SECTION 8
WATER MAINS, FIRE LINES, AND WATER SERVICE LATERALS

8.01 GENERAL

A. Scope. The purpose of this Section is to govern the furnishing of all materials, labor, equipment, tools, superintendence, and other services necessary to construct water mains, fire lines, and water service laterals complete with appurtenances, including extensions and relocations, at the locations shown on the Drawings, and in conformance with these Specifications. References herein are to "City of Topeka and Shawnee County Standard Technical Specifications," unless otherwise noted.

B. One-Year Correction Period. All work specified herein is specifically identified as being subject to the one-year correction period, as covered under Article 13 "Warranty and Guarantee; Tests and Inspections; Correction, Removal or Acceptance of Defective Work" in the General Conditions This includes any trench settlement and leaks that occur within one year of the Final Completion date.

C. Traffic Control. The Contractor shall provide work zone traffic control for all water line work, as specified in Subsection 4.24 "Work Zone Traffic Control" unless otherwise indicated in the Contract Documents. Work zone traffic control shall be subsidiary to the water line work unless bid items for work zone traffic control are included in the bid form.

D. Excavation, Backfill, and Compaction. All excavation, backfill and compaction for water line work shall be as specified in Section 2 "Trench and Structure Excavation, Backfill and Compaction." Unless otherwise indicated in the Contract Documents, all excavation, backfill, and compaction for water line work shall be subsidiary to other bid items.

E. Pavement Restoration. The Contractor shall complete the removal, replacement, and restoration of pavements as necessary to complete water line work as specified in Subsection 4.06 "Pavement Removal and Replacement for Excavations." Unless otherwise indicated in the Contract Documents, this work shall be paid for as indicated in the bid form.

F. Submittals. Prior to Pre-Construction Meeting and before starting the Work, the Contractor shall submit electronic copies of the following information to the Engineer for review and approval as indicated in Subsection 1.05 "Shop Drawings and Engineering Data." Contractor shall include a letter of transmittal listing materials included with each submittal and a statement that "Contractor has reviewed included material(s) documentation and that same conform fully to the Drawings and Contract Documents requirements."

(1) Manufacturer's certification, representative test reports, and catalog cuts (as appropriate) for each material type and category proposed to be incorporated into the Work for: pipe; fittings; valves and lids; hydrants; backflow devices; air release valves; tracer wire; tapping sleeves; meter and backflow device vaults; manholes and vaults; bedding and backfill materials; and all other appurtenances and accessories supplied.

(2) Maintenance manuals for all mechanical equipment installed into the Work as requested.

(3) Manufacturer's warranty documents shall become effective as of Substantial Completion date and respective expiration dates shall be listed with Contractor's transmittal to the Engineer.

(4) Pipe laying schedule prepared by the Manufacturer for all ductile iron water line 16 inches in diameter and larger. This schedule shall be a station-to-station summary of all relevant information (e.g. size, thickness/classification, joint types, etc.) for all pipe, fittings, valves, and any other appurtenances to be incorporated into the Work.

G. Coordination of Work. All work shall be fully coordinated with other work, and submittals must be checked and approved for each of the trades. Conflicts in the sequence of the work shall be coordinated through consultation with the Engineer.

H. Quality Assurance. Items submitted for approval in accordance with the requirements of the Contract Documents shall be of the manufacturer indicated, or an Engineer approved equal, and in compliance with the approved submittals, and as specified herein. All pipe, fittings, valves and boxes, hydrants, and appurtenances shall be manufactured in North America.

I. Pre-Construction Survey. Prior to mobilization, the Contractor shall make photographic record of the Project site and surrounding properties from different vantage points. Construction limits shall be flagged prior to collecting photographs. The photographs shall be of sufficient detail to reveal the character of existing surfaces, including the condition of such features as pavement, curbs, sidewalks, driveways, and inlets which may be affected by construction operations. Document existing conditions adjacent to the Project site, and existing buildings both on and adjoining the Project site to accurately record the physical conditions at the start of the Work. All photographs shall be taken digitally and labeled. The label shall depict the location, purpose of the photo and any other descriptive characteristics needed for identification purposes. The Contractor shall submit a copy of the digital photos on a flash storage device or a mutually agreed file sharing website prior to commencement of construction operations to both the Owner and Engineer.

Video recordings in lieu of photographs are acceptable. The video recordings shall display continuous running time and date. Provide audio narration while the video recording is recorded including a description of items being viewed. Confirm the date and time at the beginning and end of each recording.

All property that is damaged by the Contractor during construction shall be repaired or replaced as directed by the Engineer to like-new condition regardless of its physical condition prior to the start of construction.

8.02 DISTRIBUTION AND FIRE LINE PIPE

A. Materials. This Subsection governs materials for pipe four inches in diameter and larger, in accordance with sizes and materials shown on the Drawings. Pipe 10 inches in diameter and 14 inches in diameter shall only be used in repair situations, subject to approval by the Engineer.

(1) Ductile Iron Pipe. Ductile iron pipe shall be used for all pipes 30 inches in diameter and larger unless alternate materials are shown on the Drawings and may be used for pipe 24 inches in diameter and smaller, subject to approval by the Engineer. Ductile iron pipe wall thickness shall be Class 51 unless otherwise indicated on the Drawings.

All pipe and pipe joints shall be bell and spigot, push-on type (e.g. American Fastite, U.S. Pipe Tyton) or welded, boltless restrained joint type (e.g. American Flex-Ring, U.S. Pipe TR Flex), welded-ring and restraint gland restrained joint type (e.g. Mechanical Joint Coupled Joint (American) and MECH-LOK (U.S. Pipe) and shall be AWWA C151/ANSI A21.51, as indicated on the Drawings. Acceptable manufacturers are AMERICAN, US Pipe, and McWane, or Engineer-approved equal.

The exterior of all ductile iron pipe shall be undercoated with a layer of arc-sprayed zinc per ISO 8179. The mass of the zinc applied shall be 200 g/m^2 of pipe surface area. A finishing layer topcoat shall be applied to the zinc. The coating system shall conform in every respect to ISO 8179-1 "Ductile iron pipes, fittings, accessories and their joints – External zinc-based coating – Part 1: Metallic zinc with finishing layer."

Exterior coatings shall be bituminous coal tar base not less than (NLT) 1-mil thick in accordance with AWWA C151/ANSI A21.51. Inside coatings for use under normal conditions shall be cement-mortar lining with a seal coat of bituminous coal tar base material in accordance with AWWA C104/ANSI A21.4, unless otherwise specified, in accordance with ANSI A21.4. Rubber joint gaskets shall be in accordance with AWWA C111/ANSI A21.11. Joint lubricant must be labeled with manufacturer's name and conform to ANSI A21.11. Normal laying length is 20 feet. Restrained joint pipe and welded thrust collar pipe shall be factory fabricated by only the pipe manufacturer.

(2) Polyvinyl Chloride (PVC) Pipe. PVC pipe may be used for all piping four inches in diameter through 18 inches in diameter, in accordance with the Contract Documents and as approved by the Engineer. PVC pipe may be used for piping 20 inches or 24 inches in diameter, as indicated on the Drawing. All PVC pipe shall be pressure class 235 unless otherwise indicated on the Drawings and shall be manufactured in accordance with AWWA C900. Pipe joints shall be bell and spigot, push-on type with integral elastomeric gasket, in conformance with ASTM D3139 and ASTM F477.

Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign material, blisters, and other visible deleterious faults. Pipe shall be manufactured from rigid polyvinyl chloride compound with cell classification 12454 as defined in ASTM D1784. Normal laying length is 20 feet.

(3) Fusible Polyvinyl Chloride (FPVC) Pipe. FPVC pipe may be used for all piping four inches in diameter through 18 inches in diameter, in accordance with the Contract Documents and as approved by the Engineer. FPVC pipe may be used for piping 20 inches or 24 inches in diameter, as indicated on the Drawing. All FPVC pipe shall be pressure class 235 unless otherwise indicated on the Drawings. All pipe shall be manufactured in accordance with AWWA C900. The ends shall be extruded with plain ends and shall be square to the pipe and free of any bevel or chamfer.

Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters or other visible deleterious faults. Pipe shall be manufactured from rigid polyvinyl chloride compound with cell classification 12454 as defined in ASTM D1784. Normal laying length is 40 feet.

(4) Molecularly Oriented Polyvinyl Chloride (PVCO) Pipe. PVCO pipe may be used

for all piping six inches in diameter through 12 inches in diameter, in accordance with the Contract Documents and as approved by the Engineer. All PVCO pipe shall be pressure class 305, unless otherwise indicated on the Drawings. All pipe shall be manufactured in accordance with AWWA C909. Pipe joints shall be bell and spigot, push-on type with integral elastomeric gaskets in conformance with ASTM D3139 and ASTM F477.

Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters or other visible deleterious faults. Pipe shall be manufactured from rigid polyvinyl chloride compound with cell classification 12454 as defined in ASTM D1784. Normal laying length is 20 feet.

(5) Restrained Joint Polyvinyl Chloride (RJ PVC) Pipe. RJ PVC pipe may be used for pipe four inches in diameter through 18 inches in diameter, in accordance with the Contract Documents and as approved by the Engineer. R J PVC pipe may be used for piping 20 inches or 24 inches in diameter, as indicated on the Drawing. All pipe shall be manufactured in accordance with AWWA C900. Pipe joints can be non-metallic mechanically restrained elastomeric bell and spigot joints of either coupled or integral bell type in conformance with ASTM F477. RJ PVC pipe that utilizes a metallic grip ring for restraint may not be used unless approved by the Engineer.

Pipe shall be homogeneous throughout and be free of visible cracks, holes, foreign material, blisters or other visible deleterious faults. Pipe shall be manufactured from rigid polyvinyl chloride compound with cell classification 12454 as defined in ASTM D1784. Normal laying length is 20 feet.

(6) Fire Line Piping. Either ductile iron pipe or PVC pipe may be used for private fire lines and fire loops. However, if PVC pipe is used it must be pressure class 305.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

(*)" DUCTILE IRON [WATER/FIRE] LINE, CLASS (XX)	Unit: Lineal Foot (L.F.)
(*)" PVC [WATER/FIRE] LINE, PC (XXX)	Unit: Lineal Foot (L.F.)
(*)" FPVC [WATER/FIRE] LINE, PC (XXX)	Unit: Lineal Foot (L.F.)
(*)" RJ DUCTILE IRON [WATER/FIRE] LINE, CLASS (XX)	Unit: Lineal Foot (L.F.)
(*)" RJ PVC [WATER/FIRE] LINE, PC (XXX)	Unit: Lineal Foot (L.F.)
(*)" RJ PVC [WATER/FIRE] LINE, PC (XXX), BY HDD	Unit: Lineal Foot (L.F.)

(*) – Nominal outside diameter of pipe.
(XX) – Special thickness class of ductile iron pipe.
(XXX) – Pressure class of PVC pipe.

(2) Measurement. Water mains and fire lines (i.e. water line) shall be measured by length of pipe installed to the nearest lineal foot for the various types and sizes. Final quantities will be computed from pipe manufacturers invoice amounts delivered to the jobsite, less waste and excess pipe.

(3) Payment. Payment for water mains and fire lines, measured as provided above, shall be made at the respective unit price per lineal foot included in the Contractor's bid. Such payment shall be full compensation for installed water line, completed and accepted, including all pipe, joint materials, tracer wire, tracer boxes, corrosion protection (ductile iron only), trenching, horizontal directional drilling (HDD), sheeting and shoring, cutting and fitting, laying, bedding, jointing, testing, backfilling, compaction, earthwork, grading, and any other incidental items required to complete the Work as detailed and specified.

8.03 FITTINGS

A. Materials. This Subsection governs materials for fittings four inches in diameter and larger, including tees, crosses, bends, reducers, sleeves, plugs, caps, swivel adapters, compression-style couplings, and tapping sleeves, as well as materials for mechanical joint restraint (MJR) devices, or retainer glands, used for the purpose of restraining a plain end of pipe at an MJ fitting.

(1) Mechanical Joint (MJ) Fittings. All MJ fittings shall be ductile iron and manufactured in conformance with AWWA C110/ANSI A21.10 (full-body type) or AWWA C153/ANSI A21.53 (compact type). MJ fittings 24 inches in diameter and smaller shall be pressure class 350 psi and may be full-body or compact. MJ fittings 30 inches in diameter and larger shall be pressure class 250 psi and must be full-body. All MJ fittings shall be lined and coated as specified for ductile iron pipe. All buried MJ fittings shall be furnished with full-body glands, Type 304 or 316 SS T-head bolts, and Type 304 or 316 SS nuts with PTFE coating. When indicated on the Drawings or provided by the Contractor, tie-rods shall be 316 SS with Teflon coated nuts and duc-lugs, either all-thread or eye-bolt type. Acceptable manufacturers include American, Tyler Union, or Engineer-approved equal.

(2) Mechanical Joint Restraint (MJR). All MJR devices shall be manufactured of ductile iron and factory coated. MJR devices shall consist of either multiple gripping wedges or a split or solid serrated ring incorporated into a follower gland meeting the applicable requirements of ANSI/AWWA C110/A21.10 and specifically designed for the respective pipe material being used. Split-ring restraints will not be permitted on new construction except under special circumstances. All MJR devices shall utilize a standard MJ gasket and match the standard MJ bolt circle. The wedge screws shall be compressed to the outside wall of the pipe, after fully setting the joint, with twist-off torque calibrated bolts/nuts to ensure proper actuating of the MJ restraint. MJR devices shall be epoxy coated. Restraint device shall be designed for a minimum working pressure of 350 psi. MJR devices are only required where noted on the Drawings. They may also be used in combination with an MJ fitting where a restrained joint (RJ) fitting is noted on the Drawings or where a fitting falls within the limits of RJ piping, as noted in the profile, for piping 12 inches in diameter and smaller. Blocking at MJ fittings where MRJ devices are installed is only required where noted on the Drawings. Acceptable manufacturers include ROMAC Grip Rings and EBAA Iron Mega-Lugs or Engineer-approved equal.

(3) Restrained Joint (RJ) Fittings. All RJ fittings shall be ductile iron and manufactured in conformance with AWWA C110/ANSI A21.10 (full-body type) or AWWA C153/ANSI A21.53 (compact type). RJ fittings 24 inches in diameter and smaller shall be pressure class 350 psi and may be full-body or compact. RJ fittings 30 inches

in diameter and larger shall be pressure class 250 psi and must be full-body. All RJ fittings shall be lined and coated as specified for ductile iron pipe. RJ fittings shall be welded, boltless restrained joint type (e.g. American Flex-Ring, U.S. Pipe TR Flex) and shall meet AWWA C151/ANSI A21.51. An MJ fitting with MJR may be used in place of an RJ fitting for sizes 24 inches in diameter and smaller unless otherwise indicated on the Drawings. Acceptable manufacturers include AMERICAN, US Pipe, and McWane, or Engineer-approved equal.

(4) Swivel Adapters. Swivel adapters shall be used between MJ fittings and MJ valves and between MJ valves and fire hydrants where noted on the Drawings. Acceptable manufacturers include Tyler Union and Star Pipe Products, or Engineer-approved equal. Fabricated swivel adapter fittings are not acceptable.

(5) Compression-Style Couplings and Caps. Special bolted, radial, compression-style couplings, both restrained and unrestrained, may be used to connect new piping to an existing main of unknown outside diameter (O.D.) using dedicated range, limited range, or wide range couplings as approved by the Engineer for sizes 2 inches to 24 inches nominal diameter in accordance with AWWA C219 and NSF 61. Restrained, compression-style caps may be used to cap an existing main when approved by the Engineer. Acceptable suppliers include Hymax and Romac, or Engineer-approved equal.

(6) Tapping Sleeves. Tapping sleeves shall be Power Seal Pipeline Products Model 3490AS MJ, Ford FTSS MJ, Mueller H-304MJ, JCM 439 or Engineer-approved equal. Tapping sleeves shall be stainless steel Grade 18-8, Type 304 per ASTM A240, full circle gasket type. All nuts and bolts shall be stainless steel (type 304) and PTFE coated nuts per ASTM A193 and A194. Outlet shall be integral MJ.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

(*)"x(*)" TEE	Unit: Each (EA)
(*)"x(*)" CROSS	Unit: Each (EA)
(*)" [90º/45º/22 1/2º/11 1/4 º] BEND	Unit: Each (EA)
(*)" [45 º/22 1/2 º/11 1/4º] VERTICAL BEND [(TOP)/(BOTTOM)]	Unit: Each (EA)
(*)"x(*)" REDUCER	Unit: Each (EA)
(*)" SLEEVE	Unit: Each (EA)
(*)" PLUG	Unit: Each (EA)
(*)" CAP	Unit: Each (EA)
(*)" [90º] SWIVELx[SOLID/SWIVEL] ADAPTER	Unit: Each (EA)
(*)" COUPLING	Unit: Each (EA)
(*)" RESTRAINED COUPLING	Unit: Each (EA)
(*)"x(*)" TAPPING SLEEVE	Unit: Each (EA)

(*) – Nominal outside diameter of pipe.

(2) Measurement. Fittings shall be measured per each fitting installed for the various types and sizes.

(3) Payment. Payment for fittings, measured as provided above, shall be made at the respective unit price per each included in the Contractor's bid. Such payment shall be full compensation for the installed fitting, completed and accepted, including the fitting and accessories, all labor, excavation, installation, jointing (including glands and MJR), concrete thrust blocking, strapping and anchoring, bedding, corrosive protection, sheeting and shoring, backfilling, compaction, testing, and any other incidental items required to complete the Work as detailed and specified. Temporary fittings not intended to be permanently incorporated into the Work may be reused and, only if undamaged, permanently incorporated into the Work with approval from the Owner's Representative. Temporary fittings not permanently incorporated into the Work shall be retained by the Contractor or salvaged and delivered to the Owner.

8.04 VALVES

A. Materials. This Subsection governs materials for gate valves, butterfly valves, air release valves, and combination valves, as well as materials for valve boxes and extension stems.

(1) Gate Valves. Unless otherwise indicated on the Drawings or directed by the Engineer, gate valves shall be used on all water mains smaller than 12 inches in diameter. Valves shall be NSF61 certified and be designed for buried service. The size and location of valves shall be as shown on the Drawings. Valve ends shall be MJ type, conforming to AWWA C111/ANSI A21.11. All gate valves shall be resilient-seated, pressure class 250 psi, MJ ductile iron body, bronze mounted with non-rising stems sealed with 3-O ring seals, clockwise to open, with 2-inch square operating nuts painted red. Gate valves shall conform to all applicable requirements of AWWA C509 or AWWA C515 and shall be epoxy coated inside and outside with NLT 8-mils DFT conforming to AWWA C550. All exposed valve bolts and nuts shall be 304/316 stainless steel with PTFE coated nuts conforming to ASTM A276.

The valve 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 bonnet shall be stainless steel. Acceptable resilient wedge gate valve manufacturers include Mueller Series A-2360 (A-2361 or A-2362), American Series 2500 MM or Engineer-approved equal.

(2) Butterfly Valves. Unless otherwise indicated on the Drawings or directed by the Engineer, butterfly valves shall be used on all water mains 12 inches in diameter and larger. Valves shall be NSF61 certified and be designed for buried service. The size and location of valves shall be as shown on the Drawings. Valve ends shall be MJ type, conforming to AWWA C111/ANSI A21.11. All butterfly valves shall be minimum 200 psi, cast iron body, configured with a horizontal valve shaft and a vertical actuator shaft with 2-inch square operating nuts painted red, clockwise to open. Butterfly valves shall be fitted with Buna-N seats, type 304 or 316 stainless steel shaft, cast iron disc with 316 stainless steel edge disc, and nylon self-lubricating shaft bearings, conforming to AWWA C504 Class 150B, and epoxy coated inside and outside conforming to AWWA C550. Valve discs shall seat at 90 degree with the pipe axis. All exposed valve bolts and nuts shall be 304 or 316 stainless steel with PTFE coated nuts conforming to ASTM 276.

Valve operators shall be designed for buried service, totally enclosed, permanently lubricated link lever traveling nut type designed to hold the valve in any intermediate

position between full-open and closed. Operators shall meet all minimum standards of AWWA C504. Operator shall be provided with a stop-limiting device capable of withstanding input torque of 300 ft-lbs at extreme operator positions without damage to operator or valve. The actuator size and corresponding number of turns to open/close shall be as listed below:

Valve Size (in.)	Actuator Size (Pratt)	# of Turns to Open/Close
12	MDT-3S	30
14	MDT-3S	30
16	MDT-3S	30
18	MDT-4S	40
20	MDT-4S	40
24	MDT-4S	40
30	MDT-5S	136
36	MDT-5S	136
42	MDT-5S	136
48	MDT-6S	215

Butterfly valves shall be "Ground Hog" model manufactured by the Henry Pratt Co. to the City of Topeka standard, or Engineer-approved equal.

(3) Extension Stems. Extension stems shall be fabricated from solid steel shafting not smaller in diameter than the stem of the valve. All connections shall be non-pinned. Pipe couplings will not be acceptable.

Extension stems shall be provided for buried valves when the operating nut is more than 5 feet below finished grade. Each extension stem for a buried valve shall extend to within 1 foot of the finished ground surface, without exception, and shall be provided with spacers, which will center the stem in the valve box, and shall be equipped with a 2-inch wrench nut painted red.

(4) Valve Boxes, Bases, Lids and Covers. All buried valves shall be provided with valve boxes. Valve boxes shall be 6-inch, PVC AWWA C900 Pressure Class 235 pipe.

Outside the traveled roadway, valve boxes shall be fitted with a cast iron, "flat top" lid imprinted with only "WATER". Lids shall be Clay & Bailey No. 2615-6 or Engineer-approved equal.

In pavement or gravel, valve boxes shall be fitted with a cast iron lid, traffic-rated ring and cover, and ring imprinted with only "WATER". Lid and cover shall be Clay & Bailey No. 2196, EJ 1577 Set, or Engineer-approved equal.

All parts of valve box extensions, lids, and covers shall be coated by dipping in bituminous 'varnish'.

Valve boxes that need extensions must be extended by approved method. All risers need to be sealed to prevent debris and infiltration.

(3) Air Release and Combination Valves. When required on the Drawings, air release

valves or combination air-release and vacuum-relief valves shall be installed with a 1-inch saddle tap and corporation valve on top centerline of pipe at highest elevation (2-inch on pipe sizes 16 inches or larger). The valve shall be set in a 1-inch service City Standard Meter Pit, with Top being removable and finished to grade.

Air release valves shall be float operated and shall incorporate a simple lever mechanism to enable the valve to automatically release accumulated air from a fluid system while that system is pressurized and operating. The isolation valve will normally be manually closed. Air release valve shall close drop tight. All internal metal parts shall be of stainless steel, withstanding a test pressure of 1,000 psig. The linkage/lever mechanism shall be designed to prevent jamming. The body and cover shall be of cast iron conforming to ASTM A126 Class B, shall be epoxy coated and shall be designed to withstand a test pressure of 450 psig.

The open end of the air relief pipe from an automatically operated valve shall be extended to at least 1 foot above grade and provided with a screened, downward-facing elbow. The open end of the air relief pipe from a manually operated air relief valve should be extended to the top of the pit.

For a vacuum relief valve, the open end of the relief pipe from a manual or automatic combined air/vacuum relief valve shall always be extended to at least 1 foot above grade and provided with a screened, downward-facing elbow.

All piping and isolation valves shall be brass except for the air outlet from the valve, which shall be cast iron or aluminum tubing which shall be painted. Each valve assembly shall be installed complete. Acceptable manufacturers include APCO Series 140C, G.A. Industries 945, Val-Matic 20XC, or Engineer-approved equal.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

(*)" BUTTERFLY VALVE AND BOX	Unit: Each (EA)
(*)" GATE VALVE AND BOX	Unit: Each (EA)
INSTALL (*)" BUTTERFLY VALVE AND BOX	Unit: Each (EA)
INSTALL (*)" GATE VALVE AND BOX	Unit: Each (EA)

(*) – Nominal outside diameter of pipe.

(2) Measurement. Fittings shall be measured per each valve installed for the various types and sizes.

(3) Payment. Payment for valves, measured as provided above, shall be made at the respective unit price per each included in the Contractor's bid. Such payment shall be full compensation for the installed valve, completed and accepted, including the valve (when furnished by the Contractor) and accessories, all labor, excavation, installation, jointing (including glands and MJR), support blocking, valve box, valve box ring and lid, corrosive protection, backfilling, compaction, testing, and any other incidental items required to complete the Work as detailed and specified. When the bid item begins with "Install" the valve shall be Owner-furnished. The Contractor shall still furnish all necessary accessories and will be responsible for the transport of the

valve(s) from the Owner's warehouse near the intersection of SW 19th Street and SW Western Avenue to the Project site.

8.05 FIRE HYDRANTS

A. Materials. This Subsection governs materials for fire hydrants, both public and private.

(1) Dry-Barrel Fire Hydrants. Dry-barrel fire hydrants shall be furnished with a 6-inch MJ inlet, have two 2.5-inch NST hose nozzles and a 4.5-inch pumper nozzle with City of Topeka standard thread, be traffic model with breakaway flange or coupling and safety stem, and in accordance with AWWA C502. All nozzles shall be of bronze and equipped with caps made of cast iron. Nozzle caps shall be attached to the hydrant body with a non-kinking chain and include a recess at the inner back edge of the cap threads to retain a replaceable gasket. Fire hydrant shall have tapered operating/nozzle cap nuts per City of Topeka standard (7/8-inch square at base by ¾-inch square at end, 1 to 2 inches long).

Fire hydrants shall have compression type 5.25-inch main shut-off valve, close with pressure and be equipped with replaceable minimum dual O-ring shaft seals, and capable of 200 psi working pressure and 400 psi test pressure. The unit shall be fully bronze mounted with replaceable bronze seats, bronze cap nut and weather cap. Direction to OPEN shall be clockwise, with an arrow and the word "OPEN" cast in relief on the hydrant top to indicate direction of opening. Hydrants shall be furnished with a 6-inch MJ boot, Buna-N gaskets, Type 304/316 SS bolts and nuts (Teflon coated) required for installation.

Fire hydrants shall have standard minimum depth of bury of four feet. Where the bury depth is greater than four feet, as indicated on the Drawings, Contractor shall either furnish a fire hydrant with the appropriate bury depth or furnish and install barrel extensions as required to fit final hydrant bury depth and finished grade requirements. Extensions shall be in 6-inch increments with the least number of extensions practicable to conform to the final hydrant bury depth required.

Fire hydrant main valve assembly shall include an automatic drain system that consists of two openings that are bronze or bronze-lined in the valve seat that are force flushed each time hydrant is operated and when hydrant valve is closed, the water retained in the body during operation will drain to the gravel placed around hydrant base or shoe, and close when hydrant is flowing. Drain valve seals shall be long-life, non-metallic material that are mechanically secured by non- corrosive fasteners. The drain system shall be free of devices requiring field adjustment. All surfaces of drain channel shall be bronze or they shall be protected with factory applied epoxy coating per AWWA C550.

Fire hydrants shall be painted with one-coat zinc-chromate primer (NLT 3-mils DFT) and two-coats premium enamel (each 3-mils DFT, 6-mils total). Buried portion shall have top coats black and brite hydrant red on exposed hydrant body. Pumper nozzle caps on all private hydrants, as designated by the Engineer, shall be painted Sherwin-Williams industrial yellow # B54- Y37. Friction losses through hydrant shall not exceed 2.5 psi at 1,000 GPM through pumper nozzle when tested per AWWA C502. Acceptable manufacturers include Mueller Super Centurion 250 Model A-423, and American Darling Model B-84-B-5, or Engineer-approved equal. All hydrants shall

have manufacturer 5-year warranty on materials and workmanship.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

FIRE HYDRANT Unit: Each (EA)
FIRE HYDRANT ADDITIONAL BURY DEPTH Unit: Vertical Foot (V.F.)

(2) Measurement. Fire hydrants shall be measured per each installed. Where the bury depth is greater than four feet, additional bury depth shall be measured in vertical feet to the nearest 0.5 feet.

(3) Payment. Payment for fire hydrants, measured as provided above, shall be made at the respective unit price per each included in the Contractor's bid. Such payment shall be full compensation for the installed fire hydrant, completed and accepted, including the fire hydrant and accessories, all labor, excavation, installation, jointing (including glands and MJR), corrosive protection, concrete thrust blocking, support blocking, drainage material, backfilling, compaction, testing, and any other incidental items required to complete the Work as detailed and specified.

Payment for fire hydrant additional bury depth, measured as provided above, shall be made at the respective unit price per vertical foot included in the Contractor's bid. Such payment shall be full compensation for the additional bury depth, including the extension(s) and/or added cost of fire hydrant, additional labor, additional excavation, and any other incidental items required to complete the Work.

8.06 TRACER WIRE

A. Materials. This Subsection governs materials for tracer wire, wire connectors, tracer boxes, and ground rods.

(1) Tracer Wire. All water mains and service lines shall be installed with tracer wire for locating. For open-trench installations, tracer wire shall be minimum 12 AWG solid steel core, soft-drawn tracer wire, average 250 lb. tensile break load with blue color 30-mil high molecular weight-high density polyethylene (HMW-HDPE) jacket complying with ASTM D1248, 30-volt rating. For horizontal directional drill (HDD) installations, tracer wire shall be minimum 12 AWG solid, steel core, hard-drawn extra high-strength wire, average 1,150 lb. tensile break load with blue color 45-mil HMW-HDPE jacket complying with ASTM D1248, 30-volt rating. For pipe bursting installations, tracer wire shall be minimum 7x17 stranded copper clad steel wire, average 4,700 lb. tensile break load with blue color 45-mil HMW-HDPE jacket complying with ASTM D1248, 30-volt rating. Minimum of 21% conductivity. Tracer wire shall be manufactured by Copperhead Industries, LLC, or Engineer-approved equal.

(2) Wire Connectors. To make wire connections water-tight and to prevent corrosion or any deterioration of electrical conductivity in the future, the twisted bare ends shall be sealed using water-resistant, pre-filled wire connectors designed for wet, damp, or corrosive wiring conditions and intended for direct burial. Wire connectors shall be Copperhead Industries, LLC model SCB-01, 3M DBO/B-6, or Engineer-approved

equal.

(3) Tracer Boxes. Tracer wire shall terminate at a magnetically detectible tracer box with a blue ABS cover. Tracer boxes shall be manufactured by Copperhead Industries, LLC, or Engineer-approved equal. For off-pavement installations, use SnakePit model LD14BTP. For low traffic and driveway installations, use SnakePit model CD14BTP.

(4) Ground Rods. All tracer wire dead-ends shall be connected to a ground rod. Grounding of trace wire shall be achieved using a 1.5-lb drive-in magnesium ground rod with 20 feet of copper-clad steel wire with 30-mil insulation rated for direct bury. Ground rod shall be buried at the same elevation as the utility. Ground rods shall be Copperhead Industries, LLC ANO-14 or Engineer-approved equal.

B. Bid Items, Measurement, and Payment. All materials and labor under this Subsection, described or implied, are subsidiary.

8.07 CORROSION PROTECTION

A. Materials. This Subsection governs materials for corrosion protection, including polyethylene encasement and securing tape.

(1) Polyethylene Encasement. All ductile iron pipe and all valves, fittings, and fire hydrant barrels (buried portion) shall be protected from corrosive soils and bury conditions using polyethylene encasement. Encasement shall be loose-fitting, 8-mil, low-density polyethylene (LDPE) in tube form conforming to AWWA C105 and sized for the pipe being protected. For valves, fittings, fire hydrants and other irregularly shaped applications, use sheets of polyethylene encasement 48 inches in width or wider.

(2) Securing Tape. Securing tape shall be two inches wide by 10 mils thick with one side adhesive. Securing tape shall be furnished by the polyethylene encasement manufacturer.

B. Bid Items, Measurement, and Payment. All materials and labor under this Subsection, described or implied, are subsidiary.

8.08 BEDDING MATERIAL

A. Materials. This Subsection governs bedding material.

(1) Bedding Material. Bedding material for all direct buried pipe shall be crushed limestone (i.e. 1/4" chip) provided however, for native soils that are sand, silt or silty sand; the pipe shall be bedded using the native soils. Bedding shall fully encompass the pipe from NLT four inches below bottom of pipe barrel to the top of pipe bell, from trench wall to trench wall. When trench is in shale or in rock, an additional two inches of bedding material shall be placed under the pipe barrel. Bedding aggregate should have the following characteristics:

Retained on No. 4 Sieve	20% ±10%
Retained on No. 8 Sieve	94%

Retained on No. 100 Sieve (wash) not less than	98%
Deleterious Substances, (max)	5%

B. Bid Items, Measurement, and Payment. All materials and labor under this Subsection, described or implied, are subsidiary.

8.09 CONCRETE BLOCKING

A. Materials. This Subsection governs concrete used for thrust blocking, gravity blocking, cradles, and anchorages.

(1) Concrete. Concrete used for thrust blocking, gravity blocking, cradles, and anchorages shall be Commercial Grade as defined in Section 5 "Concrete Pavement and Structures". Minimum 28-day compressive strength shall be 3,000 psi using Type I/II Portland cement. High-early strength concrete may be necessary for some tie-ins to limit service interruptions. Minimum 24-hour compressive strength shall be 3,000; minimum 28-day compressive strength shall be 3,500 psi. High-early strength concrete mixes shall use Type III Portland cement (Type I, II, or I/II cement may be used if strength and time requirements are met). Slump shall not exceed 3 inches.

B. Bid Items, Measurement, and Payment. All materials and labor under this Subsection, described or implied, are subsidiary.

8.10 THRUST COLLAR WITH CONCRETE BLOCK

A. Materials. The materials related to thrust collars and concrete blocks are governed by earlier Subsections.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

(*)" THRUST COLLAR AND PIPE	Unit: Each (EA)
(*)" THRUST COLLAR ON EXISTING	Unit: Each (EA)

(*) – Nominal outside diameter of pipe.

(2) Measurement. Thrust collars shall be measured per each installed for the various sizes. Measurement for water line piping is covered elsewhere.

(3) Payment. Payment for thrust collars, measured as provided above, shall be made at the respective unit price per each included in the Contractor's bid. Such payment shall be full compensation for the installed thrust collar, completed and accepted, including the thrust collar, whether factory fabricated on ductile iron pipe or field-installed on new or existing piping, all labor, excavation, installation, corrosive protection, concrete thrust blocking and steel reinforcement, backfilling, compaction, testing, and any other incidental items required to complete the Work as detailed and specified. When installed on new piping, the piping shall be paid for under other bid items.

8.11 MAKE CONNECTION TO EXISTING

A. Materials. The materials related to making connections to existing distribution, service line, and fire line piping and are governed by earlier Subsections.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

MAKE CONNECTION TO (*)" (XXX)
[WATER/SERVICE/FIRE] LINE; [LOCATION] Unit: lump sum (LS)

(*) – Nominal outside diameter of pipe.
(XXX) – Pipe material (abbreviated).
[LOCATION] – Station, street name, intersection, or other.

(2) Measurement. All connections to existing distribution system piping and to existing service lines and fire lines four inches in diameter and larger shall be measured by the lump sum. Connections to existing service lines and fire lines smaller than four inches in diameter are covered elsewhere.

(3) Payment. Payment for connections to existing piping, measured as provided above, shall be made at the respective lump sum price included in the Contractor's bid. Such payment shall be full compensation for making the connection to an existing line, completed and accepted, including all labor, coordination, excavation, cutting of the existing piping, dewatering the trench, backfilling, compaction, filling and flushing, testing, and any other incidental items required to complete the Work as detailed and specified.

8.12 WATER SERVICES

A. Materials. This Subsection governs materials for water services. All service materials shall be NSF 61 and NSF 372 product certified as applicable. For additional information, see "Water & Sewer Utility Services Installation Standards."

(1) Service Pipe. All new water service piping shall have minimum 1-inch nominal diameter from the main to the meter/setter. Water service piping for 1 to 2-inch water services shall be either Type K soft copper or high-density polyethylene (HDPE) SDR 9 tubing with CTS size, conforming with AWWA C901, with joints meeting AWWA C800 standards. All HDPE tubing shall utilize solid 304 tubular stainless steel insert stiffeners, dimpled and flanged to retain placement within the service line. 4-inch and Larger Service Pipe. Water service piping, fittings and valves and appurtenances shall conform with Section 8.02 for respective components.

(2) Tapping Pipe Saddles. For 2-inch mains, saddle shall be style model Ford S90-xxx Style A fabricated with stainless steel band and bolts with Teflon coated nuts and epoxy coated saddle fitted with heavy duty EPDM gasket sized for the pipeline material. For 4-inch and larger mains with 1 - 1.5 - 2-inch tap sizes, saddle shall be 2-piece bolted style model Ford S90-xxx Style A, 202B-xxx or 202BS-xxx per AWWA C800/ASTM B62 & B584, with AWWA tap threads and machined to rigid standards, with EPDM rubber gasket bonded in place per ASTM D2000, with lower

saddle of 18-8 type 304 stainless 3.25-inch wide band and with four 18-8 type 304 stainless 5/8-inch bolts welded to band and passivated to resist corrosion having coated SS hex nuts and SS washers.

(3) Corporation Stops. For Service pipe sizes 1 through 2-inch, corps shall be Ford Ballcorp model FB-1000-xx AWWA "CC" inlet threads in conformance with AWWA C800. In situations of a metal service line is installed (or existing) that is connected to a metal water main (installed or existing), a service insulator shall be installed for protection against service/main line electrolysis by using a Service Insulator.

(4) Adaptive Couplings. All copper and HDPE tubing couplings shall be Grip Joint Couplings and insert stiffeners, including copper gaskets when appropriate, as follows:

i. Straight Couplings:

Joint Coupling for copper or plastic tubing	Ford C44-xx
Male Iron Pipe for copper or plastic tubing	Ford C84-xx
Female Iron Pipe for copper or plastic tubing	Ford C14-xx
Female Copper Thread for copper or plastic tubing	Ford C04-xx

ii. Quarter Bends:

Pack Joint Ell Coupling x Copper or Plastic Tubing	Ford L44-xx

iii. Ball Valve Curb Stop (when required):

Ball valve for copper or plastic tubing	Ford B44-xxx

iv. Insert Stiffeners – stainless steel inserts:

304 tubular stainless steel insert (ASTM 240-92B)	INSERT-xx style

(5) Meter Setters, Meter Boxes/Pits, Rings and Covers, and Extension Rings, Meter and Meter Reading Unit. Shall be provided by the City and in conformance with the City of Topeka Water and Sewer Utilities Installation Standards.

B. Bid Items, Measurement, and Payment.

(1) Bid Items:

(*)" SERVICE LINE	Unit: Lineal Foot (L.F.)
(*)"x(*)" TAPPING SADDLE AND CORP STOP	Unit: Each (EA)
INSTALL (*)" METER, METER BOX/PIT AND TOP	Unit: Each (EA)

(2) Measurement. Service piping shall be measured by length of pipe installed to the nearest lineal foot for the various types and sizes. Final quantities shall be determined by measuring the amount of service line installed. Tapping saddle and corp stop shall be measured per each tapping saddle and corp stop installed for the various types and sizes. Meter package installation shall be measured per each meter package installed.

(3) Payment. Payment for service piping, measured as provided above, shall be made

at the respective unit price per lineal foot included in the Contractor's bid. Such payment shall be full compensation for installed service line, completed and accepted, including all pipe, joint materials, tracer wire, moling (under pavement), trenching, cutting and fitting, laying, jointing, testing, backfilling, compaction, earthwork, grading, and any other incidental items required to complete the Work as detailed and specified.

Payment for tapping sleeve and corp stop, measured as provided above, shall be made at the respective unit price per each included in the Contractor's bid. Such payment shall be full compensation for the installed tapping sleeve and corp stop, completed and accepted, including all labor, excavation, installation, repair of polyethylene encasement, backfilling, compaction, testing, and any other incidental items required to complete the Work as detailed and specified.

Payment for installation of meter, meter box/pit, and top, measured as provided above, shall be made at the respective unit price per each included in the Contractor's bid. Such payment shall be full compensation for the installed meter package, completed and accepted, including all labor, excavation, installation, materials for making connections to new and existing service line, inspection services, backfilling, compaction, testing, and any other incidental items required to complete the Work as detailed and specified. Though the meter package is Owner-furnished, the Contractor shall still furnish all necessary jointing and connecting accessories and will be responsible for the transport of the meter package from the Owner's warehouse near the intersection of SW 19th Street and SW Western Avenue to the Project site.

8.13 CONSTRUCTION/INSTALLATION REQUIREMENTS

The Contractor shall investigate all conditions affecting the work, arrange work procedures and schedule accordingly, and have, on hand, such pipe, fittings, valves, hydrants, accessories and bedding materials required and necessary to meet the project site conditions and provide a complete installation. Generally, construction and material installation shall conform to AWWA C600, "Installation of Ductile Iron Mains and Their Appurtenances", AWWA C605 "Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings" and AWWA Manual M23, "PVC Pipe - Design and Installation".

All work shall be performed and materials installed by qualified, trained and competent workers in strict accordance with the manufacturer's instructions and recommendations. Material suppliers shall have a responsibility to provide the Contractor services of a field representative to instruct and train the Contractor on proper handling and installation of water pipeline materials as outlined in this document.

New piping shall be laid to the elevations shown on the Drawings. Before installing new piping in any location where doing so will result in less than 42 inches of cover, the Contractor shall coordinate with the Project Representative for Engineer approval. In locations where new piping is installed beneath pavement, cover is measured from the bottom of pavement to the top of pipe.

A. Pipe and Materials Handling. All pipe, fittings, valves, hydrants and accessories shall be checked by the Contractor immediately upon delivery to the work site for compliance with this Specification and conformance to Engineer-approved submittals and for damaged or

defective material(s). Improper handling of pipe, fittings, valves, hydrants and accessories resulting in damage to respective material item(s) will be grounds for rejection of said material(s). Any damaged or defective material(s) so identified shall be moved to a nearby location and shall be removed from the work site within 24 hours of discovery.

All pipe and appurtenances are subject to inspection at time of delivery. Neither inspection nor failure to provide inspection shall relieve the manufacturer of the responsibility to provide materials that fully conform to these Specifications. All materials found or identified to not conform to these requirements shall be made satisfactory or be replaced. Any visible defect or failure to meet the quality standards herein will be grounds for rejection of those items.

All pipe and appurtenances (as applicable) shall be legibly and permanently marked with critical information, including nominal size, class and/or dimension ratio, applicable conformance standards (e.g. ANSI/AWWA/ASTM), manufacturer's name, production record code, seal or mark of testing agency verifying suitability of pipe material for potable water service and for use in fire protection systems (e.g. UL/FM/NSF, as applicable)

Handling (equipment) procedures shall be in accordance with the approved manufacturer's recommendations/guidance for proper handling of products to prevent harm to material(s) coatings and linings. Improper handling of pipe or materials that results in damage to interior lining or exterior coatings will be grounds for rejection of said items. The Project Representative will be the sole judge as to the acceptability of any material item as being acceptable or not for installation into the Work. Hooks shall not be used. Under no circumstances shall pipe or accessories be dropped or dumped.

Cutting of ductile iron pipe is discouraged; the Contractor is urged to plan the work to minimize the necessity for cutting. Cutting of ductile iron pipe that absolutely must be done for insertion of valves, fittings, or closure pieces shall be by use of manufacturer-approved cutting equipment, such as abrasive pipe saw, rotary wheel-cutter, guillotine pipe saw, milling wheel saw, or roller-chain cutter. Cut ends and rough edges shall be ground smooth and true. For push-on joint connections, the cut end shall be beveled by methods recommended by the pipe manufacturer. Pipe cuts for push-on joints shall be field marked for proper insertion lengths. The Work shall be done by workers trained and experienced in pipe cutting and shall be accomplished in such a manner to not damage the lining or coating of the pipe.

Upon delivery and again during installation, each pipe and fitting shall be inspected for defects, cracks and other deficiencies. The interior of all pipes, fittings and valves shall be thoroughly cleaned of all foreign matter before installation and shall be kept clean thereafter. Any coating damaged by the Contractor shall be repaired or replaced before placement into the Work. Damaged exterior coating shall be recoated to the satisfaction of the Engineer by applying coal-tar or other coating material as specified for the original coating for the protection of the materials being installed.

B. Grading and Excavation. Grading and excavation preparatory to pipeline and appurtenance construction shall be performed in accordance with Section 3 "Earthwork and Grading." All trenching shall be performed in accordance with Section 2 "Trench and Structure Excavation, Backfill and Compaction."

Grading and excavation 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 by the Engineer when required by field conditions. In paralleling existing water, furnish temporary service to the consumers with minimum interruption until permanent service can be restored by the Contractor.

C. Trench Excavation. The Contractor shall not open more trenches 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, boring, jacking, HDD or pipe bursting is specified and shown on the Drawings, all trench excavations shall generally be open-cut.

The Contractor shall excavate the bottom of the trench to the line, grade and elevation as shown on the Drawings. The excavation and the width of the trench shall be as specified in the City of Topeka's Standard Drawing Details. If the water main is being installed in a location where pavement is not otherwise planned for removal or replacement as a part of the same project, pavement removal shall be as specified in Subsection 4.06 "Pavement Removal and Replacement for Excavations."

No classification of excavated materials will be made unless otherwise indicated in the Contract Documents or provided for on the bid form. Excavation and trenching work shall include the removal and subsequent handling of all materials excavated or otherwise removed in performance of the Work regardless of the type, character, composition, or condition thereof. 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.

Any part of the trench excavated below required trench grade shall be corrected with placement of additional bedding material by the Contractor at no cost to the Owner. 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 workers. Unstable trench bottoms shall be stabilized as specified in Subsection 2.05 "Stabilizing Trench Bottoms." Trench bottoms that are otherwise solid but become mucky on top due to construction operations shall be reinforced with one or more layers of ¾" crushed limestone as approved by the Project Representative. Not more than ½-inch depth of mud or muck shall be allowed to remain on stabilized trench bottoms when the pipe bedding material is placed thereon. Under no circumstances shall the pipe be laid in water, and no pipe shall be laid under unsuitable trench conditions.

The alignment and elevation of the pipeline shall be as shown on the Drawings. The Contractor must maintain a constant check of the horizontal alignment and trench depth (i.e. vertical alignment) and will be held responsible for any deviations therefrom. Unless otherwise shown or indicated on the Drawings or unless otherwise set forth by the Engineer, the horizontal and vertical alignment for open-trench installations shall be maintained to within the following tolerances: Horizontal 3 inches; Vertical 1.5 inches. Allowable tolerances for HDD and other trenchless installation methods are specified elsewhere.

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 and as required in the Project Documents. Greater pipe cover depths may be necessary on existing pipe, conduits, drains, drainage structures, or other obstruction encountered at normal pipe grades. Measurement of

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

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 as show on the Drawings. The surface of pipe bedding shall be graded to provide a uniform bearing and continuous support for each pipe at every point along its entire length.

Unless shown otherwise on the Drawings 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 Drawings or a geotechnical report to determine soil types and depth of rock. Resistance to penetration was generally 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 that will be encountered from an inspection in the ground, from his/her own investigation of the test hole information, or from such other investigations, as he/she may desire.

All rock excavation shall be carried to a minimum of 6 inches below the bottom of the standard trench bottom. Bedding 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 and remove any rock or boulders from being placed (accidently or otherwise) within excavated trench to 2 feet above the pipeline. When borrow material is necessary to replace rock removed from the trench, it shall be considered subsidiary to the bid item “Rock Excavation.”

D. Limiting Trench Width. Trenches shall be excavated to a width that will provide adequate working space and pipe clearances for proper pipe installation, jointing and embedment. However, limiting the trench width below six inches above the top of the installed pipe shall be as shown on the Drawings or as detailed.

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 in accordance with Subsection 2.04 “Control of Ground Water and Surface Water.”

All excavations for concrete structures or trenches that extend down to or below static groundwater elevations shall be dewatered by lowering and maintaining the groundwater surface beneath such excavations a depth 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 that is used for drainage purposes, and all such pipes or conduits shall be left clean and free of sediment. Ground water shall be controlled as specified in Subsection 2.04 “Control of Ground Water and Surface Water.” Trench stabilization shall be as specified in Subsections 2.05 “Stabilizing Trench Bottoms” and 2.06 “Stabilizing Structure Subgrade.” Removal of water is subsidiary.

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 in accordance with Subsection 2.03 "Sheeting and Bracing." Trench shoring and bracing is subsidiary. Trench sheeting shall not be pulled unless pipe strength is sufficient to carry trench loads based on trench width and doing so will not disturb the design pipeline grade/alignment to the back of sheeting. Sheeting may not be pulled after backfilling, unless so directed by the Engineer. Where trench sheeting is left in place, such sheeting shall not be braced against the pipe, but shall be supported in a manner that will preclude concentrated loads or horizontal thrusts on the pipe. Cross braces installed above the pipe to support sheeting may be removed as pipe embedment is being completed.

G. Bedding. The Contractor shall not place bedding material until the excavation has reached the required sub-grade. Bedding shall be placed per AWWA Manual M23 for PVC, PVCO, and FPVC pipe and per AWWA Manual M41 for ductile iron pipe. Bedding for pipeline materials shall be as specified. Bedding shall be placed and compacted as specified for Type 'A' Compaction or as shown on the Drawings. Furnishing and placing bedding material is subsidiary.

H. Laying of Pipeline Materials. Every precaution shall be taken to prevent foreign material from entering the pipeline while materials are stored/stock-piled for use and while it is being placed. If the pipe laying crew cannot put the line into the trench without foreign material entering the pipe, the Engineer may require that the exposed end(s) of the pipe be enclosed so that the material cannot enter the exposed pipe. Pipe shall be placed in a flat bottom trench accurately graded and bedded to uniformly support the entire length of the barrel of the pipe with bell holes excavated for the joints.

At times when laying pipe is not in progress, the open ends of the pipe shall be closed or covered by use of watertight cap or plug secured in such manner that debris and/or water due to trenching or water line leakage, rainfall or infiltration cannot occur. The Contractor shall ensure that all pipe, fittings and valves are thoroughly cleaned of all foreign matter before installation and kept clean until the pipeline is put into service. 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 affected surfaces shall be wiped clean and, if necessary, wire brushed, and kept clean until jointing is completed.

Pipe shall not be laid in a wet trench. In the event surface or groundwater accumulates in the trench, the excavation shall be dewatered to permit the Work to continue. At times when the pipe laying is not in progress and at the close of the day's work or for other reasons, such as rest breaks or meal periods, the open end(s) of the pipe shall be closed by watertight cap or plug secured so that no water from the trench may enter the pipe. Sufficient backfill material shall also be placed over the pipe to prevent flotation.

If water accumulates in the trench, the watertight plug(s) shall remain in place until the trench is free of standing water and mud that may enter the pipe. Pipelines in place shall not be used for draining trenches. Dewatering of trenches is subsidiary.

Except where necessary for making connections with other lines, pipe shall be laid with the bells facing in the direction of progress. Except at closures, or when authorized by the Engineer, not more than two (2) lengths of pipe shall be in position ahead of each made-up joint. 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

appurtenances shall be rejected and marked as such and removed from the work site immediately.

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 for current or previously placed pipe(s). If the insertion mark is not visible after assembly, the joints shall be dissembled and reinstalled correctly. 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 via NSF61 approval. 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.

Restrained joints and anchoring joints shall be installed in strict accordance with the pipe manufacturer's recommendations and this Section.

Alignment of pipe or runs intended to be straight shall be laid straight. For ductile iron pipe, changes in horizontal or vertical alignment may be achieved by deflection at the joints when so indicated on the Drawings. Joint deflection shall not exceed the values listed in AWWA C600 for push-on type joints and mechanical joints or the pipe manufacturer's published limits, whichever is less. For gasket-joint and fused-joint PVC and PVCO pipe, changes in horizontal and vertical alignment may be achieved by longitudinal bending of the pipe barrel when so indicated on the Drawings. Longitudinal bending shall result in a bending radius not less than three-times the minimum listed in AWWA C605 or not less than three-times the manufacturer's minimum allowable bending radius, whichever is greater. When gasket-joint pipe is bent, the Contractor shall block or brace the pipe joints to ensure bending the pipe does not result in joint offset that exceeds the manufacturer's published limits. Pipe shall be protected from lateral displacement by pipe embedment material when being placed as specified.

I. Tracer Wire. Tracer wire shall be installed with all water mains and all fire lines along the top 120-degee sector of each pipeline and on all service laterals to the meter (required to be connected with main line tracer wire). Tracer wire shall be taped to the top of each pipeline at not greater than three-foot (3') intervals to retain the wire over the central top area of the pipe.

Tracer wire shall be extended to the ground surface and terminated in a tracer box. Tracer boxes shall be installed at all fire hydrants. Tracer boxes shall be located 12 inches from the barrel of the hydrant and positioned 180 degrees from the 4.5-inch pumper nozzle. Tracer wire shall also be extended into pits/vaults and manholes with 2-foot pigtail.

The Contractor shall prepare a continuity test on all tracer wire in the presence of the Engineer. If the tracer wire is found to be not continuous after testing, the Contractor shall repair or replace the failed segment of wire.

J. Corrosion Protection Wrap. The poly-wrap shall be wrapped as snugly as practicable without stretching or compromising wrap via soil/bedding compression or filling with bedding materials when backfilling trench. Any sections of wrap that are punctured or otherwise compromised in any manner during installation shall be either re-wrapped or the

original wrap removed/discarded and new poly-wrap installed. The poly-wrap tubing on pipeline sections shall be folded in a reasonably snug manner along the pipe length and taped at not greater than three-foot (3') intervals along the pipe length, with end wrap overlaps of 1-foot at each end and with outer layer ends taped around the full circumference of pipe or valve or fitting or hydrant barrel not less than three (3) full turns with tape. See DIPRA's "Polyethylene Encasement: Effective, Economical Protection for Ductile Iron Pipe in Corrosive Environments" for installation guidance.

K. Bedding and Cover. Initial Bedding material shall be placed in finished excavated trench bottom as shown on the Drawings and in accordance with trench conditions. Bedding material shall be spread in a uniform manner to provide a consistent support for pipe and other accessories when placed. When the correct horizontal and vertical alignment is confirmed, additional bedding material shall be "sprinkled" or "loosely spread" over the pipe and accessories in a fashion to assure material filling the space along the pipe haunches and so as not to displace alignment until material covers the pipe as required. Bedding material shall not be "dumped" into the trench or directly onto the pipe.

L. Fittings, Valves and Valve Boxes Installation. Fittings, valves, valve boxes and air release valves shall be installed at the locations shown on the Drawings. All valves and fittings shall be loaded and unloaded by lifting; under no circumstances shall valves be dropped, skidded, or rolled. Valves shall be stored at all times in a safe manner to prevent damage and kept free of dirt, mud, or other foreign matter. All valve gaskets shall be stored and placed in a cool location, out of direct sunlight and out of contact with petroleum products. All gaskets shall be used on a first-in, first-out basis. Gate valves and fittings shall be set and joined to new pipe in the manner specified herein for the placement and joining of pipe. All butterfly valves operators shall be oriented on the north or west side of the main.

Valves and valve boxes shall be firmly supported, centered, and plumbed over the operating nut of the valve, with the top of the box brought flush with the finished grade. After being placed in proper position, earth shall be filled in around each valve box and thoroughly tamped on each side of the box.

All connections requiring bolts shall be installed and tightened in strict accord with manufacturer's installation instructions. Jointing hardware shall not be over tightened but shall meet the recommended torque tightness in accordance with the manufacturer's installation instructions.

Chambers, vaults, and pits containing valves, blow-offs, meters, or other such appurtenances to the distribution system, shall not be connected directly to any storm drain or sanitary sewer. Such chambers, vaults, and pits shall be drained to the surface of the ground where they are not subject to flooding by surface water, or to absorption pits underground. Likewise, blow-offs, air relief valves, and combined air/vacuum relief valves shall not be connected directly to any sewer.

M. Anchoring and Blocking. All bends, tees, crosses and plugs installed shall be provided with concrete blockings and/or restrained joint type connections as specified or as shown on the Drawings. In all cases concrete shall conform to the dimensions and neat lines detailed on the Drawings and shall be placed directly against undisturbed trench wall opposing the thrust of the pipeline. The trench wall is to act as a form for the concrete. The edge of the block shall be vertical and shall be hand finished to a smooth, firm surface. If necessary for wall stabilization, the trench wall shall be given a "plaster" coat of cement mortar. No concrete

or blocking shall be placed within 3 inches of the jointing area. All blocking shall have formed neat lines and smooth (troweled) surfaces.

Valves that are not otherwise adequately restrained shall have a concrete thrust collar located on one side of the valve as shown on the Drawings. All in-line valves greater than 12 inches and any end of line valves shall be restrained to thrust collar pipe.

No concrete shall be placed until excavation has been approved by the Project Representative. Should over-excavation occur, the Contractor shall fill the over-excavated areas with concrete at their sole expense. All steel clamps, tie rods, anchor bolts and other structural or anchorage shapes used in anchors and blocking, but not encased in concrete, shall be stainless steel 304 or 316.

Concrete blocking shall not be backfilled over until 75% of the design compressive strength is attained based upon cylinder breaks or until the concrete has cured for 5 days.

If the blocking contains 1% calcium chloride and when approved by the Engineer, pressure testing can begin 3 days after the block has been poured.

N. Tapping Sleeves and Valves. Where shown on the Drawings, the Contractor shall furnish and install the tapping sleeves and valves. Service taps to water mains shall be performed by City employee under the direction of the Utilities Director or duly licensed contractors under the direct supervision of an employee of the Utilities Department.

O. Fire Hydrants. Hydrants shall be installed at locations shown on the Drawings or as directed by the Project Representative, and shall include all necessary excavation, bedding, blocking and backfill to make the installation complete. If the fire hydrant location is in a traffic area, it shall be positioned a minimum of three feet (3') from the back of curb with a minimum clearance of three feet (3') around the fire hydrant. Each hydrant shall be inspected before installation for direction of opening, nozzle sizes, threading, caps and chains, operating nut, tightness of pressure-containing bolting, cleanliness of inlet elbow and weep-hole openings and handling damage or cracks/chips. Defective hydrants shall be corrected or replaced.

Hydrants shall be set to a grade that allows their proper operation and installed plumb and true. The weep holes of the hydrant shall be kept clear and free to drain. Traffic hydrants will be set with the break-away joint above the finished grade line. The areas around each hydrant (and branch valve in turf/gravel) shall be thoroughly compacted to prevent settlement of these areas.

The Contractor shall "black bag" hydrant until operational and rotate the hydrant pumper nozzle for proper orientation, pumping nozzle facing adjacent curb unless directed otherwise, following the system becoming operational.

P. Backfill and Compaction. The Contractor shall not backfill over pipes before the Project Representative approves pipes as being set on line/grade and properly joined. Backfill and compaction shall be completed as specified in Subsections 2.09 "Compaction" and 2.10 "Backfill". Backfill and compaction are subsidiary.

Q. Connection to Existing Mains. Water shall not be allowed to flow from the new pipeline into existing pipelines until the new line has been thoroughly flushed, disinfected, tested and

approved by the Project Representative. Subsequent to approval, the Utilities Department will close the necessary valves and the Contractor shall make the connections at the locations shown on the Drawings using the types of fittings and lengths of straight pipe called-for or as may be required by field conditions. The Contractor shall excavate the main(s) to provide a safe working area of sufficient size for pipe removal and installation of new fitting(s), valve(s) and straight pipe.

The excavation shall extend below the pipeline to be removed to provide a minimum working space adequate to allow for pipe cutting, installation of fittings/valves, and collection/pumping of released water. For large-diameter interconnects, the Contractor shall place a 4-inch-thick concrete "working slab" a minimum of 2.5 feet below the new fitting(s) and valve(s) to be installed. This working slab is to provide temporary support of the new and existing piping/fittings until final blocking, bedding, and backfilling can be completed and is considered subsidiary.

It may become necessary to test the new pipeline in segments, omitting the required testing of some connections with existing pipelines as specified for new construction. In either case, the methods of testing and disinfection shall be approved by the Project Representative. This work shall be subsidiary.

The Contractor shall either employ the services of a mechanical contractor to air out any reconnected service line 4-inches in diameter and larger and all fire lines or make arrangements with the customer so that the customer's personnel may air out the service. The fire line backflow device shall be tested and reported as required. The mechanical contractor or certified backflow service contractor shall be duly experienced, licensed and permitted for this work. The cost of this work shall be subsidiary to the water line installation.

Connection to existing mains shall be so scheduled and timed as to cause the least possible interference with the operation of existing mains and service to existing customers, as approved by the Project Representative.

R. Temporary Blow-Off Assemblies. Temporary blow-off assemblies shall be constructed at the locations shown on the Drawings and in the manner indicated in the Contract Documents or as directed by the Engineer as necessary to pressure test and disinfect water pipes. Construction shall be as per the manufacturer's recommendations or as specified in the Project Documents. Blow-offs shall discharge at a location designated by the Engineer. Hosing may be required to convey blow-off to the desired point of discharge.

S. Conflicting Utilities. The Contractor shall excavate the utilities that are to be crossed by trenching and/or pot-holing a minimum distance of 150 feet in advance of the work-in-progress to allow the Engineer sufficient time to check the grades and to communicate with the owner(s) of those utilities reasonable time to relocate such conflicts, should that become necessary. Any delay resulting from the required relocation of a conflicting utility crossing or their appurtenances will not be grounds for granting any additional days or payment to the Contractor.

T. Pavement Replacement. Unless otherwise indicated in the Project Documents, the Contractor shall replace pavement as specified in Subsection 4.06 "Pavement Removal and Replacement for Excavations."

U. Surface Restoration. In areas where turf is the required restoration, the top portion of the

backfill beneath established finish grades shall be finished with not less than four inches of compacted viable topsoil and shall be topsoil salvaged during the excavation and trenching operation whenever practicable and as directed by the Project Representative. Immediately prior to dumping and spreading topsoil, the surface shall be loosened by disking or scarifying to a depth of two inches to permit 'bonding' of the topsoil to the underlying soil surface.

Areas designated with "topsoil and seeding" shall have topsoil pulverized and smoothed, fertilized, seeded, rolled to press seed into soil and mulched. Areas designated to be "sodded" shall have topsoil pulverized and smoothed, designated variety of sod grass placed with tight joints and staked, followed by rolling of entire area to smooth, level and compact the sod and topsoil layers.

V. Stream Crossings. Stream crossings shall be made in accordance with these Specifications and as shown on the Drawings. The trench width shall be as required for proper pipe installation and the trench depth shall be sufficient for a minimum of seven feet (7') of cover over the top of pipe beneath a navigable or unnavigable streambed. Pipe encasement, where required, shall be in accordance with the Specifications and placed as indicated on the Drawings. All work performed and all operations of the Contractor, their employees, or his subcontractors within the limits of stream crossing shall be in conformity with all the requirements, regulations and be under the control (through the Project Representative) of the authority owning or having jurisdiction over and control of the stream.

At stream crossings where the pipe is to be installed inside a casing pipe or tunnel liner, polyethylene casing spacers shall be strapped to each pipe before it is placed in the casing pipe or tunnel liner in accordance with these Specifications and as shown on the Drawings. The ends of each casing pipe or tunnel liner shall be closed with a single piece pull over neoprene rubber end seal with a minimum thickness of 1/8-inch with stainless steel bands or as shown on the Drawings. The closures for each casing pipe or tunnel line shall not be constructed until all testing of the line has been completed and accepted. The work shall be performed in accordance with Subsection 2.12, "Tunneling and Boring".

W. Highway and Railroad Crossings. The Contractor shall make highway and railroad crossings in accordance with these Specifications, the Special Provisions and as shown on the Drawings. All work performed and all operations of the Contractor, their employees, or their subcontractors within the limits of highway or railroad rights-of-way shall be in conformity with all the requirements and regulations and be under the control (through the Engineer) of the authority owning or having jurisdiction over and control of the right-of-way.

At highway and railroad crossings where the pipe is to be installed inside a casing pipe or tunnel liner, polyethylene casing spacers shall be strapped to each pipe before it is placed in the casing pipe or tunnel liner in accordance with these Specifications and as shown on the Drawings. The ends of each casing pipe or tunnel liner shall be closed with a single piece pull over neoprene rubber end seal with a minimum thickness of 1/8-inch with stainless steel bands or as shown on the Drawings. The closures for each casing pipe or tunnel line shall not be constructed until all testing of the line has been completed and accepted. The work shall be performed in accordance with Subsection 2.12, "Tunneling and Boring".

X. Water Services.

(1) Service Connection Taps. The Contractor shall furnish and install the tapping saddle and corp stop; the Utilities Department will make the actual wet tap. Service

taps to water mains shall only be performed by City employee under the direction of the Utilities Director or duly licensed contractors under the direct supervision of an employee of the Utilities Department. After the tap is complete, the Contractor shall complete the piping connections and set the meter setter, box, and cover.

(2) Service Connection Pipe: 1", 1.5" and 2". Piping shall be continuous from main to meter box with no intermediate couplings, unless approved by the Engineer. Polyethylene water service line must be laid with tracer wire using metal inserts with all fittings. Note that three-inch (3") piping of any kind shall not be permitted between the main and the meter.

(3) Service Connection Pipe: 4" and larger. Pipe installation shall conform with mainline pipe of corresponding sizes and materials. All service pipe shall be laid with tracer wire.

8.14 ABANDONMENT / SALVAGE OF UNUSED WATER MAINS - SERVICES

A. Abandonment Requirements. All existing water mains, appurtenances or service lines that will not be re-used in the new construction, or re-used for reconstruction of existing building sites shall be abandoned in a manner pre-approved by the Engineer. All water main appurtenances (valves, hydrants, etc.) shall be abandoned by removal of subject appurtenances and installing a plug or cap, as appropriate, using type 304/316 SS bolts and nuts (Teflon coated).

Main, appurtenance and/or service abandonment at the street main shall be a condition of any site demolition permit(s) issued or in the case of duplication, service lines that will remain unused on new or reconstruction. All water service lines 2-inch diameter and smaller shall be abandoned by turning off the corporation tap stop valve, disconnecting and removing 2 – 3 feet of service line, removing corp valve and installing a standard brass plug on saddle. The brass cap (and plug) shall be Ford copper tube nut with FIP on the small end and MIP nut (part # C01.xy and C08.ab) or as approved by the Engineer. The remaining service line may remain abandoned in place.

B. Salvage Requirements. The Contractor shall carefully remove and salvage valves, fittings or other designated waterline appurtenances and transport them to a location designated by the Engineer. Removal shall include any concrete blocks interfering with the removal of the designated item or interfering with intended extension or modification of the waterline. No extra payment shall be made for the removal and disposal of concrete or blocks.

Removal of valves, fittings, or other appurtenances shall be accomplished by unbolting the valve or fitting, if possible. If corrosion prevents removal by unbolting, the item shall be removed by neatly cutting or sawing the existing water line or appurtenance as close to the item as possible. Where the existing line is to remain in service, removal shall be accomplished in such a manner that rejoining of the water line can be accomplished with as few joints and/or sleeves as possible. Where the existing water line is to be abandoned in place, it shall be plugged with concrete or another suitable device to provide a permanent watertight seal.

Items to be salvaged and removed shall be lifted and handled with care and in no case shall be dropped, thrown, skidded or rolled. The Contractor shall clean salvaged items to be free

of dirt and debris prior to delivery to the Owner.

8.15 PRESSURE TESTING AND LEAKAGE ALLOWED

A. General. After installation, all newly installed mains shall be flushed and pressure/leakage tested and disinfected by chlorination prior to final acceptance. All flushing work shall be done in the presence of the Project Representative. The Contractor shall notify the Project Representative at least 24 hours in advance of the times and places at which flushing work is to be done and how it is to be performed. Water Division personnel will operate all existing system valving and Contractor-installed valves that control flow of potable water, with the Contractor manipulating the new water main valve(s) and hydrant(s) to slowly fill the new main and remove/expel all air from the section of water line being tested. When hydrants are in the test section, the test shall be made against closed hydrant valve(s); all new service or fire lines shall be tested to their terminus.

Pipe and accessories to be tested shall be filled slowly with potable water at a maximum velocity of 1.0 ft per second while venting air. After filling, lines shall be flushed at blow-offs and dead-ends at a minimum velocity of at least 3.0 feet per second in the pipeline being tested. Flushing shall be carried out until turbidity-free water (i.e., < 5 NTU or system ambient values) is obtained from all points along the main. Certain contaminants, such as caked deposits, resist flushing at any feasible velocity and pigging of the main may be required.

A minimum of one (1) change of treated water (up to three changes without charge to Contractor for water volume usage) shall be used in the flushing operations. A special pipeline pig may be required when the flushing velocity cannot be achieved or when necessary to conserve water during water use restriction period, to remove caked deposits, or to prevent erosion damage, nuisance, or traffic interruption, as directed by the Project Representative. The Contractor shall make provisions for launching and retrieving the pig at no additional charge or cost to Owner.

Valves shall be closed slowly to prevent excessive surges, while also maintaining positive pressure at all times throughout the pipeline section being tested. Flushing water shall be discharged without causing erosion damage, nuisance, or interruption of traffic. Flushed water will be tested for total chlorine residual and if greater than 0.5 mg/L, then discharged water shall be de-chlorinated by the Contractor using an Engineer-approved method as provided herein.

The Contractor shall provide the pressure gauges with a range of 0 – 200 psig and intervals not exceeding 5 psi, a measuring meter capable of reading to nearest 0.10-gallon increments, an injection booster pump, pipe/hoses, connections and other necessary apparatus and the necessary labor to conduct the test. Prior to filling the pipeline test section and performing the actual test, and before placement of final surfacing, the Contractor shall place sufficient backfill and thrust blocking or other types of restraining systems to prevent pipe movement.

When existing water mains are used to supply test water, they shall be protected from backflow contamination by method approved by Engineer. Tests shall be performed only after the pipeline test section has been properly filled, flushed, and purged of air. When hydrants are in the pressure test section, the test shall be made against the closed hydrant valve.

The specified test pressure shall be applied by means of an approved pumping assembly connected to the pipeline in a manner approved by the Project Representative. The test pressure shall not exceed the design pressure of the pipe, fittings, valves, hydrants, and thrust restraints as herein provided. During testing, the system and exposed pipe, fittings, valves, and hydrants shall be carefully inspected for leakage; visible leaks shall be stopped and defective elements shall be repaired or removed/replaced and the test repeated until the pressure test requirements have been met.

The Contractor shall perform hydrostatic test (pre-test) of the test segment at the specified test pressure. The pre-test shall continue until the Contractor has satisfied himself that the test segment will pass the hydrostatic test. In general, pressure and leakage testing shall conform to applicable sections of AWWA C600 and C605 and as required herein.

B. Test Duration. The duration of the final hydrostatic test shall be a minimum of two hours at the required pressures for the test section. The pipeline shall be allowed to stabilize at the test pressure before conducting the hydrostatic test. This may require several cycles of pressurizing and bleeding trapped air prior to beginning the final test.

C. Test Pressure. The test pressure shall be no less than 150 psig for PVC, PVCO, FPVC, and ductile iron pipelines. The hydrostatic test pressure shall not be less than 1.25 times the stated sustained working pressure at the highest elevation along the test section, and not less than 1.5 times the stated sustained working pressure at the lowest elevation of the test section. In the event that the lowest and highest elevations of the section being tested exceeds 58 feet, the pipeline section to be pressure tested shall be reduced in length such that the segment to be tested conforms with the foregoing criteria and pressure requirements.

The hydrostatic test pressure shall not vary by more than +/- 5.0 psig for the duration of the test period. The test pressure shall be maintained within this tolerance by adding make-up water through the metered pressure test pump into the pipeline test segment. All make-up water added shall be accurately measured in gallons (and fractions thereof) by suitable methods. The total make-up water added during and at the conclusion of the test period to reach the required test pressure shall not exceed the calculated leakage allowance for the pipeline segment being hydrostatically being tested.

D. Testing Allowance; Leakage. No pipe installation will be accepted if the leakage is greater than that determined by the following formulas for PVC, PVCO, FPVC or ductile iron. When multiple pipe sizes are concurrently being tested, the allowable leakage shall be calculated based on the sum of leakages determined for each size of the tested segment. No pipe installation will be accepted if the actual measured leakage is greater than that determined by following formula.

$$Q = \frac{L \times D \times P^{0.5}}{148{,}000}$$

where,
Q = allowable leakage, in gallons per hour
L = length of pipe tested (by size), in feet
D = nominal diameter of the pipe, in inches
P = average test pressure during the leakage test, based upon high and low

points within the segment size tested, in pounds per square inch

The above equation is based on a leakage rate of 10.5 gallons per day per mile per inch of nominal diameter of pipe. Leakage values determined by the above formula for 1,000 feet of pipe are presented in AWWA C600 and AWWA C605.

During the test, the new system and exposed pipe, fittings, valves, and hydrants shall be carefully examined for leakage. Visible leaks shall be stopped. Defective elements shall be repaired or removed and replaced and the test repeated until the test requirements have been met.

A swift loss of water pressure in the main could be the result of a break in the line, major valve opening, loose mechanical joint bolts, a missing or dislodged gasket, or inadequate thrust blocking. A slow loss of pressure in excess of allowable limits could be the result of minor problems such as a leaking valve or a corporation stop not completely shut off. In addition, air entrapped in the line can result in an apparent leakage in excess of the allowable limit.

Recommendations for avoiding minor leaks include the following:

- Vent all high points in the line by use of air release valves, corporation stops, or hydrants.
- Check all mechanical joint bolted connections.
- Cure concrete thrust blocks before testing.
- Ensure that exposed gasket grooves are properly cleaned before inserting gaskets.
- When inserting pipe into a mechanical joint or gasket joint, ensure that the spigot end is squarely cut and beveled properly for the hub.

One approach for determining if the apparent leakage is the result of air entrapped in a line is to immediately repeat the leakage test (i.e., continue the test for another two hours) and determine the amount of make-up water required to fill the line a second time. If this amount is significantly less than the first filling, the difference in apparent leakage is probably the result of air being present in the line. If no significant difference in make-up water is recorded, a leak is probable.

8.16 DISINFECTION OF PIPELINE

A. General. While bacteriological testing in accordance with this subsection is used to verify the absence of coliform organisms and is generally accepted as verification that disinfection of the pipeline has been accomplished, adequate flushing of the line before disinfection is necessary to ensure that the disinfected pipeline will be ready for connection to the water system. Failure to pass the bacteriological test requires that the flushing or disinfection process be repeated by the Contractor. It must be remembered that the final water quality test is not the primary means for certifying the sanitary condition of a main. The sanitary handling of materials, the practices during construction, and the continual inspection of the Work are the primary means for ensuring the sanitary condition of the water main.

Of the three methods described in ANSI/AWWA C651, only one method will generally be described herein for use: the continuous feed method. Of the three forms of chlorine that may be used in the disinfection operations, only two (2) forms will be acceptable for use: sodium hypochlorite solution and calcium hypochlorite granules mixed into solution conforming to ANSI/AWWA B300.

Sodium hypochlorite solution contains approximately 5 % to 15 % available chlorine, and the storage conditions and time (age) must be controlled to minimize its deterioration. Available chlorine refers to the amount of chlorine equivalent to hypochlorite in terms of oxidizing power. It is a measure of strength and bleaching power and, in one or another of its related units of measurement, denotes the concentration of the bleach solution.

$$\text{Trade percent available chlorine} = \frac{\text{gpl available chlorine}}{10}$$

(Eq 1, AWWA B300 II.B)

Calcium hypochlorite is available in granular form and must contain approximately 65 % available chlorine by weight. Prior to use, the material should be stored in a cool, dry, and dark environment to minimize its deterioration. Do not use calcium hypochlorite intended for swimming pool disinfection, as this material has been sequestered and is extremely difficult to eliminate from the pipe after the desired contact time has been achieved.

B. Basic Disinfection Procedure. The basic disinfection procedure consists of multiple steps and procedures to ensure successful disinfection of the pipeline.

(1) Inspecting materials delivered to the work site and at the time of installation to ensure their integrity.

(2) Preventing contaminating materials from entering the water main during storage, construction, or repair and noting potential contamination at the construction site.

(3) Removing by flushing minimum 3.0 ft/sec or other means as necessary, those materials that may have entered the water main or accessories.

(4) Chlorinating any residual contamination that may remain and flushing the chlorinated water from the main.

(5) Protecting the existing distribution system from backflow caused by

hydrostatic pressure test and/or disinfection procedures.

(6) Documenting that an adequate level of chlorine contacted each pipe and accessory to provide disinfection.

(7) Determining the bacteriological quality by laboratory test after disinfection procedures.

(8) Final connection of the approved new water main to the active distribution system.

The continuous feed method consists of mixing the hypochlorite granules into a concentrated mixture to create a strong chlorine concentrated solution and feeding the solution into the pipeline to achieve an initial free chlorine concentration throughout the pipeline. The potable water and chlorine solution shall result in the entire pipeline and components being disinfected with a free chlorine residual of not less than 10 mg/L after a 24-hour holding period.

At a point not more than ten feet downstream from the beginning of the new main, water entering the main shall receive a dose of chlorine fed at a constant rate such that the water will have not less than 25 mg/L initial free chlorine in the pipeline. To ensure that this concentration is provided, measure the chlorine concentration at regular intervals in accordance with the procedures described in the current edition of *Standard Methods for the Examination of Water and Wastewater*, or AWWA Manual M12, or using appropriate Serim Monitor for Chlorine free chlorine test strips as manufactured by www.SanitationTools.com. Solutions of 1 percent free chlorine may be prepared with either type hypochlorite granule. Calcium hypochlorite solution requires one lb. of granule in 8 gallons of water.

Chlorine application shall not cease until the entire main and all included accessories are filled with heavily chlorinated water. The chlorinated water shall remain in the main for at least 24 hours, during which time valves, hydrants, and service lines in the treated section shall be operated to ensure disinfection of the appurtenances. At the end of this contact period, the treated water in all portions of the main shall have a residual of not less than 10 mg/L of free chlorine.

C. Final Flushing. After the applicable retention period, heavily chlorinated water should not remain in prolonged contact with the pipe. In order to prevent damage to the pipe lining or to prevent corrosion damage to the pipe and appurtenances, the heavily chlorinated water shall be flushed from the main, fittings, valves, and all branches until chlorine measurements show that the concentration in the water leaving the main is no higher than that generally prevailing in the distribution system or that is acceptable for domestic use.

The environment to which the chlorinated water is to be discharged shall be inspected. If there is any possibility that the chlorinated discharge will cause damage to the environment, the Contractor shall apply a neutralizing chemical to the water to be wasted to thoroughly neutralize the residual chlorine. State and local regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water. Chlorine residual of water being disposed shall be neutralized by treating with ascorbic acid. Periodic grab samples shall be taken after a travel distance of about 250 to 300 feet from the de-chlorination chemical addition point with chlorine residual being measured. De-chlorination chemical

addition will be adjusted to achieve a chlorine residual of not more than 0.2 mg/L.

D. Bacteriological Samples and Testing. In conformance with Option B of AWWA C651, section 5.1.1.1, after the flushing and disinfection procedures have been accomplished, representative samples will be collected for each increment of 1,200 feet or portion thereof and from the beginning and from the end of the line and on all branch lines by trained Water Division personnel. Samples shall be analyzed promptly following collection by a State recognized water testing laboratory for: chlorine residual, turbidity, pH, and a standard heterotrophic plate count (HPC) test, including coliforms. Unless otherwise provided, the Topeka Water Treatment Plant laboratory will perform bacteriological analyses of the first and second series of samples on each test segment without charge. A record or report of the bacteriological test results for each sample tested shall be provided to the Contractor and to Project Representative for the Owner's project record files.

If sample results from the lab indicate a measured HPC greater than 500 colony-forming units per milliliter (CFU/mL), flushing should be resumed and another series of bacteriological samples collected and analyzed until no coliforms are present and the HPC is less than 500 CFU/mL. If the initial disinfection fails to produce satisfactory bacteriological results or if other water quality is affected, the main test segment may be re-flushed and shall be re-sampled. If check samples also fail to produce acceptable results, the main test segment shall be re-chlorinated by the continuous feed method until satisfactory bacteriological results are obtained.

All additional flushing, disinfecting, bacteriological sampling, and analyses costs, including the Project Representative's time, over and above a second series may be back-charged to the Contractor.

E. Final Connections to Existing Mains. All water mains and appurtenances must be completely installed, flushed, and disinfected, and satisfactory bacteriological results received prior to permanent connections being made to the active distribution system. Sanitary construction practices must be followed during installation of the final connection(s) so that there is no contamination of the new or existing water main with foreign material or trench /ground water.

Connections shall have all pipe, fittings, and valves required for the connection sprayed with a minimum of one to five percent (1%-5%) solution of chlorine just prior to being installed. After the spraying procedure, the ends of the piping must be covered with plastic wrap, a watertight plug(s), a watertight cap(s), or means acceptable to Project Representative.

8.17 SEPARATION OF WATER MAINS AND OTHER POLLUTION SOURCES

The Contractor shall notify the Engineer in accordance with requirements of the Kansas Department of Health and Environment (KDHE), if, during the performance of the Work, the Contractor encounters or uncovers a known or unknown source of pollution. The Engineer will inspect the known or suspected point of pollution and advise the Contractor as to what course of action shall be taken prior to continuation of the installation of the water main or appurtenances.

A minimum horizontal distance of 10 feet shall be maintained between the barrel OD of new main and any sanitary or combined sewer main or manhole. When the new water main or appurtenance crosses below the sanitary sewer or is within two feet above the sanitary sewer, the sewer shall be encased in concrete a distance of 10' on either side of the crossing or

constructed of ductile iron pipe conforming to ASTM A536 or AWWA C151, minimum thickness class 50 with gasketed, push-on or mechanical joints conforming to AWWA/ANSI C110/A21.1 or AWWA/ANSI C111/A21.11, or PVC pipe conforming to ASTM D3034 with minimum wall thickness SDR 26, ASTM F679, or ASTM F794, with gasketed push-on joints in conformance with ASTM D3212 or as detailed on the Drawings.

For pressure sewer lines there shall be at least 2 feet vertical separation at crossings, with the water mains always crossing above sewer force main. Where it is not practical to maintain the horizontal or vertical separation between the water main and the sanitary force main, an equivalent protection method may be substituted on a case-by-case basis if supported by data and consultation from the Engineer and approval by KDHE.

A minimum distance of 25 feet shall be maintained between all potable water lines and all pollution sources, e.g., septic tanks, septic tank absorption fields, waste stabilization ponds, sewage contamination, wastewater, landfill leachate, and all CAFO facilities. Under no circumstances shall a water line be extended through an area that is a real or potential source of contamination to the water line or water supply. Under no conditions shall the encasement of a water line be considered as adequate protection of a water line or a water supply for the purpose of extending the water line through a real or potential source of contamination.

END OF
SECTION