

Section VI – Technical Specifications

ITEM III – SANITARY SEWER SYSTEM FORCE MAINS

3.01 General

- A. All sanitary sewer force mains shall be constructed of either PVC or ductile iron unless otherwise specified in the Special Conditions or shown on the plans. Tunnel liners and casing pipes shall be installed at railroad, street, or highway crossings when shown on the plans.
- B. All PVC and ductile iron sewer pipe and fittings shall be suitably marked at their places of manufacture to show their class, strength, or thickness, as applicable.

3.02 PVC Pipe

- A. Conform to the requirements of AWWA C900, ASTM D1784, and ASTM D2241. Pipe shall be type PSM, rigid Poly Vinyl Chloride (PVC) material with integrally formed, factory fabricated, or twice gasketed coupling type, rubber ring type joints. **PVC force main pipe** shall have a minimum wall thickness of DR 18 and shall be Class 150. Pipe shall be Type I, Grade I and shall be made from clear virgin material. PVC material shall have a cell classification of 12454-B or C as defined in ASTM D-1784.
- B. Nominal laying lengths shall be 20 feet plus or minus one inch. Provision shall be made for expansion and contraction at each joint, through the rubber gasket and pipe bell.
- C. All pipe shall be smooth and free of cracks or other imperfections.
- D. All PVC force main shall be green in color and imprinted with “Sewer” in large letters.
- E. Install trace wire and metallic detection tape in accordance with Sections 3.04L. and 3.04M.

3.03 Ductile Iron Pipe

- A. Ductile iron pipe shall be in accordance with ANSI A21.50/AWWA C150 and conform to the requirements of ANSI A21.51/AWWA C151, latest standards. Product shall be composed of 60-42-10 ductile iron. Push-on and restrained joint pipe shall have a minimum rated working pressure of 150 psi. The minimum pressure class of all buried **sewer force main pipe** shall be as

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follows unless the pipe manufacturer recommends a thicker wall for depth of bury and bedding shown:

Pipe Diameter (inches)	Minimum Pressure Class (psi)
4” – 12”	350
14” – 20”	250
24”	200
30” – 64”	150

- B. **Exposed pipe shall be furnished with an exterior coating of red primer in order to facilitate painting.** All flanged pipe or Victaulic grooved pipe shall be Class 53 minimum.

- C. Nominal laying lengths shall be either 18 feet or 20 feet plus or minus one inch. Provision shall be made for expansion and contraction at each joint, through the rubber gasket and pipe bell.

- D. All pipe shall be smooth and free of cracks or other imperfections.

- E. **All ductile iron pipe shall be lined on the interior surface with Protecto 401 Ceramic Epoxy.** The material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, and shall meet the following requirements:
 - 1. A permeability rating of 0.00 when tested according to Method A of ASTM E-96-66, Procedure A with a test duration of 30 days.

 - 2. The following requirements from coupon testing:
 - a. 0.0 undercutting results after a one year period when subjected to ASTM B-117 Salt Spray.

 - b. Less than 0.5 mm undercutting after 30 days when subjected to ASTM G-95 Cathodic Disbondment 1.5 volts @ 77°F.

 - c. Immersion Testing rated using ASTM D-714-87 no effect after one year when tested with 20% Sulfuric Acid, 25% Sodium Hydroxide, 160°F Distilled water and 120°F Tap water.

 - 3. Protecto 401 Ceramic Epoxy lining shall be subjected to the application

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procedure:

- a. The lining shall be applied by a competent firm with a successful history of applying linings to the interior of pipe and fittings.
- b. Prior to abrasive blasting, the entire area to receive the protective compound shall be cleaned of oil, grease, etc. using a solvent according to the guidelines outlined in DIPRA-1 Solvent Cleaning. Following solvent cleaning, all areas to receive protective coating shall be abrasive blasted using compressed air nozzles with sand or grit abrasive media so that all rust, loose oxides, etc. are removed from the surface.
- c. After the surface preparation and within 8 hours of surface preparation, the interior of the pipe shall receive 40 mils nominal dry thickness of Protecto 401. No lining shall take place when the substance or ambient temperature is below 40oF. The surface also must be dry and dust free. If flange pipe or fittings are included in the project the lining shall not be used on the face of the flange.
- d. Coating of Bell Sockets and Spigot Ends - Due to the tolerances involved, the gasket area and spigot end up to 6 inches back from the end of the spigot end must be coated with 6 mils nominal, 10 mils maximum Protecto Joint Compound. The Joint Compound shall be applied by brush to ensure coverage. Care should be taken that the Joint Compound is smooth without excess buildup in the gasket seat or on the spigot ends. Coating of the gasket seat and spigot ends shall be done after the application of the lining.
- e. The number of coats of lining material applied shall be as recommended by the lining manufacturer. However, in no case shall this material be applied above the dry thickness per coat recommended by the lining manufacturer in printed literature. The maximum or minimum time between coats shall be that time recommended by the lining material manufacturer. No material shall be used for lining which is not indefinitely recoatable with itself without roughening of the surface.
- f. Protecto Joint Compound shall be used for touch-up or repair in accordance with manufacturer's recommendations.
- g. Lining Inspection:

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All ductile iron pipe and fittings shall be checked for thickness using a magnetic film thickness gauge. The thickness testing shall be done using the method outlined in SSPC-PA-2 Film Thickness rating.

The interior lining of all pipe and fittings shall be tested for pinholes with a nondestructive 2,500 volt test. Any defects found shall be repaired prior to shipment.

Each pipe joint and fitting shall be marked with the date of application of the lining system along with its numerical sequence of application on that date and records maintained by the applicator of his work.

- h. Lining Certification - The pipe or fitting manufacturer must supply a certificate attesting to the fact that the applicator met the requirements of this specification, and that the material used was as specified.
4. Restrained Joint Piping:
- a. All restrained joint piping shall be Fastite with Fast Grip Gasket as manufactured by American Cast Iron Pipe Company or approved equal.

3.04 Pipe Accessories

- A. Pipe Joints: Elastomeric gasket joints conforming to the following:
- 1. Gaskets for pipe and fittings shall be a continuous ring of elastomeric material compounded to resist deterioration and of a texture to assure a permanent and watertight seal. Gaskets shall have smooth surfaces, free from pitting, blisters, porosity, or any other defects. Gaskets shall conform to the requirements of the applicable ANSI, AWWA, and ASTM specifications for the type of pipe specified.
 - 2. Gasket lubricant shall be a potable hydrogenated vegetable oil, insoluble in cold water, non-toxic, shall not support the growth of bacteria, and shall not impart taste or odor to the water. It shall not contain soaps, detergents, organic solvents or other deleterious ingredients and shall have no deteriorating effects on the gasket. The lubricant shall be semi-paste, easily applicable, adherent to the inside of the bell, and shall remain in a usable state throughout the range of temperature in which the pipe is normally installed. Lubricant shall be delivered to the

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jobsite in unopened containers bearing the manufacturers name and trade name or trade mark.

- B. Fittings: Provide the size, configuration, and type as indicated on the Drawings. Fittings shall be installed with blocks in accordance with the details provided on the Drawings. All fittings shall be of at least the same class as the pipe with which they are to be used and shall conform to the following:
1. Pipes 3” and smaller - PVC fittings and adapters shall conform to the same requirements as the pipe provided and shall be the same classification as the pipe. PVC material shall have a cell classification of 12454-B as defined in ASTM D1784.
 2. PVC Fittings for Pipes 4” and larger - shall conform to AWWA C900. PVC fittings shall have a minimum wall thickness of DR 18. PVC material shall be in conformance with ASTM D1784.
 3. DIP Fittings for Pipes 4” and larger - shall conform to ANSI A21.10/AWWA C110 or ANSI A21.53/AWWA C153. Ductile iron shall be in accordance with ASTM A-536 with minimum physical characteristics of 70,000 psi tensile strength, 50,000 psi yield strength, and 5% elongation. Pipe shall have push-on or mechanical joint ends conforming to ANSI A21.11 (AWWA C111), except where flanged or other type joints are shown or required. Flanged pipe shall conform to ANSI A21.15 (AWWA C115). Flanges shall be Class 125 except where class 250 is specifically noted, and shall conform to ANSI A21.10. Drilling and facing of flanges shall be in accordance with ANSI B16.1. Fittings shall be lined with Protecto 401 Ceramic Epoxy. The lining quality, application procedure, inspection, and certification shall meet the requirements outlined under Part 2.1 B.4 of this Section.
- C. Combination Air and Vacuum Valves: Provide combination air and vacuum valves where indicated on the Drawings, and not specified in other sections of these specifications.
1. Provide single body, cast iron, float operated combination air and vacuum valve.
 2. Valve shall be suitable for sewage service at a working pressure of 150 psi; and capable of exhausting large amounts of air during filling, exhausting small amounts of accumulated air during operation, and

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admitting large amounts of air upon impending vacuum during draining.

3. Provide a valve with 2-inch inlet and 1-inch outlet, having a 3/16-inch orifice.
4. Valve shall be provided with flushing attachments consisting of an inlet isolating valve, bronze blow-off and flushing valve, and a minimum of 5 feet of rubber hose with quick disconnects.
5. Provide Crispin Universal Combo Sewer Valve Model US 10SB or equal.

D. Tapping Sleeves And Saddles:

1. Saddles: Ford Model H-10488 or Rockwell #313 Double strap saddles with epoxy coating and 304 Stainless Steel Straps and Nuts suitable for 200 psi working pressure.
2. Sleeves: Cast iron Split sleeves with both end seals and side seals are required for all taps of same size as run. Rockwell Model 622-XXXXXXXXXX-031 - Fabricated Steel Sleeves with Epoxy Coating and 304 Stainless Steel Bolts and nuts will be acceptable for all reducing size taps. All Sleeves shall be suitable for 150 psi working pressure. Valves shall be supplied to integrally fit to the sleeve and provide connection to the existing water main without any interruption of service.

E. Gate Valves

1. General:
 - a. End connections as required for the piping in which they are installed.
 - b. Suitable For working pressure of not less than 150 psi.
 - c. Open by turning counter counter-clockwise.
 - d. Provide stem extensions, if required, to bring operating nut to within two feet of finished grade.
2. Two inch and smaller:
 - a. Use all bronze, screw ends, double disc or wedge disc, rising stem.

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- b. “T” head operator for buried service, handwheel operator for exposed locations.
 3. Three-inch and larger:
 - a. Use double disc complying with ANSI/AWWA C500.
 - b. Buried service: Non rising stem with two inch metal operating nut with arrow indicating direction of opening.
 - c. Exposed: Outside screw and yoke with handwheel operator.
 - d. Provide bypass valve where required for pressure and valve size.
- F. Plug Valves
 1. General:
 - a. Provide non-lubricated, eccentric type plug valves having resilient faced plugs, complying with AWWA Standard C504 and other requirements specified herein.
 - b. Furnish screwed, flanged or mechanical joint end connections as indicated on the Drawings.
 - c. Provide valves of bolted bonnet design:
 - i. Valves 4" and larger to be designed to allow repacking without removing the bonnet and the packing shall be adjustable.
 - ii. Packing to be replaceable with the valve under pressure with valve open or closed with pressure on either side of the plug.
 - d. Provide valves capable of drip-tight shutoff up to full rating 175 psi for 4" through 12", 150 psi for 14" through 36", and with pressure in either direction. Pressure ratings shall be 125 psi for 42" and larger.
 - e. Valve bodies shall be cast iron complying with ASTM A126, Class B and AWWA Standard C-504-80, Section 5.4.
 - f. All exposed nuts, bolts, springs, etc. shall be stainless steel on all valves.
 2. Port Areas
 - a. Four inch through twenty inch valves, not less than 80% of full pipe area.
 - b. Twenty-four inch and larger, not less than 70% of full pipe area.

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- c. Port to be smoothly shaped with an unobstructed waterway when open.
3. Seats
 - a. Provide corrosion resistant seats complying with AWWA Standard C507-73 and AWWA Standard C504.
 - b. Three inch and larger valves to have a 1/8" thick welded-in overlay of not less than 90% nickel content on all surfaces contacting the plug face.
 - c. Seat to be raised from the valve body and machined to a smooth finish.
4. Bearings
 - a. Provide valves through twenty inch size with permanently lubricated, 316 stainless steel bearings in the upper and lower plug stem journals.
 - b. Provide twenty-four inch and larger valves with bronze bearings and stainless steel sleeves in the upper and lower plug stem journals.
 - c. Bearings to comply with AWWA Standard C507-73 and AWWA Standard C504.
 - d. Lower bearing housing to be raised from the body to reduce the possibility of grit and sand entering the bearing housing.
5. Flanged End Connections
 - a. Provide, where indicated, valves with flanged ends, faced and drilled to ANSI 125/150 pound standard.
 - b. Flanged valves through 12" to have face-to-face dimensions of AWWA standard gate valves.
6. Resilient Plug Facing
 - a. Provide neoprene plug facings vulcanized to the plug and suitable for use with domestic wastewater.
 - b. Plug to be one piece.
 - c. Do not use plugs with cast inlays.
7. Buried Service Valves

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- a. Provide seals on all shafts and gaskets on valve covers to prevent entry of water and dirt.
8. Actuators
- a. Manual valves to be provided with lever or gear actuators and tee wrenches, extension stems, floor stands, chainwheels, etc. as indicated on the Drawings.
 - i. Provide a lever for each lever operated valve.
 - ii. Provide one tee wrench for every five valves utilizing the tee wrench operation.
 - b. Valves furnished for installation in a valve box to be provided with a 2" square operating nut and extension within 18" of the top of the valve box.
 - c. Provide 6" and larger valves with gear actuators.
 - i. Provide gear to fit on hexagonal valve shaft to allow operation without the use of roll pins.
 - ii. Handwheel and chainwheel components between the input and the stop-limiting devices to be designed to withstand, without damage, a pull of 200 Pounds as required by the American Water Works Association (AWWA) Standard C504-74 Section 11.2.3.
 - iii. Pulley and chain for chainwheel actuators to be hot-dipped galvanized unless otherwise noted on the plans.
 - iv. Gear actuators, normal service:
 - aa. Enclose all gearing in a semi-steel housing suitable for running in a lubricant with seals provided on all shafts to prevent entry of dirt or water into the actuator.
 - bb. Support actuator shaft and quadrant on permanently lubricated bronze bearings:
 - cc. Provide valve position indicator and an adjustable stop to set closing torque.
 - dd. All exposed nuts, bolts and washers to be stainless steel.
 - ee. Provide air gap between the actuator and the valve body to prevent leakage from the valve into the actuator.

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- v. Gear actuators, buried service:
 - aa. Provide neoprene seals on all shafts and gaskets on actuator covers to prevent entry of water and dirt.
 - bb. Mounting brackets to be totally enclosed with gasket seals.
 - cc. Support actuator shaft and quadrant on permanently lubricated bronze bearings.
 - dd. All exposed nuts, bolts and washers to be stainless steel.

d. Power actuators: Where indicated, furnish power actuators.

- i. Electric motor actuators:
 - aa. Comply with Section 11289.
- ii. The plug valve manufacturer shall secure and install power actuators on the valves and shall accept total responsibility for its installation and satisfactory operation.

G. Check Valves

1. Cushioned swing check valves, 3" and larger:

- a. Valves 3" diameter and larger shall have cast iron body with bronze seating ring and stainless steel shaft for attachment of weight and lever with non-adjustable air cushioned shock chamber.
- b. The cushioned chamber shall be mounted to the side of the valve body with piston operating in the chamber which will prevent valve closing without any hammering action.
- c. Shock absorption shall be by air with adjustable closing speed.
- d. The valve shall be specifically designed for application in the Fluid being transferred. The valve shall be as manufactured by G.A. Industries, Inc., or Engineer approved equal.

2. Swing check valves, smaller than 3":

- a. Valves smaller than 3 inch diameter shall be all brass.
- b. End connections as required for the piping in which they are installed.
- c. Valves shall have swing removable disc.

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- d. Valves shall be Class 250 working pressure type.
3. Ball check valves, smaller than 3":
 - a. Furnish bronze bodied valve.
 - b. Valve ends to be female NPT.
 - c. Provide threaded bronze cap.
 - d. Provide hollow stainless steel ball with a specific gravity greater than 1.0.
 - e. Provide rubber seat.
 - f. Maximum working pressure - 150 psi.
 - g. Maximum working temperature - 185 degrees F.
 - h. Provide Flygt Model HDL Type 2002, ABS Type 50 or equal.
- H. Mud Valves
1. Provide Flanged frame, faces and drilled, 125# standard, iron bodied, rising stem, with bronzed bushed removable yoke.
 - a. Provide bronze tapered accurately machined seating surfaces.
 2. Provide ball bearing, cast iron floor stand with operating handwheel and position indicator.
 3. Stems:
 - a. Provide solid, stainless steel stems, of diameter to safely withstand opening and closing thrusts.
 - b. Provide opening and closing stainless steel stop collars at top of stem.
 - c. Stem couplings to be threaded and keyed.
 4. Stem guides:
 - a. Use cast iron, two piece, bronze bushed guides, adjustable in two directions.
 - b. Space so that L/r ratio of the stem does not exceed 200.
 5. Stem cover:
 - a. Provide each rising stem unit with clear butyrate plastic pipe cover with mylar markings in engineering units.

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- b. Provide top cover and lower end to mount in housing or adapter plate.
 - c. Provide vents to prevent condensation accumulation.
 - 6. Provide Waterman Industries, Inc. Model MV-12 or equal.
- I. PVC Ball Valves
 - 1. Provide PVC ball valves where shown on the plans.
 - 2. Provide true union ball valves, "Hayward True Union or equal.
 - 3. Provide adjustable seats.
 - 4. Provide Viton gaskets and seals.
- J. Stainless Steel Ball Valves
 - 1. Provide stainless steel ball valves where indicated on the plans for threaded pipe.
 - 2. Valves shall have a three-piece swing-out design.
 - 3. Valves shall have an adjustable three-piece stem packing.
 - 4. Provide blowout-proof stems on valves.
 - 5. Valve seats are to be supported by a small stainless steel coned disc spring which provides a positive sealing force at high and low pressures.
 - a. Seats are to automatically compensate for wear and thermal expansion.
 - 6. Seal flanges to center body section with O-rings which are fully contained and seal independently of the ball seat.
 - 7. Provide stem which rides on a Vespel thrust washer allowing lower operating torques and longer life.
 - 8. Materials of construction are as follows:

Body, ball, stem, gland	316 SS
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Flanges	316 SS
Stem packing, ball seats	TFE
Deformable glands	Ceramic filled TFE
Stem thrust washer	Vespel
Coned disc springs	316 SS
Grounding spring	316 SS
Flanged seals	Viton O-rings
All bolts and nuts	316 SS
Stop plate	316 SS
Nameplate	302 SS
Handle grip	Vinyl

9. Provide ball valves similar and equal to the Series "60" as manufactured by Whitey.

K. Valve Boxes:

1. Each valve buried in the ground shall be provided with an approved valve box and cover. The boxes shall be adjustable screw type made of close-grained gray cast iron, in three pieces, comprising of the lower base piece which shall fit around the stuffing box gland and rest on the valve bonnet, the upper part which shall screw onto the lower part and have a socket to receive the cover. The cover shall have the word "SEWER" cast on the upper surface in raised letters. All castings shall be thoroughly cleaned and heavily coated with asphalt or coal-tar varnish.
2. Each valve box shall be provided with a concrete valve marker and protector as detailed on the plans.
3. Each valve box shall be fitted with an extension stem for use with the buried service non-rising stem valves. The stem shall be of metal and used to extend the position of the 2" operating nut to within 4 feet of grade. Each stem shall be fitted with a self centering disk below the operating nut to keep the stem aligned in the valve box and minimize the amount of grit that can enter the valve box.

L. Trace Wire:

1. Trace wire shall be a 12-gauge green insulated copper wire.
2. Install in trench along the pipe. Splice trace wire in accordance with manufacturers recommendations.

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M. Metallic Detection Tape:

1. Provide 2" wide metallic detection tape on all buried PVC piping.
 - a. Provide 5.0 mil overall thickness with no less than a 50 gauge solid aluminum foil core.
 - b. Foil to be visible from both sides.
 - c. No inks or printing extended to the edges of the tape.
 - d. Encase printing to avoid ink rub-off.
 - e. Tensile strength - 28 lbs/inch.
 - f. Use heat set mylar inks.
2. Locate 12" below ground surface in pipe trench.
3. Color to be as indicated below:
 - a. Chemical lines - High visibility safety yellow.
 - b. Potable water lines - Safety precaution blue.
 - c. Sanitary sewer - Safety green.
 - d. Force mains, non-potable water and all other lines Safety Green.
4. Wording on tape shall indicate pipe contents.

3.05 Pipe Installation

- A. Excavation, pipe foundation materials, and backfill shall be in accordance with Section I, EXCAVATION.
- B. Install trace wire and metallic detection tape in accordance with Sections 3.04L and 3.04M.
- C. Request inspection prior to and immediately after placing bedding.
- D. PVC force main installation shall conform to ASTM D-2321 or ASTM D-2774. DIP force main installation shall conform to ASTM A-377.
- E. All sewer force mains shall be constructed with a minimum of three (3) feet of cover, unless justified by SCDHEC (e.g., use of ductile iron pipe may have cover less than three (3) feet) and approved by the City.
- F. There shall be at least a 10 foot horizontal separation between sanitary sewer force mains and potable water mains. There shall be an 18 inch vertical separation at a crossing as required by SCDHEC R.61-67.

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- G. For force mains, thrust blocking or restraint joints shall be provided at all changes in alignment greater than or equal to 30 degrees.
- H. Automatic air relief valves shall be placed at high points in the force main sewer to prevent air locking.
- I. Compaction testing will be performed in accordance with one of the following test methods. ASTM D1557, ASTM-D698, AASHTO-T180, ASTM-D1556, ASTM-D2922, ASTM-D3017.
- J. Moisture content testing will be performed in accordance with one of the following test methods. ASTM D1557, ASTM-D698, AASHTO-T180, ASTM-D1556, ASTM-D2922, ASTM-D3017.
- K. If tests indicate Work does not meet specified requirements, remove Work, replace and retest at no cost to Owner.
- L. Frequency of Tests: The frequency of testing shall be determined solely by the Engineer.
- H. Pressure Test: Pressure tests shall be performed on all completed sections of force main to the requirements of AWWA C600 (DIP) or AWWA C-605 (PVC). All pressure tests shall be performed in accordance with the following: All lines shall be cleaned and flushed with water prior to the test. All line segments shall be tested at a test pressure of twice the working pressure as directed by the Engineer or 150 psi, whichever is greater, held for a minimum period of two hours. The test gage shall be a 4 1/2 inch diameter, oil filled gage with a range of 0 - 160 PSIG. Any other type of gage must have a prior approval of the Engineer in order to be acceptable. The test gage shall be located at a location that is determined by the Engineer. The pipe section is considered to have failed the test if the line leakage exceeds the maximum allowable leakage as defined under AWWA C600 or AWWA C-605 over the duration of the test.
 - 1. No piping installation will be accepted until the leakage is less than the number of gallons per hour as determines by the formula:
L = 0.000007 SD x sq. root of P; where
L = allowable leakage in gallons per hour;
S = length of pipe tested in feet;
D = nominal diameter of pipe in inches; and
P = average test pressure in lbs. per sq. inch gauge.

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2. When testing against closed metal seated valves, an additional leakage per closed valve of 0.0078 gallons per hour per inch of nominal valve size will be allowed.
 3. Should any test of pipe disclose leakage greater than that specified above, locate and repair the defective joint or joints until the leakage is within the specified allowance, and at no additional cost to the Owner.
- I. Protect work until project close-out.

END OF SECTION

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