

SECTION 2576**SANITARY SEWER FORCE MAINS (INTERIM)****PART 1: GENERAL****1.1 GENERAL DESCRIPTION OF WORK COVERED**

Furnish and install all pipe, fittings, structures and accessories required for sanitary sewer force mains.

1.2 QUALITY ASSURANCE**1.2.1 AWWA Standards**

Construction materials and methods shall comply with the requirements of the latest published edition of American Water Works Association (AWWA) Standards. Applicable standards include, but may not be limited to, the following:

1	AWWA C110, C110a	Gray Iron and Ductile Iron Fittings, 2-inch through 48-inch for Water and Other Liquids
2	AWWA C111	Rubber Gasket Joints for Cast Iron Pressure Pipe and Fittings
3	AWWA C151	Ductile Iron Pipe, Centrifugally Cast in Metal Mold or Sand Lined Molds, for Water or Other Liquids
4	AWWA C153	Ductile Iron Compact Fittings, 3-inch through 12-inch for Water and Other Liquids
5	AWWA C213	Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines
6	AWWA C301	Prestressed Concrete Cylinder Pipe (PCCP), 16-inch and Larger
7	AWWA C509	Gate Valves
8	AWWA C550	Protective Epoxy Interior Coatings for Valves and Hydrants
9	AWWA C900	Polyvinyl Chloride (PVC) Pressure Pipe 4-inch through 12-inch for Water
10	AWWA C950	Glass Fiber Reinforced Thermosetting Resin Pressure Pipe

1.2.2 ASTM Standards

In addition, construction materials and methods shall also comply with the requirements of the latest published editions of the American Society for Testing and Materials (ASTM) Standards.

PART 2: MATERIALS AND EQUIPMENT**2.1 GENERAL**

All items furnished shall be new and unused. Pipe to be furnished will be PVC Pressure Rating 160 SDR26 per ASTM D2241 with epoxy lined Ductile Iron fittings unless shown otherwise on the plans and bid documents. All pipe, fittings and accessories shall be suitable and rated for appropriate pressure use. SDR32-5 pipe may be approved for low pressure force mains.

2.2 DELIVERY, STORAGE AND HANDLING

Certificates of compliance with specifications shall be required for all materials used on the project. All materials shall be protected during transportation, storage, handling and

installation to avoid physical damage. All materials shall be stored to prevent physical deterioration due to sun and weather. The ECUA reserves the right to reject material which in any way does not meet the requirements of these Specifications.

2.3 FORCE MAINS

2.3.1 Polyvinyl Chloride Pipe (PVC)

PVC pipe shall meet ASTM D2241, AWWA C900 or C905 Standards, with minimum designations per table below. PVC pipe shall be provided with push-on joints with bell integrally cast into pipe, and shall be installed with elastomeric gaskets, as provided in ASTM F477.

TABLE 2.3 - PVC PIPE STANDARDS					
Standard	Nominal Size	Dimension Ratio	OD	Pressure Class (psi)	Pressure Rating (psi)
ASTM D2241	2"-18"	SDR26	IP	(128)	160
ASTM D2241	3"-18"	SDR32.5	IP	(100)	125
AWWA C900	4"-12"	DR25	CI	100	(165)
AWWA C905	14"-36"	DR25	CI	(100)	165

A. Markings

PVC pipe shall be marked to indicate the following:

1. Nominal Pipe Size and OD Base
2. Material Code Designation
3. Dimension Ratio
4. Pressure Class or Pressure Rating
5. Manufacturer's Name or Trademark
6. Appropriate AWWA or ASTM Designation Number

B. Color-Coding

One of the following methods of color-coding the pipe shall be used:

1. 3 brown stripes (1/2 inch high) with permanent ink along the entire length of white pipe with the word "FORCE MAIN" in 3/4 inch letters every 21 inches along each stripe.
2. Brown pigment to color entire pipe.

2.3.2 Ductile Iron Pipe (DIP)

Ductile iron pipe shall meet AWWA Standard C151 and pressure class based on Table 2.3.2 below for design operating pressures of up to 150 psig, installed in Class 2 Trenching conditions. Increase pressure class or bedding class as required by AWWA C151 for surface loads greater than indicated above or operating pressures greater than 150 psi. DIP shall be constructed with push-on joints using rubber gaskets in accordance with AWWA Standard C111. Other methods of joint construction, such as mechanical, flanged, or ball-and-socket, may be required in special applications as appropriate. DIP shall be epoxy lined to not less than 20 mil. and exterior coated with manufacturer's standard bituminous coating unless otherwise specified.

Diameter	Class	Max. Depth of Bury
3-inch & 4-inch	350	32 feet
6-inch & 8-inch	350	28 feet
10-inch & 12-inch	350	14 feet
14-inch thru 20-inch	250	10 feet
24-inch thru 64-inch	200	8 feet

A. Markings

Each ductile iron pipe section shall be marked to indicate the weight class or nominal thickness, and casting period. The manufacturer's mark, country where cast, year in which the pipe was produced, and the letters DI or DUCTILE shall be cast or stamped on the pipe. All required markings shall be clear and legible, and all cast marks shall be on or near the bell. All letters and numerals on pipe sizes 14-inch and larger shall be not less than 0.5-inch in height.

B. Encasement

When required, DIP shall be encased in polyethylene material in accordance with AWWA Standard C105.

2.3.3 Glass Fiber Reinforced Thermosetting Resin Pipe (18-Inch And Larger)

Pipe manufactured by Price Brothers as HOBAS Pipe and complying with AWWA C950 may be used. Detail specifications will be developed for pipe and fittings when required or allowed as an alternate.

2.3.4 Prestressed Concrete Cylinder Pipe (Pccp) (16" And Larger)

This pipe shall comply with AWWA C301. When required, detail specifications will be developed for pipe and fittings.

2.4 FORCE MAIN APPURTENANCES

2.4.1 Force Main Fittings

Force main fittings shall include tees, wyes, bends, reducers, and other appurtenances commonly used in pipe construction. Fittings shall meet AWWA Standard C110 or C153 with pressure ratings of not less than that specified for adjacent pipe. Fittings shall be constructed with mechanical joints, unless otherwise specified, and shall be supplied complete with low alloy steel bolts and nuts, EPR gaskets and other necessary parts required for field assembly. Fittings shall be epoxy lined as specified for adjacent pipe.

A. Pipe Couplings

Pipe couplings shall be solid sleeve type with mechanical joints at each end containing and compressing a gasket. Couplings shall be ductile iron, 12 inches minimum in length, with low alloy steel bolts and nuts, and EPR gaskets. Rings and gaskets shall be sized to conform exactly to the requirements of the pipe manufacturer.

B. Pipe Cut-in Sleeves

Cut-in sleeves shall be solid ductile iron, one end plain for insertion to female fitting, the other end flanged mechanical joint, furnished with loose attaching flange and fastener, nominal length of 20-21 inches. Rings and gaskets shall be sized to conform with the requirements of the pipe manufacturer.

Approved Manufacturers

Manufacturer	Model	Application
Clow	F-1220	for centrifugally cast or sand cast pipe (special)
Clow	F-3459	for all classes of centrifugally cast pipe
Union Foundry	21-4520 21-4610 24-4800	MJ X PE FLG X PE MJ X FLG
Clow	F-3459	for all classes of centrifugally cast pipe
Others as approved by ECUA in writing.		

C. Repair Clamps

Repair clamps shall not be used in the installation of new pipe except with the written permission of the Engineer. Repair clamps shall be full circle and selected based on Table 2.4.1.3 below.

TABLE 2.4.1.3 - REPAIR CLAMP SIZES	
Pipe Diameter	Maximum Sections
Up to 12-inch	Single Section
14-inch to 24-inch	Double Section
26-inch and above	Triple Section

Repair clamps shall be composed of stainless steel bands and bolts, DI lugs and full gridded virgin EPR compounded gasket.

Repair clamps shall be sized so that the OD of the existing pipe being repaired falls within the designated range for the clamp size. Repair clamps shall have ample length to give full gasketing at both ends.

Approved Manufacturers

Manufacturer	Model
Ford	FS1 (all SS), Fordflex (SS-DI Lugs)
Rockwell	2XX*
JCM	101,102,103,104,131,132,133,134
Mueller	520, 530
Others as approved by ECUA in writing.	

*XX: See Mfr.'s catalog to complete model numbers by size.

D. Pipe Restraints

Retainer glands shall be used on all force main fittings and appurtenances, unless otherwise approved. Stainless steel all-thread tie rods may otherwise be used, with the written permission of the Engineer. In cases of tees, tapping sleeves, and flushing hydrants, the fitting shall be restrained with retainer glands and thrust blocks. See ECUA Standard Details D-43 and D-44.

Approved Manufacturers

Manufacturer	Model
EBAA Iron Works	MegaLug
Others as approved by ECUA in writing.	

E. Expansion Joints

Expansion joint fittings shall be used where specified on the Construction Plans. They shall be of the rigid or flexible type as specified, and manufactured of ductile iron in accordance with 2.4.1 above. They shall be capable of expanding or contracting to the extent shown on the plans, but in no case less than 4-inch axially, and designed to prevent separation beyond the maximum extension without the use of external tie rods.

Fittings shall be provided with restrained mechanical joints, individually pressure tested to a minimum of 350 psi against their own restraints, and internally coated on all exposed surfaces with a minimum of 15 mils. of fusion bonded epoxy conforming to AWWA C213. They shall be capable of deflecting not less than 15° by means of an integral ball at each joint in the case of flexible types.

Approved Manufacturers

Type	Manufacturer	Model
Rigid	EBAA Iron, Inc.	EX-TEND 200
Flexible	EBAA Iron, Inc.	Flex-Tend
Others as approved by ECUA in writing.		

F. Tapping Sleeves

Tapping sleeves shall be mechanical joint or fabricated-type designed for a working pressure of 200 psig without leakage. The outlet branch connection shall have a recessed flanged face for connection of tapping valve with standard dimensions in accordance with MSS SP-60. A complete set of neoprene or other elastomer gaskets shall be furnished. Sleeves shall be furnished to fit cast iron, cement-asbestos, Class 160 or C900/905 PVC pipe with side connection as shown on plans or specifications in standard pipe sizes of 4-inch X 4-inch through 16-inch X 12-inch. Sleeves shall be furnished with all necessary installation parts such as mechanical joint loose flange ends, bolts, fasteners, seals and gaskets.

Approved Manufacturers

Manufacturer	Main Material	Model
Clow	CI & C900 PVC Class 50, 100, 150, 200 10-inch & 12-inch Class 50, 100	F-5205 F-5207 4 F-5205
American Darling	CI & C900 PVC CI & CA	2800C 2800A
Mueller	CI, DI - 4-inch - 12-inch CA - 4-inch - 8-inch CI Class C & D - 10-inch - 14-inch CA - 4-inch-12-inch	H615 H615 H616 H619
M & H	MJ Class A-B Pipe MJ Class C-D Pipe	1174 1274
Others as approved by ECUA in writing		

Note: To specify exact fitting when ordering, state line diameter and line material.

1. Mechanical Joint Tapping Sleeves

Mechanical joint tapping sleeves shall be cast iron with mechanical joint main ends and a standard special dimension tapping machine attaching flange on the branch connection. The sleeve shall be of split configuration and fabricated in accordance with AWWA Specification C-110 with joints to AWWA Specification C-111.

2. Fabricated Tapping Sleeves

Fabricated tapping sleeves shall be the high-strength type having a wide body, made of 285 Grade C steel, which conforms to and reinforces the pipe to be tapped. Body length must be at least twice that of the tap size. The sleeve shall have, as a minimum, a 7/8-inch wide recessed Buna-N gasket around the outlet, and 3/4-inch high-strength corrosion resistant alloy bolts. Sleeve to be furnished with manufacturer's standard corrosion resistant coating.

Approved Manufacturers

Manufacturer	Model
JCM Industries	Model 412
Smith & Blair	622
Ford	FTS
Others as approved by ECUA in writing.	

G. Pipe Hangers and Supports

Hangers and supports shall be in compliance with Federal Specification WW-H-171E, or Manufacturer's Standardization Society SP-69, or UL listed. Materials of construction shall be in accordance with the requirements outlined in Table 2.4.1.7 below.

TABLE 2.4.1.7 - PIPE HANGERS AND SUPPORTS MATERIALS OF CONSTRUCTION	
Part I.D.	Material
Clamps	Steel - Epoxy Coated or Galvanized Cast Iron - Galvanized Malleable Iron
Hanger Rods	Steel - Electro Galvanized Steel - Stainless 304
Rollers/Bases/Roller Stands	Cast Iron
Fasteners/Fittings	Galvanized Steel Stainless
Hanger Rod Inserts	Steel: Cadmium Plated Steel: Galvanized Universal Concrete Insert - Cast Iron - Galvanized
Rod Attachments	Clevis - Forged Steel Turnbuckle: 1) Forged Steel, 2) Malleable Iron Sockets, Eye Nuts, Extension - Malleable Iron
Rollers	Steel or Iron Core, Insulated from Structure

Approved Manufacturers

Manufacturer	Part I.D.	Model No.
ITT Grinnell	Clevis Hanger	590
	Socket Clamp	224
		246

	<u>Concrete Inserts:</u>	
	CB-Universal	282
	Screen Insert	152
	<u>Rod Attachments:</u>	
	Eye Nut	290
	Forged Clevis	299
	Forged Turnbuckle	230
	Carbon Steel	233
	Couplings	136
	Socket Eye	110R
	Extension	157
	<u>Pipe Rolls:</u>	
	Adjustable Swivel	174
	Adjustable Steel Yoke	181
	Pipe Roll with Base	274
Pipe Roll and Plate	277	
Others as approved by ECUA in writing.		

2.4.2 Valves

All valves shall be manufactured in accordance with the current appropriate AWWA Standard.

A. Resilient Seated Gate Valves

Resilient seated gate valves shall be designed and fabricated in accordance with the current AWWA Standard C-509. The basic design of the gate valves shall have a cast iron body, elastomer encapsulated cast iron disc, bronze stem and operating nuts with non-rising stem design. The valve working pressure shall be 200 psig with a test pressure of 400 psig.

1. Materials and Construction

Valves shall open counterclockwise with a 2-inch square cast iron operating nut secured to the valve stem by a corrosion resistant nut to threads on the valve stem. The valve stem shall be made of high tensile strength bronze and shall be of one piece construction sealed by O-Rings. The thrust collar shall be secured in place by a stuffing box or bonnet cover with a thrust washer located above the thrust collar. Valve construction shall be so that upper O-Rings can be replaced with the valve in service. The disc shall be cast iron encapsulated with an elastomer material bonded in accordance with ASTM D429 and shall be secured to the threaded stem by a bronze nut. The disc shall effect a seal that is bubble-tight at 200 psig.

2. Corrosion Resistant Coatings

All interior and exterior cast iron surfaces shall be coated with fusion bonded epoxy in accordance with AWWA Standard C-550.

3. Body Sizing

Valve body length shall be per ANSI Standard B16.2 for the type of end connections specified. In the full open position, the valve internal bore shall be smooth and obstruction-free without cavities or projections that could accumulate solids. The internal cross-sectional area of the valve shall be approximately equal to the nominal cross-sectional area for Schedule 40 PVC pipe of the same nominal internal diameter.

4. End Connections

Valves shall be furnished with mechanical joint end connections, complete with flange kits, unless otherwise specified on the plans or purchase order.

When flanged ends are specified they shall be flat face nominal 125# ANSI B16.1 Standard with bolt holes straddling the vertical center line.

Approved Manufacturers

Manufacturer	VALVE BODY CONNECTIONS			TAPPING VALVES
	MJ x MJ	MJ x FLG	FLG x FLG	MJ x SF
American Darling	4-inch - 12-inch CSR-80X	4-inch - 12-inch CSR-80X	CSR-80X Specify Ends	4-inch - 12-inch No. 862 16-inch - 24-inch*
Clow	2-inch - 12-inch F6100	4-inch - 12-inch F-6106	4-inch - 12-inch F-6102	4-inch - 12-inch F-6114 14-inch - 24-inch F-5093*
Kennedy	3-inch - 12-inch F-1571-XNRS	3-inch - 12-inch F-1572-XNRS	3-inch - 12-inch F-1561-XNRS	3-inch - 12-inch F-950X
M & H	4-inch - 12-inch S-4067-01		4-inch - 12-inch S-4067	2-inch - 12-inch H-667 200 PSI 14-inch - 24-inch H-667 150 PSI
Others as approved by ECUA in writing.				

*Metal seated only, specify bypass if required
14-inch and larger valves specify special appurtenances.

B. Resilient Seated Tapping Valves

These resilient seated gate valves shall be designed and fabricated in accordance with the current AWWA Standard C-509. The basic design of the gate valves shall have a cast iron body, elastomer encapsulated cast iron disc, bronze stem and operating nuts with non-rising stem design. The valve working pressure shall be 200 psig with a test pressure of 400 psig.

1. Materials and Construction

Valves shall open counterclockwise with a 2-inch square cast iron operating nut secured to the valve stem by a corrosion resistant nut to threads on the valve stem. The valve stem shall be made of high tensile strength bronze and shall be of one piece construction sealed by O-Rings. The thrust collar shall be secured in place by a stuffing box or bonnet cover with a thrust washer located above the thrust collar. Valve construction shall be so that upper O-Rings can be replaced with the valve in service. The disc shall be cast iron encapsulated with an elastomer material bonded in accordance with ASTM D429 and shall be secured to the threaded stem by a bronze nut. The disk shall effect a seal that is bubble-tight at 200 psig.

2. Corrosion Resistant Coatings

All interior and exterior cast iron surfaces shall be coated with fusion bonded epoxy in accordance with AWWA Standard C-550

3. Body Sizing

Valve body length shall be per ANSI Standard B16.1 for tapping valves. Tapping valves shall conform to Specification AWWA C509, latest revision, covering gate valves except as modified for passage and clearance of tapping machine cutters. The opening through the valve shall be at least 1/4-inch larger than nominal valve diameter. Tapping valves shall allow full size shell cutters to be used.

4. End Connections

Valves shall be furnished at one end of the body with projecting face flange in accordance with specification MSS SP-60 for tapping valve/saddle connections to bolt to a standard tapping sleeve and the other end for mechanical joint.
Approved Manufacturers

See Section 2.4.2.1 above.

C. Air Release Valves

Force mains shall be laid so as to minimize the number of high points. Air release valves shall be installed at all high points in force mains wherever the high point is more than one pipe diameter above the adjacent low points. Exact locations of air release valves shall be field determined. In all case, installation should be in the furthest downstream portion of each high point.

1. Manual Air Release Valves

Manual air release valves shall comprise a 2-inch diameter saddle and corporation stop, extended to grade, and terminated with a lockable curb stop housed in a meter box. These components are specified in Section 2556.2.7. See Standard Detail D-60.

2. Automatic Air Release Valves

Automatic air release valves shall be float operated to release accumulated air whenever the system is pressurized. The body and end covers shall be of cast iron conforming to ASTM A48, Class 35. All internal metal parts, including the float, shall be stainless steel. The air vent valve shall close drip tight, be rated for 200 psi operating pressure and 300 psi test pressure, and shall incorporate a renewable Viton seat. See Standard Detail D-61.

Approved Manufacturers

Manufacturer	Model
Empire Specialty Co., Inc., Mars, PA	Figure 905
Others as approved by ECUA in writing.	

D. Check Valves

Check valves are required on all force mains which manifold into an equal or larger sized force main. The check valve is to be installed in a vault adjacent to the gate valve at the point of connection into the larger line in order to prevent backflow from the larger line into the smaller line. Details shall be as shown in Section 2575.2.06.D.2 on page 2575.7, except that mechanical joint ends may be used.

E. Valve Vaults or Chambers

All valves which are not designed for direct burial shall be installed in vaults, which shall be constructed from standard precast concrete manhole sections. They shall be sized to allow sufficient room for maintenance and repair in situ. For shallow installations, flat tops should be used as shown in the ECUA Standard Shallow Manhole Detail D-2. Gravel bottoms shall be installed in areas where the water table is below the bottom. Where it is higher, a minimum 4-inch concrete bottom shall be provided with a 12-inch x 12-inch sump.

F. Valve Boxes

Valve boxes shall be provided for all direct buried valves. Nominal 6-inch cast-iron sliding-type pipe shaft with cover and base casting shall be used. The box top shall be set at finished grade and encased with a concrete ring in unpaved areas. Each valve box shall be furnished with a drop-in cover marked "SEWER". See ECUA Standard Detail D-34.

2.4.3 Location Aids

All new force main and service line installations shall include an approved method for locating lines from the ground surface after completion.

2.4.4. Tracer Wire

Tracer wire for force mains shall be minimum 12 gauge copper with brown PVC insulation. Tracer wire systems shall be electrically continuous covering all mains within the project. Wire-to-wire connectors shall be made with silicone-filled wire nuts. Wire-to-appurtenance attachments shall be made with lug-type terminals.

Approved Manufacturers (Tracer Wire Silicone-filled Wire Nut Connectors)

Manufacturer	Model
Ideal Industries	Twister® DB Plus
King Technology, Inc.	Failsafe™
Others as approved by ECUA in writing.	

2.4.5 Pipeline Markers

Markers shall be of a passive electronic type that reflects a signal back to an electronic hand-held transmitter/detector. Electronic components shall be enclosed in a waterproof polyethylene housing. Markers shall have a different response frequency for each service line type.

Markers shall be ScotchMark® products manufactured by 3M Telecom Systems Group, Austin, Texas. Alternate manufacturers are not acceptable.

Application	Usable Depth	Dimension/ Configuration	Service	Color Code	Model
Near Surface	2 feet	3½" L X 5/8" Ø Cylinder	Water	Blue	1434
			Wastewater	Green	1435
Medium Depth	4 feet	4" Ø Ball	Water	Blue	1403
			Wastewater	Green	1435
Deep	6 feet	8" Ø X 1" Thick Disc	Water	Blue	1257
			Wastewater	Green	1258

PART 3: EXECUTION

3.1 GENERAL

The contractor shall provide all labor, equipment and materials as required to install all pipes, valves, fittings, and other appurtenances as indicated on the construction plans or as specified in the contract documents.

3.2 POTABLE WATER LINE SEPARATION FROM SANITARY SEWER LINES

- A. When a gravity sewer line must cross under a water line with less than 18-inch vertical clearance, one of the following methods may be used.
1. Fully encase sewer line with a minimum of 4 inches of concrete (2500 psi) for a minimum distance of 10 feet either side of the point of crossing, which must be at least 5 feet from a water line joint. If the crossing is other than at right angles, increase the length of encasement so that the end of the encasement will be at least 12 feet from a water line joint.
 2. Use equally rated pressure pipe for the sewer lines with no joints closer than 12 feet apart and at least 6-inch vertical clearance.
 3. Install sewer pipe into at least a 20-foot section of steel casing (casing I.D. slightly larger than sewer pipe bell O.D.) and center over crossing so that end of casing will be at least 12 feet from water line joint. Seal the ends of the casing with non-shrink grout.
- B. When a gravity sewer line must cross over a potable water line, regardless of clearance, because the water line cannot be relayed above sewer, use method 2 or 3 in subsection A. Concrete encasement will not be allowed.
- C. When a sanitary force main must cross under a potable water line with less than an 18-inch vertical clearance, or over the water line, use a higher rated pressure pipe as in method 2 or 3 in subsection A.
- D. When the water line being crossed in A, B or C is a house or building service lateral, 2-inch or smaller and the service lateral is a continuous piece of PE DR9 tubing, then the above rules do not apply; but locate so that the distance to a sewer or force main joint is as great as possible.
- E. When a gravity sewer line must run parallel to and less than 18 inches below a potable water line and:
1. 6 to 10 feet apart for less than 40 feet, use method 1, 2 or 3 in subsection A.
 2. 6 to 10 feet apart for over 40 feet, use method A2 and stagger joints.

3. 3 to 6 feet apart for any distance, use a higher rated pressure pipe as in method A2.
- F. When a sanitary force main must run parallel to and less than 18 inches below a potable water line and:
1. 6 to 10 feet apart for any distance, use a higher rated pressure pipe as in method A2.
 2. 3 to 6 feet apart, use a higher rated pressure pipe for both water and force main. Example: If force main is PC160 PVC DR26, and water line is C-900 DR25; then force main should be PVC DR21 and water line should be DR21, using extreme care to have both properly color-coded.

3.3 PIPE INSTALLATION

The contractor shall utilize equipment and methods in accordance with sound construction practices to insure pipe installation to line and grade as indicated.

3.3.1 Trench Excavation

Refer to Section 2221: Trench Excavation Backfill and Compaction. Maintain minimum of 30 inches and maximum of 36 inches of cover below finished grade unless shown otherwise on the construction plans.

3.3.2 Alignment

Pipe shall be installed along the alignment indicated by the construction plans. Accomplish horizontal and vertical changes in alignment of pipe with bends or other appropriate fittings. Limit joint deflection as recommended by the pipe manufacturer.

3.3.3 Pipe Preparation

The contractor shall clean the interior of all pipes, fittings, and joints prior to installation. Pipes shall be inspected for defects prior to installation. Damaged pipe shall be rejected and removed from the project.

3.3.4 Pipe Installation

Install pipe only when weather and trench conditions are suitable. Do not lay pipe in water. Join pipe in accordance with manufacturer's recommendations.

Provide initial backfill or anchoring as necessary to prevent displacement and preserve alignment after establishing final position.

Encase force main in steel casing or use ductile iron pipe when crossing under pipe, conduit, or structure when a 6-inch separation distance cannot be maintained. This protection shall extend a minimum of 5 feet beyond crossed structure.

3.3.5 Protection

Prevent the introduction of foreign matter into the pipe at all times. Close open ends of pipe with water tight fitting closures or plugs. Do not let water fill trench, but include provisions to prevent flotation should water control measures prove inadequate.

Remove water, sand, mud and other undesirable materials from trench before removal of pipe closure piece.

3.3.6 Cutting

PVC pipe shall be cut in a neat workmanlike manner, and the spigot end shall be beveled per manufacturer's recommendation. Ductile iron pipe shall be cut in accordance with manufacturer's recommendation. Do not allow excessive heat to develop. Smooth and bevel cut end by power grinding. Use of pipe with damaged lining is unacceptable.

3.3.7 Closure Pieces

Closure pieces shall only be used where called for on plans, or with written permission of the ECUA. Closure may be accomplished with sleeve coupling as long as its length is such that gaskets are not less than 3 inches from pipe ends.

3.3.8 Joint Restraints and Thrust Blocking

Joint restraints and/or thrust blocking must be provided at all horizontal or vertical turns utilizing fittings, and at tees, 90's, and dead-ends.

3.4 **APPURTENANCE INSTALLATION**

3.4.1 Valves

Valves shall be installed with operating stems vertical when installation is direct burial. Valves shall be installed on a suitable bearing surface so as to prevent vertical displacement.

A. Air Release Valves

Air release valves shall be located and installed at the down-stream end of all high points as shown in Details D-60 or D-61 for manual or automatic types respectively as indicated on the approved construction plans.

B. Check Valves

Check valves complete with vaults shall be installed at locations shown in the approved construction plans in accordance with the manufacturer's instructions.

3.4.2 Valve Boxes

Valve boxes shall be centered on the valve. The earth shall be compacted around each valve box to a distance of 4 feet on all sides of box, or to undisturbed trench face if less than 4 feet. An 18-inch diameter by 4-inch thick collar shall be constructed and sloped to direct water away from the valve box.

3.4.3 Tracer Wire

Tracer wire shall be installed on all new force mains. The tracer wire shall be placed directly above the pipe and electrically continuous throughout the project. The tracer wire shall be brought to the ground surface at each valve location in accordance with ECUA Standard Detail D-34. Splices and/or connections in the tracer wire shall be installed with silicone-filled wire nuts designed for direct burial.

3.5 TAPS ON PRESSURIZED LINES

The contractor shall perform taps on pressurized lines in accordance with these requirements. An ECUA representative shall be on-site during testing and cutting.

3.5.1 Materials

All materials used for taps on pressurized lines shall meet the requirements of these specifications. Tapping sleeves shall be properly sized for the pipe being tapped. (See Sec. 2.4.1.6) Resilient seated tapping valves shall be furnished with special end connections. (See Sec. 2.4.2.2) All other material used to accomplish the tap shall meet the relevant AWWA Standards.

3.5.2 Procedure

The contractor shall:

- A. Expose the existing pipe at the location shown on the plans, and clean the section of the pipe to receive the tapping sleeve.
- B. Check the tapping sleeve and valve for defects and make sure the gate fully retracts in the valve to allow the shell cutter free passage.
- C. Assemble the tapping sleeve on the pipe, then install the tapping valve.
- D. Pressure test the tapping sleeve and valve after it has been assembled on the force main using the test plug on the sleeve. The test pressure shall be 150 psi.
- E. Pour a thrust block behind the tapping sleeve sufficient to withstand the pressure of the new line. Also, provide a suitable bearing surface sufficient to support the weight of the sleeve, valve, and tapping machine. Refer to Section 3.3.9 and ECUA Standard Detail D-43.
- F. Assemble an approved tapping machine and proceed to make the necessary cut in accordance with the recommendation of the tapping machine manufacturer.

Approved tapping machines shall be:

1. in good working condition.
2. designed for and have a cutting bit for the pipe material to be cut.
3. equipped with a depth of cut gauge.
4. designed to capture the coupon.

PART 4: ACCEPTANCE REQUIREMENTS

4.1 INSPECTION

Upon completion of the installation, the system shall be inspected to ascertain that valves, fittings, air release valves, etc. are located in conformance with the plans, and confirm that all 'as-built' measurements have been taken. The ECUA Inspector shall

observe all appropriate activities related to properly placing the line in service including flushing, pressure and leakage testing. Final connections shall be accomplished after final clearance of lines. Tracer wire shall be tested for continuity.

4.2 FLUSHING

All newly installed force mains shall be flushed to remove any sediment, solids and/or foreign matter prior to testing. ECUA will make water available to the contractor. Flushing shall be conducted at a sufficient velocity to clear the pipe. Discharge of flushing water must be through a 2-inch diameter pipe or larger and must be controlled so as not to cause any property damage.

4.3 PRESSURE/LEAKAGE TEST

4.3.1 General

All newly installed force mains and appurtenances shall be pressure/leak tested to assure the strength of materials and quality of workmanship of the installation. Testing shall be conducted generally in accordance with ECUA Standard Detail D-12 and the requirements of AWWA Manual 23 for PVC and other flexible pipe or AWWA C600 for Ductile Iron Pipe. Leakage testing may be conducted concurrently with the pressure test.

4.3.2 Procedure

Tests are to be conducted in segments not to exceed three thousand (3,000) feet of pipe. Water in the new line shall be pumped up to a pressure of 100 psi. This pressure shall be maintained for a minimum of one (1) hour by pumping a quantifiable amount of water into the line and record the amount of water added during the test period. This represents the leakage.

Pressure/leakage tests shall be deemed acceptable when leakage does not exceed that determined by the following formula:

$$L = \frac{SD\sqrt{P}}{133200} \text{ (or 11.65 gpd/mi/inch/dia)}$$

$$\text{or } L = \frac{ND\sqrt{P}}{7400} \text{ for DI pipe 18' lengths}$$

$$\text{or } L = \frac{ND\sqrt{P}}{6600} \text{ for PVC pipe 20' lengths}$$

where: L = Maximum leakage, in gallons per hour.
 S = Length of pipe under test, in feet.
 N = Number of pipe joints in segment under test.
 D = Nominal internal diameter of pipe, in inches.
 P = Average actual leakage test pressure, psig.

Record all data for submission with as-built plans.

An ECUA Construction Inspector shall be present during test.

Refit and replace all pipe not meeting the leakage requirements. Repair clamps are not permitted.

Repair all visible leaks regardless of the amount of leakage.

PART 5: MEASUREMENT AND PAYMENT

5.1 GENERAL

Measurements shall be made to the nearest tenth of units and rounded to the nearest whole unit when totaled. Payments shall be for providing all labor, tools, equipment and materials as needed for: 1) furnishing, handling, and installing the required materials, fittings or fixtures; 2) excavation, backfill and compaction, including shoring, bracing and dewatering as required; 3) temporary removal and replacement of existing obstacles, including minor relocation and repair of other utilities; and 4) all required testing, and flushing. Payment for force main installations shall include the installation of tracer wire.

5.2 FORCE MAINS

Force mains shall be measured in lineal feet by the specified pipe size along the pipe centerline with no deduction for fittings. Payment shall be based on the contract unit price per lineal foot.

5.3 APPURTENANCES

Force main appurtenances include fittings and valves as outlined in Section 2.4 of the specifications. Incidental appurtenances such as joint restraints, couplings, tracer wire, etc. are not considered separate pay items and their cost should be included in the unit price of the installed pipe.

5.3.1 Fittings

Force main fittings including bends, reducers, tees, wyes, tapping sleeves, expansion joints, pipe hangers/supports, and cut in sleeves shall be measured and paid for on a unit (per each) basis. Fittings shall be listed by size and type.

5.3.2 Valves

Force main valves inclusive of any required valve boxes or other appropriate appurtenances shall be measured and paid for on a unit (per each) basis. Valves shall be listed by size and type.

5.4 TAPS ON PRESSURIZED LINES

Taps on pressurized lines shall be measured and paid for on a unit price (per each) basis to include tapping sleeve, tapping valve, and valve box complete, in-place. Taps shall be listed by main and branch diameters.

5.5 POLYETHYLENE WRAPPING

Polyethylene wrapping shall be measured along the centerline of the pipe. Payment will be based on the contract unit price per lineal foot.

5.6 DEWATERING

Well Point method shall be used when specified and bid item included. Measurement shall be in linear feet of pipe trench dewatered and payment by unit price per foot.

Screened and Packed Well Point method shall only be used when specifically indicated and bid item included. Measurement shall be in linear feet of pipe trench and vertical feet of screened and packed points and payment by unit price per foot.

Deep Well, Eductor Well Point, Bleeder Well or Vacuum methods will only be considered when specified.

Trench bottom sump pumps will not qualify for payment as dewatering.