FLG), or Push-On Joint, per ANSI A21.11/AWWA C111. All MJ glands shall be ductile iron. Fittings shall be distinctly cast upon them, the pressure rating and the letters "DI" or "Ductile". FLG fittings shall be used only for above ground installations.
 - c. Flanged Joints shall be provided with full-face gaskets and shall meet the requirements of ANSI A21.15/AWWA C115.

5. Appurtenances
 - a. Welded – On Outlets may not be used in lieu of tees.
 - b. Tapping Sleeves
 - i. All material in the body, lugs, outlet, flange, bridge plate, bolts, nuts and washers shall be ASTM A 276 Type 304 or Type 316 or ASTM A 564 Type 630 stainless steel.
 - ii. The body shall be a minimum of 14 gauge stainless steel and shall fit cast iron pipe classes A, B, C, and D.
 - iii. The outlet shall be a minimum of 14-gauge stainless steel. The branch outlet shall be supplied with a tap and plug to permit pressure testing the sleeve prior to tapping the main.
 - iv. The flange shall conform to AWWA C207 Class D with drilling in accordance with ANSI B 16.1 Class 125, and shall be indexed per MSS-SP 60 to accept tapping valve.
 - v. All welding on the coupling shall be done with stainless steel rods.
 - vi. Sleeve gaskets shall be full circumferential a minimum of 1/4" thick gridded with tapered lap joint ends and stainless steel bridge plates molded flush into the gasket.
 - vii. The outlet flange face shall be supplied with a bonded, full-face gasket. All gaskets shall be grade 30 specially compounded rubber, synthetic rubber, or 100 percent neoprene that shall have the necessary qualities to allow outside storage, permanence, and resistance to set after installation.
 - viii. All bolts, nuts and washers shall be loose; lifter bar style bolt attachments shall not be permitted. All bolts and/or nuts shall be impregnated or coated to prevent seizure. Minimum diameter shall be 5/8".
 - ix. Sleeve shall be designed for a minimum working pressure of 175 psi.
 - x. General: Power Seal Model 3490-AS; JMC 432; Cascade CST-Ex stainless steel extra heavy duty; Ford Model FTSS; Romac STD Band SST-III; Smith Blair Type 665.
 - xi. Power Seal Model 3490MJ or approved equal may also be used.

6. Tie Rods: ASTM A 276, Type 304 or Type 316 Stainless Steel.

7. Couplings: Dresser "Style 38" or Smith-Blair "441 or 411 Flexible Coupling"; without pipe stop. Bolted compression type couplings shall be manufactured of steel or ductile iron specifically for use with ductile iron pipe.

8. Shop Coating: Pipe and fittings shall be furnished with a standard thickness exterior bituminous coating complying with ANSI/AWWA C116/A21.51. Fittings may be furnished with a fusion-bonded epoxy coating complying with ANSI/AWWA C116/A21.16.

9. Linings: All pipes and fittings shall be cement mortar lined conforming to ANSI A21.41/AWWA C 104. All buried pipe and fittings shall be coated with black asphaltic coating minimum 1 mil in thickness per ANSI A21.51/AWWA C 151. Fittings shall have distinctly cast upon them the pressure rating and letters "DI" or "DUCTILE". Any pipe or fittings above ground shall be prime coated with 6 mils DFT of Tnemec 140-1211 Epoxy Primer.
10. Bolts and Nuts
- a. Bolts: ASTM A 307, chamfered or rounded ends projecting 1/4 to 1/2 inch from surface.
b. Nuts: ASTM A 307, hexagonal, ANSI B18.2.2.
11. Marking: Markings shall be legibly indented in the pipe or painted thereon with waterproof paint.
12. Protective Coatings
- a. Polyethylene Encasement
- i. Polyethylene encasement materials shall be in accordance with ASTM D 4976 and AWWA C105/A21.5; LLD-12 mil or KDCL-4 mil. LLD-12 mil polywrap shall be blue.

<u>Item</u>	<u>LLD-12 mil</u>	<u>HDCL-4 mil</u>
Tensile Strength, psi	4,400	6,300
Elongation, percent	1,000	100
Dielectric Strength, v/mil	1,900	800
Tear Resistance, gf	4,400	250
Impact Resistance, g	1,100	800

- ii. The minimum tube size for each pipe diameter shall be in accordance with AWWA C105 as follows:

Polyethylene Flat Tube Widths (inches)		
Nominal Pipe Diameter (inches)	Push-on Bell & Spigot Joints	Mechanical Joints
4	14	16
6	17	20
8	21	24
10	25	27
12	29	30
14	33	34
16	37	37
18	41	41
20	45	45
24	53	53

- iii. Adhesive tape shall be a general purpose adhesive tape 1-inch wide and approximately 8 mils thick, such as Scotch Tape No. 50, Polyken No. 900, Tapecoat CT or approved equal (Duct Tape will not be allowed).
- b. Exterior Surfaces Underground (Excluding Pipe & Fittings): All metal surfaces, including each mechanical coupling, shall be thoroughly cleaned and then coated with Tnemec coal-tar epoxy "High-Build Tnemec Tar". All material and the application thereof shall conform to AWWA C203.

- c. Above ground pipe and fittings shall be field coated with Tnemec Coal Tar Epoxy “High-Build Tnemec Tar”.

B. Polyvinyl Chloride (PVC) 4-inch through 12-inch

1. Pipe: PVC pipe shall meet the requirements of ANSI/AWWA C900 or ANSI/AWWA C909 with cast iron pipe O.D., for PVC pipe. Materials from which the pipe is manufactured shall have been tested and approved for conveying potable water by the National Sanitation Foundation and the Underwriter’s Laboratories, and shall be marked with the U.L. logo.
2. Fittings: Where fittings are required, ductile-iron fittings shall be used.

Pipe wall thickness shall be as required to provide a minimum wall thickness with a Dimension Ratio (DR) of 18 for pressure Class 235 and a DR of 14 for pressure Class 305 as defined in ANSI/AWWA C900.

Joints for PVC pipe shall be slip-on type with integral bell and spigot pipe, or pipe with extruded type couplings, meeting the requirements of ASTM D 3139, except flexible elastomeric gaskets meeting the requirements of ASTM F 477, shall be synthetic rubber. Natural rubber will not be acceptable.

C. Polyvinyl Chloride (PVC) 2 Inch: PVC pressure pipe shall be designed to carry potable water at pressures (including surge) up to the maximum class rating. Materials from which the pipe, couplings, and fittings are manufactured shall conform to ASTM D 1784, Type 1, Grade 1, 2,000 psi design stress. The minimum wall thickness for the pipe shall be DR 17 (Class 250) or Schedule 40 (Class 270).

All PVC pipe shall conform to the latest revisions of ASTM D 2241, Department of Commerce PS22-70 (SDR-PR) pressure rated pipe, and National Sanitation Foundation Testing Laboratories (NSF). Pipe ends shall be tapered to accept gasketed couplings. Flexible elastomeric gaskets, meeting the requirements of ASTM F 477, shall be synthetic rubber. Natural rubber will not be acceptable.

The couplings and fittings shall accommodate the pipe for which they are used. The minimum pressure ratings shall be 235 psi for couplings and 250 psi for the fittings. The insertion depth of the pipe in the coupling shall be controlled by an internal PVC mechanical stop in the coupling.

D. Fusible Polyvinyl Chloride (FPVC)

1. Pipe: FPVC shall meet the requirements of ASTM D 1784, cell classification 12454, for PVC compounds, AWWA C900, and ASTM D 2241 for standard dimensions. Materials from which the pipe is manufactured shall have been tested and approved for conveying potable water by the National Sanitation Foundation. Pipe shall be marked with nominal pipe size, dimension ratio, AWWA pressure class, AWWA standard designation number, NSF-61 mark verifying suitability for potable water service, extrusion production record code, and cell classification. Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters, or other visible defects. FPVC pipe shall be blue in color and pressure rated at 200 psi with a dimension ratio (D.R.) of 14 as defined in AWWA C900.

FPVC pipe shall be as manufactured under the trade name “Fusible C-900” for Underground Solutions, Inc., Poway, CA Patent No. 6,982,05, no exceptions.

2. Fittings: All fittings shall be ductile iron.

E. Prestressed Concrete Cylinder, Steel Cylinder Type

1. Pipe: All pipe shall be manufactured and designed according to the requirements of the latest editions of AWWA C301, "Prestressed Concrete Pressure Pipe, Steel-Cylinder Type, for Water and Other Liquids", AWWA C304, "Design of Prestressed Concrete Cylinder Pipe", and AWWA M9, "Concrete Pressure Pipes", except as modified herein. Prestressed concrete cylinder pipe shall be embedded cylinder type for all sizes.
 - a. The cylinder hoop stress at 1.5 times working pressure shall not exceed the yield strength of the steel. A minimum cylinder thickness of 10 gauge shall be furnished.
 - b. Cold-rolled sheets will not be acceptable.
 - c. The length of pipe with restrained joints shall be as indicated on the Plans or as specified. Restrained joints and pipe cylinders shall be designed to withstand the calculated stresses at all points along the pipe with restrained joints. The maximum longitudinal stress in pipe cylinders shall not exceed 13,500 psi at the specified working pressure; or 17,000 psi at the specified working pressure plus surge pressure, or the field test pressure, whichever is the greatest.
 - d. Mortar coating thickness shall be a minimum of one-inch (1") over the prestressing wire.
 - e. Cement: Cement shall be ASTM C 150, Type II. The 28-day rodded test cylinder concrete compressive strength used for the design of the pipe shall not exceed 7,000 psi. If a test cylinder compressive strength between 6,500 psi and 7,000 psi is used for design, a concrete mix design shall be submitted.
 - f. Fine aggregate shall be clean natural or manufactured sand as required by ASTM C 33. No "rebound" shall be allowed in the cement mortar used for pipe.
 - g. Rubber gaskets shall be synthetic rubber.

2. Joints
 - a. Bell-and-Spigot
 - i. Provide bell-and-spigot-type joints for all buried pipe unless otherwise specified or indicated on the Plans.
 - ii. Provide joints with steel joint rings and O-ring rubber gaskets conforming to AWWA C 301.
 - iii. Protect interior surface of the completed joint by grouting with Portland cement mortar.
 - iv. The exterior surface of the completed joint shall be covered with a wide joint diaper (harness clamp restrained joint diaper with full width closed cell polyethylene foam lining) filled with grout.
 - v. All bells and spigots shall be the deep joint type (minimum 4-1/8 inches in joint depth).
 - b. Flanged
 - i. Provide flanged joints for all interior and exposed exterior pipe except where otherwise specified or indicated on the Plans.
 - ii. Flanges shall have a pressure rating not less than that required for pipe.
 - iii. Flanges, bolts, and gaskets shall conform to AWWA C 207, Class D and shall be drilled ANSI B16.1 Class 125.
 - c. Coupled
 - i. Furnish couplings where indicated on the Plans or Standard Drawings.
 - ii. Furnish pipe ends suitable for receiving the style of coupling indicated on the Plans or Standard Drawings.
 - iii. Furnish anchored couplings where restraint is required to withstand specified operating or hydrostatic test pressure and where indicated on the Plans or Standard Drawings.

- d. Special
 - i. Furnish pipe with joints suitable for attaching to valves and accessories and for indicated transitions.
 - ii. Joints shall be plain end, flanged, mechanical, or as otherwise indicated on the Plans or Standard Drawings.
 - iii. Adapters may be furnished in lieu of pipe with special joints.
 - e. Restrained: Provide either clamp-type or snap-ring type rubber and steel joints acceptable to Engineer where restraint is required for joint to withstand specified operating and hydrostatic test pressure and where indicated on the Plans or Standard Drawings.
3. Closure Assemblies: Provide closure assemblies acceptable to Engineer where indicated on the Plans or Standard Drawings and as required by the sequence of construction.
4. Test Plugs
- a. Provide pressure test plugs where required to test the installation.
 - b. Design test plugs to withstand hydraulic test pressure and external loading.
 - c. Join test plugs to pipe with selected joint and restrain as required to maintain internal pressures with external loading applied.
 - d. Provide outlets of proper size to facilitate flushing and disinfection.
5. Fittings and Specials
- a. Fabricate conforming to AWWA C301 and M9.
 - b. Design to withstand internal pressure and external loading not less than that of adjoining pipe.
 - c. Furnish fittings with bell-and-spigot ends where such fittings connect with concrete pipe.
 - d. Furnish wall fittings with approved anchor ring where indicated on the Plans or Standard Drawings. Such fittings shall be of ductile iron or fabricated steel.
 - e. Furnish all adapters, outlets, and other specials as specified or where indicated on the Plans or Standard Drawings.
 - f. Furnish openings for air valve, drain, sampling, sensing, testing, and other connections with threaded bosses or flanged outlets sized and located where indicated on the Plans or Standard Drawings. Steel connections shall be lined and coated with mortar or other protective coating material if mortaring is not feasible.
 - g. Provide tangent blow-off and drain assemblies where indicated on the Plans or Standard Drawings. Outlet shall be a minimum 6-inch anchored mechanical joint spigot.
 - h. Short Bevel Fittings: Furnish and maintain two nominal full bevels and four nominal half bevel bends on site during pipe installation for minor alignment adjustments. Replenish as used until pipe is installed. Return unused bevels to pipe manufacturer.
6. Pipe Marking: In addition to the marking specified in paragraph "Pipe Marking", the following information shall be marked on each pipe, fitting, and special:
- a. Design pressure
 - b. Laying schedule number on all fittings and specials
 - c. Date of casting
 - d. Length of any short pipe

2902.3 Valves and Valve Boxes

- A. Gate Valves: The type, size, and location of valves shall be as shown on the Plans or Standard Drawings. Except as modified or provided herein, all gate valves in pipe lines shall be 200 psi, iron body, gate valves

with non-rising stems. Gate valves shall be resilient-seated conforming to all applicable requirements of ANSI/AWWA C509 and C515.

- B. Butterfly Valves:** Butterfly valves shall be used for water line valves larger than twelve (12) inches in diameter unless otherwise directed by the Engineer. Butterfly valves shall be of the rubber-seat, tight-closing type. Valve discs shall seat at 90-degree with pipe axis. Mechanical joint end valves shall be of the short body type. Packing shall be O-ring cartridge designed for permanent duty in underground service.

All butterfly valves and operators shall conform to AWWA C504 for Class 150B service. Metal mating seat surfaces shall be 18-8 stainless steel or more. Each valve shall be provided with an operator with a torque rating at least equal to the torques listed in AWWA C504, Table 1. Butterfly valves shall be epoxy coated inside and outside conforming to ANSI/AWWA C550. All exposed valve bolts and nuts shall be stainless steel.

- C. Valve Ends:** Valve ends shall be of the mechanical joint type, conforming to ANSI A21.11 /AWWA C111 except where flanged ends are required on the Plans.

The end flanges of flanged gate valves shall conform in dimensions and drilling to ANSI B16.1 for cast-iron flanges and flanged fittings, Class 125, unless explicitly provided otherwise on the Plans or Standard Drawings. The laying lengths of the flanged valves shall conform to the dimensions of ANSI B16.10.

- D. Bonnet Thrust Plates:** The bonnet shall have a removable thrust plate to permit the removal and replacement of the valve stem and “O” ring seal while the valve is in service. All bolts and nuts in the bonnet shall be stainless steel.

- E. Tapping Valves:** The size and location of the tapping valves shall be as shown on the Plans or Standard Drawings. The valves shall be 200 psi, ductile iron body, resilient-seated gate valves with non-rising stems conforming with all applicable requirements of ANSI /AWWA C509 and C515, except that the outlet end shall be standard mechanical joint end conforming to ANSI A21.11 /AWWA C111 and the inlet end shall have an inlet flange conforming to ANSI B16.1 for cast iron flanges, Class 125.

F. Tapping Sleeves

1. **Stainless Steel:** The minimum working pressure rating shall be 150 psig. The height from the flange surface to the pipe centerline shall comply with MSS SP-111. Recess dimensions are per MSS SP-60.
 - a. **Top Shell:** The top shell shall be 18-8 Type 304 stainless steel, minimum 12 gauge thickness.
 - b. **Bottom Shell:** The bottom shell shall be 18-8 Type 304 stainless steel, minimum 14 gauge thickness.
 - c. **Flange:** The flange shall be 18-8 Type 304 stainless steel and shall have a 3/4-inch NPT test report.
 - d. **Gasket:** The tapping sleeve shall have a full circumferential gasket made of synthetic rubber.
2. **Iron:** The minimum working pressure rating shall be 150 psig. The tapping sleeves shall comply with MSS SP-111.
 - a. Tapping sleeves shall be cast iron complying with ASTM A 126, Class B or DI complying with ASTM A 536 and shall be compatible with the tapping valve.
 - b. Coating shall comply with AWWA C550.

- c. Cast iron tapping sleeves shall have MJ connection x flange end. The flange end shall include a recess to provide positive alignment of the tapping valve. Recess dimension are per MSS SP-60.
- d. Bolts shall comply with ANSI/AWWA C111/A21.11.

G. Stem Seals and Coatings

- 1. All valves shall be provided with stem seals of the “O” ring type. Two “O” rings shall be used with at least one “O” ring inserted above the thrust collar. The packing plate shall be attached to the valve bonnet by not less than three (3) bolts and one “O” ring below the thrust collar.
- 2. All exterior surfaces of each valve shall be cleaned and painted in the shop with two (2) coats of asphalt varnish conforming to Federal Specifications TT-V-51-E. The interior surfaces of resilient-seated gate valves shall have a protective coating of fusion-bonded, nontoxic epoxy which is safe for potable water.

H. Valve Operation: All valves shall be equipped with a 2-inch square wrench nut and the direction of rotation to open the valve shall be to the left (counterclockwise) unless otherwise noted in the Special Provisions.

I. Extension Stems: When the distance from the top of the valve cover to the valve operating nut exceeds 3 feet, each buried valve shall be provided with an extension stem and operating nut shall conform to the Plans or Standard Drawings.

J. Valve Boxes, Bases, Lids and Covers

- 1. One-piece Valve Box and Base: One-piece valve boxes and bases shall be injection molded plastic conforming to ANSI/ASTM D 2853-70, Class 1212.
- 2. Two-piece Valve Box and Base
 - a. Valve Boxes: In paved areas, including driveways and sidewalks, valve boxes shall be 6-inch, Class 52, DIP. In non-paved areas, the Contractor may use 6-inch, Class 152, PVC pipe.
 - b. Valve Bases: Valves bases shall be Clay & Bailey No. 2260-4 or an approved equal. Bases are required under all valve boxes.
 - c. Lids and Covers: Valve lids and covers for use in pavement shall be Clay & Bailey No. 2193, 2193NS or an approved equal. Valve lids and covers for all other areas may be Clay & Bailey No. 2196, or an approved equal. Valve lids shall have “Water” cast in the lid.

2902.4 Fire Hydrants

A. General: Fire hydrants shall be dry barrel, standard compression, two-piece standpipe, break-away design conforming to AWWA C502 and shall comply with one of the two types as follows or as noted in the Special Provisions:

- 1. Hydrants shall have minimum design working pressure of 150 psig and test pressure of 300 psig.
- 2. One 4.5-inch pumper nozzle, two 2.5-inch hose nozzles, 5.25-inch minimum mechanical valve opening left and 6-inch inlet connection.
- 3. Two 2.5-inch hose nozzles, 5.25-inch minimum mechanical valve opening left and a 6-inch inlet

connection.

4. Hydrants should be the same type, configuration, and color as the fire hydrants in use by the Owning Authority as noted in the Plans or Special Provisions.
- B.** Operating Nut Dimensions: Operating stem and nozzle cap nuts shall be 1.5-inch point to flat pentagon.
- C.** Nozzle Threads and Caps: Hydrant nozzles shall meet NFPA standard thread requirements. All nozzle caps shall be equipped with chains attached to the hydrant. All hydrant threads shall be oil lubricated by means of an oil reservoir or grease zerk.
- D.** Bury Depth: The bury length of hydrant barrel shall be determined by the depth from finish grade to the invert of the connecting pipe.
- E.** Extension Kits
1. Extension kits shall be supplied by the hydrant manufacturer.
 2. All extension shall be factory painted (baked on enamel) and shall match the color of the barrel section.

2902.5 Specials

- A.** General: Air release, meter, and pressure-reducing valve vaults shall be precast concrete conforming to ASTM C 478. Access lid castings shall be as shown in the Plans, Standard Drawings, or as noted in the Special Provisions.
- Vaults that must be cast in place due to their special nature shall conform to the Plans, Standard Drawings, and concrete specifications in Section 2902.8.
- B.** Pressure Reducing Valves: Pressure reducing valves shall be designed to provide tight shutoff under conditions of no flow and shall not "hunt" under ordinary flow conditions. Pressure reducing valves shall be as noted in the Special Provisions, selected and sized as recommended by the valve manufacturer. Pressure reducing valves shall be suitable for operation under the pressure and flow conditions as shown on the Plans.
- C.** Combination Air Valves: Combination air-release and vacuum-relief valves shall be installed at the locations indicated on the Plans. Each valve assembly shall be installed complete with appropriate piping and valves as shown on the Plans or Standard Drawings. All piping and isolation valves shall be brass except for the air outlet from the valve which shall be brass or copper tubing.
- Air releases for mains 12-inches in diameter or smaller shall have 1-inch combination air-release valves, APCO No. 143C or approved equal.
- D.** Blow-Off Assemblies: Blow-off assemblies shall be installed at the locations indicated on the Plans or Standard Drawings. Blow-off assemblies shall be installed with the appurtenant piping and valves as indicated on the Plans, Standard Drawings, or Special Provisions.
- E.** Corporation Cocks: The Contractor will furnish and install three-fourth inch (3/4") corporation cocks along the pipeline where necessary to vent the line during filling. The number and location of the corporation cocks shall be determined by the Engineer. After testing and disinfection of the line, the corporation cocks shall be removed and replaced with a tapered brass plug.

2902.6 Bedding Material

Granular Bedding Material: All materials used for granular embedment for pipe bedding shall conform to the requirements of ASTM C 33 and shall meet the graduation identified in Section 2102.4.G.

2902.7 Location Wire and Tape

Location wire or detection marking tape shall be buried above water mains.

- A. Location Wire: Location wire shall be a minimum 12 gauge copper clad steel (CCS), minimum break load of 280 lbs. with blue 30 mil HDPE jacket for open trench installations or 12 gauge copper clad steel (CSS), minimum break load of 1,100 lbs. with blue 45 mil HDPE jacket for directional drilling or jack and boring installations.
- B. Detection Marking Tape: Detection marking tape shall be solid aluminum foil core tape completely encased in polyethylene jacket, 5.5 mils thick minimum, and 6-inches wide.

The detection tape marking tape shall be blue in color and have "Buried Water Line Below" printed on the tape at 20- to 30-inch intervals. The detection and marking tape shall be installed directly above the centerline of the pipe and 18- to 24-inches below finish grade.

2902.8 Concrete

This specification is intended primarily for concrete thrust blocks, encasements and vaults. Concrete for all driveway, sidewalk, roadway pavement, and/or curb and gutter replacement shall conform to the requirements of Section 2301, 2302, 2200 and the appropriate authority having jurisdiction thereof.

The concrete shall be MCIB WA535-1/2-4 as designated by the Mid-West Concrete Industry Board, Inc., Kansas City, Missouri or approved KCMMB 4K mix as indicated on the Plans or Standard Drawings.

2902.9 Casing Pipe

Casing pipe shall be used where required at railroad or highway crossings. The casing pipe shall be in accordance with the Plans, Standard Drawings, or Special Provisions and meet the requirements of the railroad or highway authority with regard to type of material, wall thickness and coating of casing pipe. No casing will be installed without the approval of the involved highway or railroad authority.

- A. Material: New, smooth wall, welded steel pipe fabricated from ASTM A 36 plate or ASTM A 1011 sheet with minimum yield point of 36,000 psi, conforming to AWWA C200.
- B. Casing Thickness: The following table provides a listing of minimum casing diameters and thickness:

Casing Pipe Diameter (inches)	Nominal Wall Thickness (inches)	
	Under Highway	Under Railroad
12	0.188	0.282
14	0.188	0.282
16	0.188	0.282
18	0.250	0.312
20	0.281	0.344
22	0.281	0.375
24	0.281	0.406
26	0.312	0.438
28	0.312	0.469
30	0.312	0.469
32	0.344	0.500
34	0.344	0.531
36	0.344	0.531
38	0.344	0.531
40	0.375	0.563
42	0.375	0.563
44	0.375	0.563
48	0.375	0.563
50	0.406	0.625
52	0.406	0.625
54	0.406	0.625
60	0.450	0.650

- C.** Joints: All joints in steel pipe casings shall be field welded to conform to API 1104 or AWWA C206.
1. Clean to SSPC-SP3 and apply iron oxide field coating to all exterior joints after field welding.
 2. Clean to SSPC-SP3 and apply iron oxide field coating to all interior joints on 24 inch diameter casings and larger after field welding.
- D.** Factory Coatings and Linings: Coat exterior and line interior of all casing pipe with iron oxide primer applied at 33 microns (1.5 mils) minimum thickness. Hold coatings and linings back from end joints to be welded at least 2 inches each side of joint.
- E.** Casing Spacers
1. Casing spacers shall be used to install the carrier pipe inside the encasement pipe. Casing spacers shall fasten tightly onto the carrier pipe so that when the carrier pipe is being installed the spacers will not move along the pipeline. Casing spacers shall be doubled on each end of the encasement.
 2. Each casing spacer shall be capable of providing support for the carrier pipe in service at a maximum spacing of 10'. Calculations shall be provided to the Engineer by the casing spacer manufacturer showing that the casing spacer will support the service load at the recommended spacing, including a factor of safety of two (2). Casing spacers used under this specification shall meet or exceed the specifications described herein as projection-type that has a minimum of projections around the circumference totaling the number of diameter inches.
 3. Projection-type casing spacers panels, risers and fasteners shall be constructed of Stainless Steel

type 304. Casing spacer skirts shall be constructed of UHMV Polyethylene. Projection-type casing spacers shall be Power Seal Model 4810 or approved equal.

- F. End Seals: Power Seal Model 4810ES or approved equal.
- G. Sand: Clean, natural sand in accordance with ASTM C 33.

SECTION 2903 CONSTRUCTION

2903.1 Grading and Excavation

- A. General: Excavation and trenching work shall include the necessary clearing, grubbing, and preparation of the site; removal and disposal of all debris; excavation and trenching as required; the handling, storage, transportation and disposal of all excavated material; all necessary sheeting, shoring, and protection work; preparation of subgrades; pumping and dewatering as necessary or required; protection of adjacent property; and other appurtenant work.

Excavation and trenching work shall be performed in a safe and proper manner with suitable precautions being taken against all hazards.

The Contractor shall explore and expose any and all obstructions in advance of excavation so that minor changes in grade and alignment may be made.

In paralleling present water, sewer and gas mains, the Contractor shall protect all service connections and shall arrange to furnish service to the consumers with minimum interruption.

All excavated material shall be piled in a manner that will not endanger the work and that will avoid obstructing sidewalks and driveways. Gutters shall be kept clear or other satisfactory provisions made for street drainage.

- B. Classification of Excavated Material: No classification of excavated materials will be made. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the contract work regardless of the type, character, composition, or condition thereof. See Section 2100 "Clearing and Site Preparation".
- C. Blasting: When blasting is permitted by the Engineer, the Contractor shall use the utmost care to protect life and property. The Contractor shall obtain any required permits from the agency having site jurisdiction and shall comply with all laws, ordinances, and the applicable safety code requirements and regulations relative to the handling, storage and use of explosives and protection of life and property, and he shall be responsible for all damage caused by his or his subcontractor's operations.

The Contractor shall provide insurance as required by the Contract Documents before performing any blasting. The governing agency shall be notified at least 24 hours before blasting operations begin.

No blasting of any kind for rock excavations or any other purpose will be allowed unless noted otherwise on the Plans or permitted by the Engineer.

- D. Unauthorized Excavation: Any part of the trench excavated below grade shall be corrected with material approved by the Engineer placed and compacted by the Contractor to the satisfaction of the Engineer.
- E. Removal of Water: The Contractor shall provide and maintain adequate dewatering equipment to remove and dispose of all surface and groundwater entering excavations, trenches, or other parts of the work. Each

excavation shall be kept dry during subgrade preparation and continually thereafter until the structure to be built, or the pipe to be installed therein, is completed to the extent that no damage from hydrostatic pressure, flotation, or other cause will result.

All excavations for concrete structures or trenches which extend down to or below static groundwater elevations shall be dewatered by lowering and maintaining the groundwater surface beneath such excavations a distance of not less than 12-inches below the bottom of the excavation.

Surface water shall be diverted or otherwise prevented from entering excavated areas or trenches to the greatest extent practicable without causing damage to adjacent property.

The Contractor will be held responsible for the condition of any pipe or conduit which he may use for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment.

- F.** Sheeting and Shoring: Except where banks are cut back on a stable slope, excavation for structures and trenches shall be properly and substantially sheeted, braced, or shored as necessary to prevent caving or sliding, to provide protection for workmen and the work, and to provide protection for existing structures and facilities. Sheeting, bracing, and shoring shall be designed and built to withstand all loads that might be caused by earth movement or pressure and shall be rigid, maintaining shape and position under all circumstances.

Trench sheeting shall not be pulled unless pipe strength is sufficient to carry trench loads based on trench width to the back of sheeting.

Sheeting shall not be pulled after backfilling.

Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner which will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed after pipe embedment has been completed.

- G.** Stabilization: Trench bottoms shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud and muck; and shall be sufficiently stable to remain firm and intact under the feet of the workmen.

Trench bottoms which are otherwise solid but which become mucky on top due to construction operations shall be reinforced with one or more layers of crushed stone or gravel. Not more than 1/2-inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding material is placed thereon.

- H.** Trench Excavation: The Contractor shall not open more trench in advance of pipe laying than is necessary to expedite the work. One block or 300 feet, whichever is the shorter, shall be the maximum length of open trench ahead of pipe laying unless by written permission of the Engineer.

Except where tunneling or boring and jacking is specified and shown on the plan by the Engineer, all trench excavations shall be open cut.

- I.** Alignment and Grade: The alignment and grade or elevation of the pipeline shall be as shown on the Plans.

The Contractor must maintain a constant check of the pipe alignment and trench depth and will be held responsible for any deviations therefrom.

Unless otherwise shown or indicated on the Plans or unless otherwise set forth by the Engineer, the

horizontal and vertical alignment of the water main shall be maintained to within the following tolerances of 3-inches horizontally and 42" to 48" vertical depth of cover.

- J.** Minimum Cover: Except where otherwise shown, trenches shall be excavated to a depth sufficient to provide a minimum depth of backfill cover over the top of the pipe as indicated above. Greater pipe cover depths may be necessary on existing pipe, conduits, drains, drainage structures, or other obstructions encountered at normal pipe grades.

Measurement of pipe cover depth shall be made vertically from the outside top of pipe to finish grade or pavement surface elevations.

K. Trench Widths

1. Minimum Widths: Minimum trench widths shall be in accordance with the Plans, Standard Drawings, and manufacturers' recommendations.
2. Maximum Widths: The allowable maximum trench widths hereinafter specified apply only to that portion of the trench below the horizontal plane parallel to and six (6) inches above the top of the pipe. The allowable maximum widths may be exceeded at manholes, bore pits, tees, and in unstable earth material. Where the maximum trench width is exceeded the Contractor shall provide the appropriate strength class of pipe embedment to provide safe support strength to the pipeline.
3. When the side clearance exceeds two and one-half (2.5) times the outside pipe diameter at either side of a flexible conduit, it shall be the Contractor's responsibility at no additional cost to the Owner to provide bedding adequate to develop the required lateral support for the pipe and/or provide a pipe of sufficient strength class to accommodate the loading conditions as approved by the Engineer.

- L.** Unauthorized Trench Widths: When, for any reason, the width of the lower portion of the trench as excavated at any point exceeds the maximum permitted in the foregoing tables, either pipe of adequate strength, special pipe embedment, or arch concrete encasement, as required by loading conditions and as determined by the Engineer, shall be furnished and installed by and at the Contractor's expense.

- M.** Trench Bottom in Earth: The trench in earth shall have a flat bottom the full width of the trench and shall be excavated to the grade to which the pipe is to be laid. The surface shall be graded to provide a uniform bearing and continuous support for each pipe at every point along its entire length.

- N.** Rock Exploration: Unless shown otherwise on the Plans or noted in the Special Provisions, no rock exploration has been made. On those projects where rock exploration has been made, test holes have been drilled at locations and intervals as shown on the Plans or subsurface information report to determine the approximate location and depth of rock.

Resistance to penetration was assumed to be "solid rock." This information is furnished for general-reference purposes only.

The Contractor must form his own opinion as to the character of materials which will be encountered from an inspection in the ground, from his own investigation of the test hole information, or from such other investigations as he may desire.

- O.** Trench Bottoms in Rock: All rock excavation shall be carried to a minimum of 6-inches below the bottom of the pipe. Granular pipe embedment material shall be used to restore the trench bottom to the desired elevation and grade and to provide a uniform bearing and continuous support for the pipe along its entire length. Care shall be exercised to prevent any portion of the pipe from coming to bear on solid rock or

boulders.

- P.** Mechanical Excavation: The use of mechanical equipment will not be permitted in locations where its operations would cause damage to trees, buildings, culverts, or other existing property, utilities, or structures above or below ground. In all such locations, hand-excavating methods shall be used.

Mechanical equipment used for trench excavation shall be of the type, design, and construction and shall be so operated that the rough trench excavation bottom elevation can be controlled, that uniform trench widths and vertical sidewalls are obtained at least from the bottom of the trench, and that trench alignment will be centered in the trench with adequate clearance between the pipe and sidewalls of the trench. Undercutting the trench sidewall to obtain clearance will not be permitted.

All mechanical trenching equipment, its operating conditions, and the manner of its operations, shall be subject at all times to the approval of the Engineer.

- Q.** Stream Crossings: Stream crossings shall be made in accordance with these specifications and as shown on the Plans.

The trench width shall be as required for proper pipe installation and the trench depth shall be as required to give minimum cover shown on the Plans or Standard Drawings. Pipe encasement, where required, shall be in accordance with the specifications and placed as indicated on the Plans or Standard Drawings.

- R.** Highway and Railroad Crossings: The Contractor shall make highway and railroad crossing in accordance with the specifications, the Special Provisions and as shown on the Plans.

All construction or work performed and all operations of the Contractor, his employees, or his subcontractors within the limits of highway or railroad right-of-ways shall be in conformity with all the requirements, regulations and be under the control (through the Engineer) of the authority owning or having jurisdiction over and control of the right-of-way.

The Contractor shall pay fees and obtain permits to make the crossings unless otherwise directed.

2903.2 Installation

- A.** General: Laying of PVC pipe, ductile-iron pipe (DIP), and HDPE pipe installation of valves, and hydrants; and embedment and backfill shall conform to the following specifications and the details as shown on the Plans or Standard Drawings.

1. Unless otherwise specified or shown on the plans, the water mains shall be laid to have a minimum cover of 42-inches, measured from the finished grade or from established street grades shown on the Plans or Standard Drawings.
2. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug which will prevent trench water from entering the pipe.
3. Where the pipe is to be installed inside a casing pipe or tunnel liner, creosoted timber skids shall be strapped to each pipe before it is placed in the casing pipe or tunnel liner in accordance with the specifications and as shown on the Plans or Standard Drawings. Sand fill shall be used when shown on the Plans or Standard Drawings. The ends of each casing pipe or tunnel liner shall be closed with a dry brick wall or as shown on the Plans or Standard Drawings. The closures for each casing pipe or tunnel liner shall not be constructed until all testing of the line has been completed and accepted.

- B.** PVC Pipe: This specification addresses the installation of AWWA C900, C905, and C909 PVC pipe. Ductile iron fittings and valves are covered in other sections. PVC shall be installed to the minimum of AWWA C605 latest revision and per the specifications.
1. Handling: Pipe, fittings, and other accessories shall at all times be handled with care to avoid damage. Under no circumstances shall they be dropped. Pipe fittings shall be handled as specified for ductile-iron pipe. Any damaged pipe, fittings, or accessories shall be rejected.
 2. Cutting Pipe: All pipes shall be cut with a saw or special cutting tool. Cutting shall be done in a neat manner without damage to the pipe. Cuts shall be smooth, straight and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed and beveled. Beveling shall be done with a specifically designed beveling tool. Hand beveling will not be allowed. When cutting pipe with couplings, mark the field cut pipe end the same distance in as the mark appeared on the original full-length pipe section.
 3. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.
 4. Pipe Laying: PVC pipe shall be installed in strict accordance with the requirements and instructions of the pipe manufacturer. It shall be protected from lateral displacement and deflection by pipe embedment material installed as specified for pipe embedment and as shown on the Plans or Standard Drawings. No pipe shall be laid under unsuitable trench conditions. Whenever pipe laying is stopped, the open end of the line shall be sealed with a watertight plug which will prevent trench water from entering the pipe.
 5. Assembly: For push on pipe, the spigot shall be inserted into the bell to the line on the spigot. The previously completed joints must be braced so the line does not become "stacked", "over belled", or inserted past the reference mark on the spigot. If the insertion mark is not visible after assembly, the joints shall be disassembled and done correctly.
 6. Alignment: Piping shall be laid to the lines and grades as specified, as indicated on reference points, or as indicated on the Plans. The Contractor must obtain approval from the Engineer for any changes in the alignment or grade.
 7. Joint Deflection: Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line using joint deflection shall not exceed the pipe manufacturer's published axial joint deflection or 1-degree, whichever is less.
 8. Bending Pipe: The Contractor will not be allowed to bend PVC pipe. The Contractor shall use the CertainTeed High Deflection Coupling if joint deflection is insufficient and an 11-1/4 bend is too large of an angle.
 9. Mechanical Joints: Mechanical joints shall be carefully assembled in accordance with the manufacturer's recommendations. If effective sealing is not obtained, the joint shall be disassembled, thoroughly cleaned, and reassembled. Kor-Blue bolts, or approved equal, shall be used for all necessary assembly. Bolts shall be uniformly tightened to the torque values listed in ANSA/AWWA C111/A21.11. Over-tightening of bolts to compensate for poor installation practice will not be permitted.
 10. Push-on Joints: All joint surfaces shall be lubricated with heavy vegetable soap solution immediately before the joint is completed. Lubricant shall be stored in closed containers and shall

be kept clean. Each spigot end shall be suitably beveled to facilitate assembly.

11. Fittings: Unless directed otherwise by Engineer, Contractor shall determine the type and locations of bends required to complete the main installation. Mains shall be installed with the least number of bends practical. The Contractor will cut off the bevel of the PVC pipe before insertion into an MJ fitting.
12. Trace Wire: The Contractor shall install trace wire in the trench with the PVC pipe.
13. Thrust Restraint for PVC: Certa-lok restrained joint PVC shall be used or installed using the EBBA Iron 1900 Series restraint harness or approved equal according to the manufacturer's recommendations. Thrust restraint devices shall be provided on all pipe installed in encasement pipes and installed for street crossings.
14. Reaction Anchorage and Blocking: Where thrust restraint devices are inappropriate or when directed by the Engineer, concrete thrust blocks, thrust collars, or gravity blocks shall be used to prevent movement of the pipe caused by internal pressure.

C. Ductile-Iron Pipe (DIP)

1. Handling: Pipe, fittings and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, hauling, and laying pipe and fittings shall be such that the pipe, pipe coating, and fittings are not damaged. Hooks shall not be used. Under no circumstances shall pipe or accessories be dropped or dumped. Pipe and fittings on which the cement lining has been broken or loosened shall be replaced by the Contractor. Where the damaged areas are small and readily accessible, the Contractor may be permitted to repair the lining.
2. All pipe coating which has been damaged shall be repaired by the Contractor before installing the pipe.
3. Cutting Pipe: Ductile-iron pipe shall be cut with either a saw or an abrasive wheel. Cutting of existing cast-iron pipe shall be done with either a saw or abrasive wheel, or when there is a free end, with mechanical pipe cutters. The cutting of pipe with a torch will not be permitted.
4. Cutting shall be done in a neat manner without damage to the pipe, or the cement lining. Cuts shall be smooth, straight, and at right angles to the pipe axis. After cutting, the end of the pipe shall be dressed with a file to remove all roughness and sharp corners.
5. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted. Such surfaces shall be wire brushed, if necessary, wiped clean, and kept clean until jointing is completed.
6. Inspection: Pipe and fittings shall be carefully examined for cracks and other defects immediately before installation. Spigot ends shall be examined with particular care since they are vulnerable to damage from handling. All defective, damaged, or unsound pipe and fittings shall be rejected and marked as such and removed from the site of the work.
7. Push-on Joints: The gasket seat in the bell shall be wiped clean after which the gasket should be placed. A thick film of lubricant should be applied to the entire inner surface of the gasket and on the spigot end of the pipe. The lubricant and the gaskets shall be as recommended and supplied by the manufacturer of the pipe being used. The lubricant shall be odorless, tasteless, nontoxic,

and suitable for use in potable water. Field-cut pipe shall be beveled by filing or by mechanical means to remove any sharp or rough edges that might otherwise damage the gasket.

8. Mechanical Joints: Mechanical joint pipe shall be used only when shown on the Plans or Standard Drawings and shall be installed in strict accordance with the manufacturer's recommendations.
9. Flanged Joints: When bolting flanged joints, care shall be taken to ensure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell-and-spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.
10. Restrained Joints: Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations.
11. Alignment of Bell-and-Spigot Pipe: Pipelines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the quantities stipulated in Tables 4 and 5 of ANSI/AWWA C600.
12. Trace Wire: The Contractor shall install trace wire in the trench with the DIP pipe.
13. Laying Pipe: Pipe shall be protected from lateral displacement by pipe embedment material installed as specified. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

D. HDPE Pipe

1. Handling: HDPE pipe and fittings shall be handled to insure installation in a sound undamaged condition. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks, or allowed to roll down slides without proper retaining ropes. During transportation each pipe shall rest on suitable pads, strips, skids, or blocks securely wedged or tied in place. Any pipe that is scratched more than 10% of the wall thickness shall not be used.
2. Laying Pipe: HDPE pipe shall not be installed when trenches or weather conditions are not suitable for such work. HDPE pipe shall be installed in a trench with engineered embedment and backfill per the Excavation and Trenching section, except the bedding material particle size shall not exceed 1/2 inch for pipe smaller than 4 inches in diameter. The bedding material may be sliced in around the pipe.
3. Fusion: Sections of polyethylene pipe should be joined into continuous lengths on the jobsite above ground. The preferred joining method shall be the butt fusion method. The butt fusion equipment used in the joining procedures should be capable of temperature requirements of 400° F, alignment, and an interfacial fusion pressure of 75psi. Electrofusion couplings shall be used when butt fusion equipment cannot be used. Electrofusion coupling assembly shall be completed as scribed in the attachment at the end of this section. Socket fusion, hot gas fusion, threading, solvents, and epoxies will not be used to join HDPE pipe. The operator of the butt fusion or electrofusion machine shall be trained and certified by the fusion equipment supplier to operate the fusion machine.
4. Trace Wire: The Contractor shall install trace wire in the trench with the HDPE pipe.

E. Fusible Polyvinyl Chloride Pipe (FPVC)

1. Handling (Pipe): Pipe shall be loaded, off-loaded, and otherwise handled in accordance with AWWA M23 and all pipe suppliers' guidelines shall be followed. The use of chains, wire rope, chokers, or other pipe handling implements that may scratch, nick, cut, or gouge the pipe are strictly prohibited. Any scratch or gouge greater than 10% of the wall thickness will be considered significant and may be cause for rejection. Damaged areas may be removed by cutting, limits of acceptable length of pipe shall be determined by the Owner or Engineer.
2. Handling (Fittings and Accessories): Fittings and accessories shall be handled in a manner that will ensure installation in a sound, undamaged condition. Equipment, tools, and methods used in unloading, reloading, and hauling fittings and accessories shall be such that fittings and accessories are not damaged. Fittings on which the cement lining has been broken or loosened shall be replaced by the Contractor at his sole expense. Where damaged areas are small and readily accessible, the Contractor may be permitted to repair the lining.
3. Cutting Pipe: All pipe shall be cut with facing blades specifically designed for cutting fusible polyvinyl chloride pipe.
4. Cleaning: The interior of all pipe and fittings shall be thoroughly cleaned of foreign matter before being installed and shall be kept clean until the work has been accepted.
5. Inspection: FPVC pipe shall be installed in strict accordance with the requirements and instructions of the pipe supplier for open cut, horizontal directional drilling (HDD), or pipe bursting installation methods.
6. Alignment: Waterlines or runs intended to be straight shall be laid straight. Deflections from a straight line or grade shall not exceed the pipe suppliers recommended bending radius guidelines.
7. Laying Pipe: Pipe shall be protected from lateral displacement by pipe embedment material installed as specified. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.
8. Tracer Wire: The Contractor shall install trace wire in the trench with the FPVC pipe.

2903.3 Jointing

- A.** Push-on Joints: The gasket seat in the bell shall be wiped clean after which the gasket should be placed. A thick film of lubricant should be applied to all of the inner surface of the gasket and on the spigot end of the pipe.

The lubricant and the gaskets shall be as recommended and supplied by the manufacturer of the pipe being used. The lubricant shall be odorless, tasteless, nontoxic, and suitable for use in potable water.

Field-cut pipe shall be bevel filed to remove any sharp or rough edges which might otherwise damage the gasket.

- B.** Mechanical Joints: The mechanical joint shall be used only when shown on the Plans or Standard Drawings.
- C.** Flanged Joints: When bolting flanged joints, care shall be taken to ensure that there is no restraint on the opposite end of the pipe or fitting which would prevent uniform gasket compression or which would cause

unnecessary stress in the flanges. One flange shall be free to move in any direction while the flange bolts are being tightened. Bell-and-spigot joints shall not be packed or assembled until all flanged joints affected thereby have been tightened. Bolts shall be tightened gradually and at a uniform rate so that gasket compression is uniform.

- D. Restrained Joints: Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations.
- E. Fused Joints: Fusible polyvinyl chloride pipe lengths shall be assembled in the field with butt fused joint. Butt fusion shall be completed in strict accordance with the pipe suppliers' written guidelines for this procedure.
1. Butt fusion shall be performed by qualified fusion technicians as documented by the pipe supplier.
 2. Fusion joints shall be recorded and logged by an electronic monitoring device (data logger) connected to the fusion machine. The fusion data logging and joint report shall be generated by software developed specifically for the butt-fusion of fusible polyvinyl chloride pipe. The software shall register and/or record the parameters required by the pipe supplier and these specifications. Data not logged by the data logger shall be logged manually and be included in the Fusion Technician's joint report. Joint reports shall be submitted and approved by the pipe supplier prior to installation of any fusible polyvinyl chloride pipe.
 3. Only appropriately sized and outfitted machines that have been approved by the pipe supplier shall be used for the fusion process. Fusion machines must incorporate the following elements:
 - a. Heat Plate: Heat plates shall be in good condition with no deep gouges or scratches. Plates shall be clean and free of any debris or contamination. Heater controls shall function properly, cord and plug shall be in good condition. The appropriately sized heat plate shall be capable of maintaining a uniform and consistent heat profile and temperature for the size of pipe being fused per the pipe suppliers' guidelines.
 - b. Carriage: Carriage shall travel smoothly with no binding at less than 50 psi. Jaws shall be in good condition with proper inserts for the pipe size being fused. Insert pins shall be installed with no interference to carriage travel.
 - c. General Machine: Overview of machine body shall yield no obvious defects, missing parts, or potential safety issues during fusion.
 - d. Data Logging Device: An approved data logging device with the current version of the pipe suppliers' recommended and compatible software shall be used. Data logging device operations and maintenance manual shall be with the unit at all times. If fusing for extended periods of time, an independent 110V power source shall be available to extend battery life.
 4. Other equipment specifically required for the fusion process shall include the following:
 - a. Pipe rollers shall be used for support of pipe to either side of the machine.
 - b. A weather protection canopy that allows full machine motion of the heat plate, fusion assembly and carriage shall be provided for fusion in inclement, extreme temperatures, and /or windy weather, per the pipe supplier's recommendations.
 - c. An infrared (IR) pyrometer for checking pipe and heat plate temperatures.
 - d. Fusion machine operations and maintenance manual shall be kept with the fusion machine at all times.

2903.4 Connection to Existing Mains

The Contractor shall furnish and install all fittings necessary to join the existing and new water mains as shown on the Plans or Standard Drawings.

The Owning Authority shall be given at least 24 hours' notice prior to turning off any water supply mains. The Contractor shall coordinate tie-ins with the Owning Authority to minimize down time.

Connections shall be made using suitable fittings from the conditions encountered. Each connection with an existing pipe shall be made at a time and under conditions which will minimize any disruption in service. Special care shall be taken to prevent contamination when dewatering, cutting into, and making connections with existing pipe. The interior of all pipe, fittings, and valves installed in such connections shall be thoroughly cleaned and swabbed with, or dipped in chlorine solution having a chlorine content of 200 parts per million (ppm).

2903.5 Polyethylene Encasements

- A.** General: Polyethylene encasement shall be installed on ductile-iron pipe and fittings. The polyethylene shall prevent contact between the pipe, fittings, and the surround embedment.
- B.** Installation: The polyethylene encasement shall be installed as specified in ANSI/AWWA C105/A21.5 "Method A".
 - 1. Method A: Polyethylene tubing shall be approximately 2-feet longer than the length of the pipe section to provide a 1-foot overlap on each adjacent pipe section. Tube ends need not be taped in place unless directed by the Engineer.
 - 2. Repairs: Any rips, punctures, or other damages to the polyethylene shall be repaired with adhesive tape or with a short length of polyethylene tube cut open, wrapped around the pipe, and secured with adhesive tape as directed by the Engineer. Duct tape is not allowed.

2903.6 Setting Valves, Fittings and Hydrants

- A.** Valves and Fittings: All valves, fittings, plugs and caps shall be set and joined to the pipe in the manner heretofore specified for cleaning, laying and joining pipe, except that large valves may require special support so that the pipe will not be required to support the valve weight.

Each valve shall be inspected before installation to ensure that all foreign substances have been removed from within the valve body, and shall be opened and closed to see that all parts are in first-class working condition. Gate valves shall be set vertical in the horizontal pipeline.

Valves and pipe shall be supported in such a manner as to prevent stress in either with no deflection in the valve/pipe joint. Valve boxes and lids shall be installed at each valve and shall be supported and maintained centered and plumb over the operating nut of the valve. The valve box shaft shall not transmit shock or stress to the valve. Install valve box covers flush with the surface of the finished area or as directed by the Engineer.

All bends and tees shall be provided with thrust blocks of plain concrete, as specified. All dead ends on new mains shall be closed with plugs or caps suitably restrained to prevent blowing off under test pressure.

- B.** Hydrants: All new hydrant installations shall be as shown on the Plans or Standard Drawings and shall include all necessary excavation and backfill to make the installation complete.

Each hydrant shall be inspected before installation for direction of opening, nozzle size and threading, nozzle caps and chains, operating nut, and cap nut dimensions, tightness of pressure-containing bolting,

cleanliness of inlet elbow and weep hole openings, and handling damage and cracks. Defective hydrants shall be corrected or replaced.

All hydrants shall stand plumb. The weep holes of the hydrant shall be kept clear and free to drain. The areas around each hydrant and hydrant valve shall be thoroughly compacted to prevent settlement of these areas.

Hydrants shall be set to a grade that allows their proper operation. Traffic hydrants with breakaway joint must be set with the joint above the ground line. Hydrants behind curbs shall be placed with the hydrant centerline at least 24-inches from the back of curb or 4-feet from the edge of pavement when there is no curb. Hydrants shall be rotated so as to have the pumper nozzle facing the street or rotated to face any direction as required by the Engineer.

2903.7 Thrust Restraint

- A.** Hydrants: The back of the base elbow of each hydrant shall be braced against a sufficient area of unexcavated earth or rock with a concrete thrust block or be restrained by suitable restrained joints as shown on the Plans or Standard Drawings.
- B.** Fittings: All plugs, caps, tees, bends and other fittings, unless otherwise specified, shall be provided with reaction blocking or suitably restrained joints as shown on the Plans or Standard Drawings.
- C.** Thrust Blocks: Vertical and horizontal reaction blocking shall be concrete as specified herein. Thrust blocks shall be installed between solid ground and the fitting to be restrained. Concrete shall be located to contain the resultant thrust force and permit access to pipe and fitting joints for repairs.
- D.** Restrained Joints: Restrained push-on or mechanical joints, mechanical joint anchoring fittings, and mechanical joints utilizing set screw ductile-iron retainer glands may be used in lieu of concrete thrust blocking if so indicated on the Plans, Standard Drawings or as approved by the Engineer.

2903.8 Embedment and Backfilling

Embedment and backfill shall be accomplished in accordance with the laying condition as specified and as shown on the Plans or Standard Drawings.

- A.** Pipe Embedment: Embedment for pipe shall be in accordance with these specifications and details of the laying condition as indicated on the Plans or Standard Drawings. See Section 2100 "Clearing and Site Preparation".
- B.** Trench Backfill: Backfill for the entire length of the pipeline shall be compacted full depth of the trench above the embedment. See Section 2100 "Clearing and Site Preparation".
- C.** Placement and Compaction: See Section 2100 "Clearing and Site Preparation".

2903.9 Disinfection and Testing

- A.** Disinfection: After installation, the entire main shall be flushed and disinfected by chlorination. Flushing shall be carried out until turbidity-free water is obtained from all points along the main at the maximum velocity, which can be developed. The flushing velocity shall be at least 2.5 feet per second. All flushing shall be done in the presence of the Engineer. The Contractor shall notify the Engineer at least 24 hours in advance of the times and places which flushing is to be done.

The Contractor shall disinfect the main or prepare the main for disinfection by the Owning Authority when so noted in the Plans, Standard Drawings, or Special Provisions.

1. Chlorination by the Contractor shall conform to AWWA C651 and be performed using a one percent (1%) chlorine solution prepared from granular calcium hypochlorite (1 pound of HTH per 8 gallons of water). Water entering the new main shall receive a dose of the chlorine solution fed at a constant rate such that the water will have not less than 60 mg/l free chlorine.

**Chlorine Required to Produce 60 mg/l
Concentration in 100-feet of Pipe**

Pipe Diameter (Inches)	1% Chlorine Solution (Gallons)
4	0.16
6	0.36
8	0.65
10	1.02
12	1.44

2. The chlorinated water shall be retained in the main for at least 24 hours, during which time all valves and hydrants in the section treated shall be operated in order to disinfect the appurtenances.
 3. At the end of the 24-hour period, the treated water in all portions of the main shall have a residual of not less than 45 mg/l free chlorine.
 4. The Contractor shall dechlorinate the test water to 0 mg/L. Mains shall be flushed prior to placing in service. The flushing water shall be disposed of without damage to public or private property.
 5. The contractor shall repeat disinfection procedure should initial treatment fail to yield satisfactory results of a passing Bac-T test or minimum residual at no cost to the Owner.
- B.** Hydrostatic Testing: The Contractor shall perform hydrostatic pressure and leakage tests in accordance with AWWA C600 procedures. Where practicable, mains shall be tested in lengths between line valves or plugs of no more than 1,000 feet in length.

Conduct test at a pressure of 150 psi measured at the highest point of the main. Duration of the test shall be not less than 2 hours. Maintain pressure throughout test +5 psi of test pressure.

Leakage test shall be conducted concurrently with the pressure test. Acceptable when leakage does not exceed that determined by the following formula:

- L = $0.0000075SD(P)^{1/2}$, in which
 L = maximum allowable leakage in gallons per hour
 S = length of pipe tested in feet
 D = nominal internal diameter of pipe being tested in inches
 P = average actual leakage test pressure in psi (pounds per square inch)

When testing against closed metal-seated valves, an additional leakage per closed valve of 0.0078 gal/hr/in of nominal valve size shall be allowed. When hydrants are in the test section, the test shall be made against the closed hydrant. All visible leaks at exposed joints and all leaks evident on the surface where joints are covered shall be repaired regardless of total leakage as shown by test. All pipes, fittings, valves and other materials found to be defective under test shall be removed and replaced at the Contractor's expense.

Lines which fail to meet test shall be repaired and retested as necessary until the test requirements are met.

2903.10 Surface Restoration

- A. Seeding and Sodding: All unpaved areas cut by the line of trench or excavation or damaged during the work shall be seeded or sodded. Seeding and sodding shall conform to the requirements of Section 2400.
- B. Sidewalks and Driveways: All paved sidewalk and driveway areas cut by the line of trench or excavation or damaged during the work shall be replaced. Sidewalk and driveway replacement shall conform to the requirements of Section 2301 and Section 2302.
- C. Streets and Curbing: All paved street, shoulder and curbing areas cut by the line of trench or excavation or damaged during the work shall be replaced to conform to the lines and grades of the original pavement and shall be of equal quality, thickness and appearance to that removed.

Paving and curb replacement shall conform to the requirements of Section 2200.

SECTION 2904 WATER MAINS NEAR SEWERS

2904.1 Horizontal Separation

Water mains shall be laid at least 10-feet horizontally from any sewer. When local conditions prevent a lateral separation of 10-feet, a water main may be laid closer than 10-feet to a sewer, provided that the water main is laid in a separate trench, or on an undisturbed earth shelf located on one side of the sewer at such an elevation that the bottom of the water main is at least 18-inches above the top of the sewer. When it is impossible to obtain proper horizontal and vertical separation as stipulated above, the sewer must be reconstructed of ductile-iron pipe and should be pressure tested to assure water tightness before backfilling. The required length of sewer to be replaced will be the length necessary to achieve 10-feet horizontal separation.

2904.2 Vertical Separation

- A. Whenever water mains must cross above sewers, the water main shall be laid at such an elevation that the bottom of the water main is 18-inches above the top of the sewer. A full length of water main pipe shall be centered over the sewer line to be crossed so that the joints will be equally distant from the sewer and as far away as possible. This vertical separation shall be maintained for that portion of the water main located within 10-feet, horizontally, or any sewer it crosses.

When it is impossible to obtain minimum vertical separation set forth above, the sewer must be reconstructed of ductile iron pipe and shall be pressure tested to assure water tightness before backfilling.

- B. Where a water main must cross under a sewer, a vertical separation of 18-inches between the bottom of the sewer and the top of the water main shall be maintained, with adequate support, especially for the larger sized sewer lines to prevent them from settling on and breaking the water main. The sewer shall be reconstructed of ductile-iron pipe for a distance of 10-feet on either side of the crossing, and shall be pressure tested to assure water tightness before backfilling.

2904.3 Sewer Manholes and Inlets

No water pipe shall pass through, or come in contact with, any part of a sewer or a sewer manhole.

SECTION 2905 MEASUREMENT AND PAYMENTS

2905.1 Methods of Measurement

The quantities of completed work will be measured in the following units:

- A. Water Main - Pipe
 - 1. Open Trenched: Measurement of various size and types of water mains including fittings or bends, will be in linear feet, as called for in the Contract Documents and/or as shown on the Plans, based on field-measured lengths of acceptably installed pipe, as measured along the centerline thereof. Retainer glands, thrust blocks, encasement, location wire and tape, and other subsidiary items to the pipe will not be measured separately.
 - 2. Tunneled, Bored or Jacked: Measurement will be made in linear feet for the applicable size, and type of water main, tunneled, bored or jacked as called for in the Contract Documents and/or as shown on the Plans, based on actual field-measured lengths of acceptably installed pipe within casing or tunnel liner, including sand fill, end seals and other subsidiary items.
- B. Valves and Valve Boxes: Measurement will be made for the applicable size and type of valve, including valve boxes, bases, lids and covers, as determined by the quantity of valves installed.
- C. Fire Hydrants: Measurement will be made based on the actual number of hydrants installed as called for on the Plans or as directed by the Engineer. No measurement for payment will be made for branch piping, fittings, couplings, thrust blocks or other appurtenant items except valves and valve boxes.
- D. Specials (Meter Vaults, Air Valves, Pressure-Relief Valves, etc.): Measurement for these type items will be made based on the actual number of units installed, as called for on the Plans or as directed by the Engineer.

2905.2 Basis of Payment

Payment will be made at the respective unit or lump-sum price listed in the Contract Documents and shall be full compensation for all labor, materials, and equipment necessary to complete the respective unit in place. There will be no separate measurement or payment for any item of work not specifically identified and listed in the Contract Documents, and all such work shall be considered a subsidiary item with all costs pertaining thereto included in the prices for other items listed in the Contract Documents. At the Engineer's option, partial payment may be made for any lump sum item listed in the Contract Documents, providing that the Contractor is diligently and satisfactorily pursuing full completion of such partially complete item in accordance with the approved job progress schedule.

END OF SECTION