

## SECTION 12 - SANITARY SEWER SYSTEM

### 12.1 GENERAL

- A. Work included in this Section consists of all gravity sanitary sewers, force mains, manholes, valves, air vents and all related equipment or material as indicated on the construction plans.

#### 12.1.2 Reference Specifications are referred to by abbreviation as follows:

- A. American National Standards Institute ----- ANSI
- B. American Society for Testing and Materials ----- ASTM
- C. American Water Works Association ----- AWWA
- D. American Railway Engineering Association -- ---- AREA

### 12.2 PRODUCTS

12.2.1 Submit shop drawings on all products supplied and installed in the project in accordance with submittals procedures.

12.2.2 Provide certified test results of pipe testing.

#### 12.2.3 Underground Pressure Pipe

##### E. Ductile Iron Pipe

- 1. Ductile iron pipe shall meet the requirements of AWWA Class 52 and rubber-gasket joints shall meet the requirements of AWWA C111 3" through 24" pipe shall be, at a minimum, class 52 with a working pressure of 350 psi. Pipe shall have a single cement-mortar lining and a bituminous seal coat conforming to the requirement of AWWA C104. A minimum of 5% of the pipe furnished shall be gauged for roundness full length and so marked. Pressure class of pipe shall be increased if the specific installation warrants it.

##### F. Polyvinylchloride (PVC) Pipe

- 1. PVC pipe shall meet requirements of AWWA C900 (DR-14, CL. 200) for sizes up to 12". Joints shall be in accordance with manufacturer's instructions and ASTM D2564, D2464, D2467, D319, and F477. If working pressures over 150 psi are encountered ductile iron pipe shall be used. Cell classification for water pipe shall be 12454-B

G. Polyethylene pipe

1. 3 Inches and Smaller –Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350-02 with a cell classification of PE: 345464C. Pipe shall have a manufacturing standard of ASTM D2737 (copper tubing size), ASTM D2239 (iron pipe size, controlled inside diameter) and ASTM D 3035 (iron pipe size, controlled outside diameter). Pipe shall have a pressure class as specified on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, and per AWWA C901, have nominal burst values of three times the Working Pressure Rating (WPR) of the pipe. Pipe shall also have the following agency listing of NSF 14.
2. 4 Inches and Larger - Pipe shall be manufactured from a PE 3408 resin listed with the Plastic Pipe Institute (PPI) as TR-4. The resin material will meet the specifications of ASTM D3350 with a cell classification of PE: 345464C. Pipe shall have a manufacturing standard of ASTM F714. Pipe O.D. size shall be ductile iron pipe size (DIPS). Pipe shall be pressure class as indicated on the plans. The pipe shall contain no recycled compounds except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipes shall be suitable for use as pressure conduits, listed as NSF 61, and per AWWA C906. Pipe shall have a nominal burst value of three and one-half times the Working Pressure Rating (WPR) of the pipe. Peak flow water velocity of 5 ft/sec shall be used in the hydraulics engineering design.

12.2.4 Gravity Pipe

H. Polyvinylchloride (PVC)

1. For pipes sized 4-inch through 15-inch, pipe shall meet requirements of ASTM D3034 type PSM SDR-26 or of ASTM F1760 DR-26 having reprocessed-recycled content.
2. For pipe sized 18-inch through 27-inch, pipe shall meet requirements of ASTM D3212.

I. Ductile Iron

1. Ductile Iron Pipe shall meet the requirements of ductile iron pressure pipe minimum Class 52 or as recommended by the pipe manufacturer for the depth of bury whichever is greater.

#### 12.2.5 Pressure Pipe Underground fittings

##### J. Ductile Iron Fittings

1. Fittings for PVC pipe and DI pipe shall be ductile iron. Ductile iron fittings shall be in accordance with AWWA C110 or AWWA C153. Pressure ratings shall be a minimum of 350 psi for fittings 24-inch and smaller and 250 psi for 30-inch. All fittings shall have a single cement mortar lining on the interior and a bituminous seal coating on the exterior. Fittings shall have mechanical joints conforming to the requirements of AWWA C111. Bolts for mechanical joint fittings shall be high strength, corrosion resistant low alloy steel with hexagon nuts having a minimum yield point of 45,000 psi in accordance with AWWA C111. Mechanical joint bolts shall be torqued with a torque wrench as per manufacturer's recommendations.
2. Couplings for underground or buried service shall be ductile iron mechanical joint in accordance with underground ductile fittings in this section.

##### K. Polyethylene Pipe Fittings

1. Fittings for polyethylene pipe shall be manufactured specifically for the intended use and be approved by the piping manufacturer to be compatible with their product. All fittings shall have a working pressure rating equal to or greater than the pipe, and shall meet all requirements of NSF 61.
2. Butt Fusion Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02, and approved for AWWA use. Butt Fusion Fittings shall have a manufacturing standard of ASTM D3261. Molded & fabricated fittings shall have a pressure rating equal to the pipe unless otherwise specified in the plans. Fabricated fittings are to be manufactured using Data Loggers. Temperature, fusion pressure and a graphic representation of the fusion cycle shall be part of the quality control records. All fittings shall be suitable for use as pressure conduits, and per AWWA C906, shall have a nominal burst value of three and one-half times the Working Pressure Rating (WPR).
3. Electrofusion Fittings shall be PE3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Electrofusion

Fittings shall have a manufacturing standard of ASTM F1055. Fittings shall have a pressure rating equal to the pipe. All electrofusion fittings shall be suitable for use as pressure conduits, and per AWWA C906, have nominal burst values of three and one-half times the Working Pressure Rating (WPR).

4. Flanged and Mechanical Joint Adapters - Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D3261.

L. Thrust Restraint

1. Contractor shall install concrete thrust blocks at all tie in points and as indicated on the contract drawings or as directed by the Project Representative based upon field conditions. Thrust blocks shall be sized as indicated on the thrust block Standard Details. Concrete shall have 3,000 psi strength at 28 days, and shall meet the requirements of ASTM C94.
2. All pipe fittings, plugs, caps, tees, and bends in underground ductile iron or PVC piping shall be restrained utilizing Megalug Series 1100 retainer glands by EBAA Iron Sales, Inc. (or approved equal) for ductile iron pipe and Megalug Series 2000PV retainer glands by EBAA Iron Sales, Inc. (or approved equal) for PVC pipe. Glands shall be manufactured of ductile iron conforming to ASTM A 536-80. Restraining devices shall be of ductile iron heat treated to a minimum hardness of 370 BHN. Dimensions of the gland shall be such that it can be used with the standardized mechanical joint bell and tee-head bolts conforming to ANSI/AWWA A21.11 and C153/A21.53. Twist-off nuts shall be used to insure proper actuating of the restraining devices. The mechanical joint restraint device shall have a working pressure of at least 250 psi with a minimum safety factor of 2.
3. All ductile iron bell and spigot pipe joints shall be restrained using US Pipe Field Lok 350 type gaskets or harness type restraints utilizing Megalug Series 1700 retainer glands by EBAA Iron Sales, Inc. (or approved equal). If all joints are not required to be restrained the minimum restrained lengths and locations shall be indicated on the drawings. Gaskets shall be manufactured by the pipe manufacturer to be compatible with their pipe.
4. PVC pipe bell and spigot joints shall be restrained on either side of valves and fitting for a length to be indicated on the drawings. Harness type restraining devices shall be used on bell and spigot

pipe joints utilizing Megalug Series 2800 restraint harness by EBAA Iron Sales, Inc. (or approved equal).

#### 12.2.6 Above Ground or Exposed Pressure Pipe

##### M. Ductile Iron Pipe

1. Ductile iron pipe installed above ground, inside buildings or underground vaults, shall be flanged ductile iron pipe class 53 in accordance with AWWA C115 (ANSI A21.15). Unless indicated otherwise on the drawings, pipe shall have Class 125 flanged joints utilizing factory installed screwed flanges (no uniflange type flanges are permitted) meeting the requirements of ANSI B 16.1, outside coating shall be red primer, and gaskets for flanged pipe shall be 1/8" thick full face red rubber. All steel flanges mating to flat face flanges shall have the raised face machined off. Pipe shall have a single cement mortar lining with asphaltic seal coat meeting the requirements for AWWA C104.

##### N. Ductile Iron Fittings

1. Fittings for ductile iron pipe shall be flanged ductile iron in accordance with AWWA C110. Fittings up to 30" diameter shall have a minimum working pressure rating of 250 psi. Unless indicated otherwise on the drawings, pipe shall have Class 125 flanged joints meeting the requirements of ANSI B 16.1, outside coating shall be red primer, and gaskets for flanged pipe shall be 1/8" thick full face red rubber. Fittings shall have a single cement-mortar lining and a bituminous seal coat conforming to the requirement of AWWA C104.
2. Couplings for above ground or exposed service shall be Dresser Style 38 or approved equal. Transition couplings shall be Dresser Style 162 or approved equal. All couplings shall be rodded unless otherwise noted.
3. Flange adaptors shall only be used for final connections to equipment or to allow for disassembly of pipe for equipment maintenance in approved locations. Flange adaptors are not to be used to make up for misaligned pipe. Flanged Adaptors shall be JCM flanged coupling adaptors model 301R or approved equal. Uniflanges are not permitted.

##### O. PVC Pipe and Fittings

1. PVC pipe shall only be used for chemical piping in sizes 1" and smaller without special approval by the County Engineer.
2. All PVC pipe and fittings shall be socket weld schedule 80.

3. When transitioning from metal to PVC, the PVC adaptor shall always be a male NPT fitting inside of a female NPT metal fitting. Should the metal fitting be a male thread, a metal coupling shall be installed to provide a female thread for the PVC adaptor.

P. Stainless Steel Pipe and Fittings

1. All stainless steel pipe shall be Schedule 40 type 304 unless specified by equipment manufacturers or for chemical compatibility to be 316.
2. Stainless steel pipe shall be threaded with threaded fittings.

12.2.7 Plug valves

- Q. Plug Valves shall be the non-lubricated eccentric type with resilient faced plugs. Port area shall be at least 80 percent of the full pipe area. Bodies shall be cast iron with welded nickel, raised seats. Valves shall have permanently lubricated corrosion resistant bearings in the bonnet and body.
- R. Packing and packing glands shall be accessible without having to disassemble valves. Packing shall be adjustable.
- S. Valves shall have resilient plug facings suitable for the service intended and shall provide dead-tight shutoff. Opening the valve shall cause the plug to be raised off the seat without scraping the seat or body walls.
- T. Plug valves shall be gear operated unless otherwise shown or specified, and shall open counter-clockwise. Exposed plug valves (located above ground, inside buildings, valve vaults, etc.) shall be flanged and provided with gear operated hand wheel actuators complete with valve position indicators.
- U. Plug valves for direct burial service shall be provided with right angle worm gear operators. Buried valves shall be provided with adjustable cast-iron valve boxes and extension stems to grade.
- V. A tee wrench shall be provided for operation of the buried valve.
- W. Inside iron or steel surfaces of valves and exterior surfaces of valves which are to be buried in the ground shall be given two coats of asphalt varnish meeting the requirements of Fed. Spc. TT-V-51a. Exterior iron or steel surfaces of other valves shall be painted as specified for the pipelines in which they are installed.
- X. 4" plug valves must pass a 3" spherical solid.
- Y. Plug valves shall be Dezurik, Milliken or approved equal.

## 12.2.8 Check Valves

### A. Swing check valves

1. 3 inch and larger
  - a) Check valves 3” and larger shall be Class 125 flanged ends ductile iron body bronze mounted, bronze disc facing, swing type lever and weight check valves in accordance with AWWA C508. Flanged end dimension and drilling shall comply with ANSI B 16.1, Class 125. Check valves 3” through 24” shall have a 250 psig maximum working pressure.
  - b) Check valves shall have an adjustable air decelerator (air cushion) installed on the outside of the valve to control valve closing.
  - c) All check valves shall have a factory installed limit switch to indicate close position for flow confirmation.
  - d) Valves shall be Apco series CVS 250, Val-Matic series 7900S-S, Milliken Series 8501 or approved equal.
2. Check valves 2” and smaller shall be class 150 bronze or stainless steel y-pattern swing check valves with threaded ends. Valves shall be Crane figure 137 (bronze), Crane Aloyco figure 49 or approved equal.

## 12.2.9 Tracer Wire

- A. Copper tracer wire shall be THHN, 12 gauge, insulated with a green colored insulation. Wire shall be secured to the pipe every 8 feet and within 12 inches on either side of fittings.
- B. Tracer wire access boxes shall be installed no more than 1000 feet apart and adjacent to all inline valves on force mains. A concrete mow collar shall be installed at finished grade around all tracer wire access boxes.
- C. Wire Connectors
  1. Connector, Wire, Set Screw Pressure type for use with No. 12 stranded wire size.
  2. Holub Industries MA-2 or equivalent
  3. Ideal Industries Model 30-222 or equivalent

- D. Wire nuts shall not be allowed underground or in electric manholes or pull boxes.

#### 12.2.10 Tracer Wire Access Boxes

- A. The tracer wire access boxes shall be made of cast iron with a permanently attached 3" x 12" ABS tube with a flared end to secure it in the ground. Its tamper-resistant cast iron locking lid has stainless steel terminal connectors on the bottom side to which tracer wires are attached. Lid is opened using a standard AWWA pentagon key. Enough slack shall be coiled inside the box to allow the removal of the lid. Lid shall be marked sewer.

#### 12.2.11 Marking Tape

- A. Tape shall be 3.5 mill polyethylene tape 3" in width with a 14 gauge metallic core, with the continuous printed message, "Caution – Sewer Line Buried Below." Tape shall be style 48288 as manufactured by the Seton Safety and Identification or approved equal.

#### 12.2.12 Steel Casing Pipe

- A. Steel casing pipe for boring or jacking under highways and railroads shall meet the requirements of ASTM A139, Grade B. Nominal pipe diameter and wall thickness shall be as indicated on the Standard Drawings. No protective coating or lining will be required. Casing pipe laid in an open cut shall be, steel pipe.

#### 12.2.13 Manholes

- A. Precast reinforced concrete manholes shall be constructed in accordance with Standard Drawings for the type and size of manhole indicated on the Drawings.
- B. Provide tongue and groove joints in manhole sections with a preformed groove in the tongue for placement of an O-ring type round, rubber gasket.
  - 1. Gasket shall comply with requirements of ASTM C361.
  - 2. Gasket shall provide the sole element in sealing the joint from either internal or external hydrostatic pressure.
- C. Liners for acid-resistant manholes shall be of fiberglass reinforced polyester (FRP) or polyvinylchloride (PVC) or high-density polyethylene (HDPE) construction and shall be installed to protect the precast manhole sections from the inside base of the manhole to the base of the manhole frame. The connection of the pipe to the manhole shall be sealed with the liner in a



manner to eliminate any exposed concrete surfaces that could be subject to damage by corrosive gases.

1. FRP liners shall consist of a 3/16-inch thick fiberglass reinforced polyester with a 15 mil gel coat interior surface. The polyester resin shall be similar to Dion No. 6694. Joints between sections of the liner shall be sealed with joint sealant.
  2. PVC liners shall consist of polyvinylchloride plates, not less than 0.060-inch thick, with integral bonding ribs and shall be similar to Amercoat "T-Lock Amer-Plate". Joints between sections of liner shall be welded in accordance with the manufacturer's instructions by T-Lock certified welders.
  3. HDPE liners shall be AGRU "Sure Grip" HDPE Concrete Protective Liner. Joints between sections of the liner shall be welded in accordance with the manufacturer's instructions by Agru certified welders. Minimum liner thickness shall be 0.078 inches.
- D. Manhole steps shall be corrosion-resistant and shall be one-inch square cast iron, rubber-covered steel or aluminum. The steps shall conform to the dimensions shown in Standard Drawings. Manhole steps shall be aligned to minimize conflicts with future connections to manhole. For sewers up to 15 inches in diameter, steps should be placed over the bench. Manhole steps shall not be placed on the downstream side of the manhole. Steps shall be installed at a maximum spacing of 12 inches.
- E. Manhole frames and covers shall be molded of gray cast iron conforming to ASTM A48, Class 30. Castings shall be coated with a coal tar pitch varnish, to which sufficient oil has been added to make a smooth coating, tough and tenacious when cold, but not tacky or brittle. Seating surfaces between frame and cover shall be machined. The dimensions and weights shall conform to the requirements shown in Section 6 -Standard Drawings.
- F. Manhole frame and covers shall be manufactured by Capitol Foundry, Neenah Foundry, or approved equal. Manhole covers shall be labeled "SEWER"
- G. Manholes shall be supplied with flexible connectors to allow connection of sewer pipes to the manholes. The manholes shall be cored at the factory and supplied with the appropriate flexible connectors. The connector shall be Kor-N-Seal, Press-Seal with a stainless steel expander ring, or approved equal.
- H. Sealant for manhole frames shall be a one-component polyurethane sealant similar to Sika "Sikaflex" Series 1A.

#### 12.2.14 Surge Analysis

- A. A Surge Analysis shall be performed on sewer force mains under the following conditions:
  - 1. Pumping systems with a total dynamic head greater than 50 ft if the flow is greater than about 500 gal/min.
  - 2. High lift pumping systems with a check valve
  - 3. Any system in which column separation can occur including:
    - a) Systems with high points.
    - b) A force main that needs automatic air venting or air vacuum valves.
    - c) A pipe line with a long (more than 300 ft) steep gradient followed by a long, shallow gradient.
    - d) Force mains larger than 8 inches when longer than 1000 ft.

#### 12.2.15 Pressure Gauges

- A. Pressure gauges shall be mounted on a wafer pressure isolator ring (sensor ring) by the sensor ring manufacturer.
- B. Pressure gauges shall be of all stainless steel construction, 3.5 to 4 inch case size, accuracy of 1% over the entire dial arc and a 1/4" NPT bottom connection, Pressure range shall be as indicated on the drawings.
- C. Gauges shall be graduated so the system operating pressures are in the middle third of the scale.
- D. Pressure gauges shall be Ashcroft stainless steel case 1009 pressure gauges or approved equal.

#### 12.2.16 Wafer Pressure Isolators Ring (Sensor Ring)

- A. Wafer pressure isolator rings shall be designed to permit pressure measurement on slurries and other hard-to-handle fluids without compromising gauge function. Isolation ring shall consist of a metal ring with an elastomer inner tube filled with silicone instrument oil. Center section of isolator ring shall be carbon steel. End plates shall be Acetal Homo Polymer (or 316 stainless steel, Kynar, Teflon) and elastomeric sleeve shall be Nitrile (or EPDM, Viton).
- B. Wafer pressure isolator rings shall fit inside the bolt circle of 150# ANSI

flanges (or shall be provided with appropriate spacers for 300# or 600# flanges). Face to face length of the wafer pressure isolator ring shall conform to specification MSS-SP67. Wafer pressure isolator ring shall be flow through design with flexible rubber sleeve around full circumference. The center section shall have a cavity behind the rubber sleeve filled with silicone fluid to transfer pressure to the gauge.

- C. All pressure instruments attached to the wafer pressure isolator ring shall be rigidly supported by a post at least 0.875 inches diameter welded to the isolator. On wafer pressure isolator rings with more than one instrument, all connections shall be 1/2" NPT as a minimum. 1/4" NPT fittings are not acceptable. The wafer pressure isolator ring shall not have a fill plug that can be inadvertently removed with the resultant loss of fill fluid.
- D. The wafer pressure isolator ring shall be vacuum filled and permanently sealed at the factory with a modular seal consisting of a rubber membrane and needle fitting to allow removal and replacement of pressure instruments without compromising the vacuum fill. The needle fitting shall have both 1/4" NPT(F) thread and 1/2 NPT(M) threads. The wafer pressure isolator ring shall be capable of operating under pressure with all instruments removed with no loss of fill fluid, without isolating valves. Pressure instruments shall be attached to the wafer pressure isolator ring with a hand tightened lock ring. It shall be possible to remove, rotate or attach pressure instruments to the wafer pressure isolator ring without requiring the use of any tools. The wafer pressure isolator ring shall be permanently filled with high viscosity silicone instrument oil to damp out surges or pressure spikes without a separate snubber.
- E. Max operating pressure without leakage: 1,000 psig
- F. Wafer pressure isolator ring shall be Onyx Valve Co model PSW, Red Valve Company Series 40 or equal.

#### 12.2.17 Pipe Supports

- A. Pipes shall be supported by steel pipe hangers, clamps, brackets, rods and inserts as required to support the imposed pipe loads. Hangers in general shall be new, manufactured of carbon steel and hot dipped galvanized after fabrication or 304 stainless steel.
- B. Pipes 2 ½ inches and larger shall be supported with adjustable floor stand type pipe supports as detailed on the drawings. Pipe supports shall be Standon Model S89 flange support, Standon Model S96 cradle support as manufactured by Material Resources, Inc. or approved equal.
- C. Pipes 2" and smaller shall be supported from the floor, walls or ceiling depending on the type of building construction. Pipe supports for these size pipes shall be as manufactured by Unistrut Building Systems, B-Line or

approved equal. Supports shall consist of floor stands, wall brackets or clevis type hangers. Strut and appurtenances shall be stainless steel. Clips for copper tubing shall be copper coated. Minimum threaded rod size shall be 3/8 inch.

- D. Ductile Iron and steel pipe supports shall be spaced in accordance with the following schedule:

Pipe sizes (inches)	1/2 - 3/4	1 - 1 1/4	1 1/2 - 2	3 - 4
Max spacing (feet)	4	6	8	10

- E. PVC pipe supports shall be spaced in accordance with the following schedule:

Nominal pipe size (inches)	1/2 - 3/4	1 - 1 1/4	1 1/2 - 2	3 - 4
Max spacing (feet)	2.5	3	4	6

- F. Maximum spacing between pipe supports shall be 10 feet for all pipes 6" and above. This is a maximum spacing and does not take into account valves, fittings, flow meters, risers, drops and other devices. Locations where these are installed will require additional supports.

- G. In addition to the above, pipe supports shall be located as per the following:

1. Maximum spacing as indicated above.
2. Maximum of 12 inches from all horizontal and vertical changes in direction.
3. On the suction and discharge of pump piping to eliminate pipe stresses on the pump flanges.
4. On the connections to all equipment to eliminate pipe stresses on the equipment connections and allow equipment removal.
5. On the inlet and outlet piping to the water meter to allow the removal of the water meter.
6. At the location of valves, fittings or other devices that cause additions weight to the piping.
7. Additional pipe supports as indicated on the drawings.

### 12.3 EXECUTION

- 12.3.1 Take all precautions necessary to ensure that pipes, valves, fittings, and related items are not damaged in unloading, handling and placing in trench. Examine each

piece of material just prior to installation to determine that no damage has occurred. Remove any damaged material from the site and replace with undamaged material.

- A. Keep pipes clean. Exercise care to keep foreign material and dirt from entering pipes during storage, handling and placing in trench. Close ends of in-place pipes at the end of any work period to prevent entry of animals and foreign material.
- B. Bed pipe as specified in Section 9 - Trenching & Backfilling.
- C. Do not lay pipe when weather or trench conditions are unsuitable.
- D. Separation of sanitary sewer lines and water lines shall be in accordance with Virginia Department of Health Regulations.

#### 12.3.2 Gravity Sewer Pipe

- A. Lay gravity sewers so as to maintain a true alignment and grade as indicated on Drawings. After completion, the pipe shall exhibit a full circle of light when lighted at one manhole and viewed from the next.
- B. Commence laying gravity sewers at the lowest point on a section of line and lay pipe with the bell ends uphill.
- C. Pipe joint. Preparatory to making pipe joints on gravity sewer lines, clean and dry all surfaces of joint pipe and jointing material. Use lubricants, as recommended by the manufacturer. Place, fit, join and adjust the jointing materials or factory fabricated joints as recommended by the manufacturer to obtain the degree of water tightness required. As soon as possible after the joint is made, place sufficient backfill material, as specified under Section 9 - Trenching & Backfilling, along each side of the pipe to resist forces that might tend to move the pipe off line and grade and sufficient backfill to prevent floating.
- D. All sanitary sewer gravity mains buried underground shall have a detectable tracer buried in the trench approximately 18 inches above the conduit but no less than 18 inches below grade.
- E. Complete backfilling as specified under Section 9 - Trenching & Backfilling. Place backfill over the pipe immediately after the pipe has been laid. Provide ductile iron pipe where cover over main line sewer pipe is less than 5.5 feet in public roads and 3.5 feet in easements.

#### 12.3.3 Sewer Force Main

- A. Install force main with a minimum depth of cover of 42 inches over the top of the pipe where no grades are shown on the drawings.

- B. Where grades on the force main conflict with existing pipes or structures, lay force main to additional depth with a uniform vertical curve to provide proper clearance without the use of fittings. No additional payment will be allowed for additional excavation. Provide allowance for expansion as directed by County Engineer.
- C. Lay force main pipe with bell ends facing the direction of laying. Where grade is 10 percent or greater, pipe shall be laid uphill with bell ends upgrade.
- D. All sanitary sewer force mains buried underground shall have a detectable tracer buried in the trench approximately 18 inches above the conduit but no less than 18 inches below grade. The detectable tape shall comply with the product specifications as detailed in the previous Section 12.2.17.
- E. Copper tracer wire shall be taped directly to the top of the pipe and be installed in a continuous traceable manner. The tracer wire shall be connected to any air-release valves (ARV) along the force main alignment. The tracer wire shall comply with the product specifications as detailed in the previous Section 12.2.18.

#### 12.3.4 Joining Pipe

- A. Join mechanical joint pipe as follows:
  - 1. Thoroughly clean inside of the bell and 8 inches of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating and other foreign matter from the joint. Paint the bell and spigot with soap solution (half cup granulated soap dissolved in 1 gallon water). Slip cast-iron gland on spigot end with lip extension of gland toward end of pipe. Paint rubber gasket with or dip into the soap solution and place on the spigot end with thick edge toward the gland.
  - 2. Push the spigot end forward to seat in the bell. Then carefully press the gasket into the bell so that it is located evenly around the joint. The gland is moved into position, bolts inserted and nuts screwed finger tight, then tighten all nuts to torque listed below.

<u>Bolts Size- Inches</u>	<u>Torque Ft. - Lbs.</u>
5/8	40 - 60
¾	60 - 90
1	70 - 100
1 1/4	90 - 120

3. Tighten nuts on alternate sides of the gland until pressure on the gland is equally distributed.
4. Permissible deflection in mechanical joint pipe shall not be greater than ½ of that listed in AWWA C600.

B. Join push-on joint pipe as follows:

1. Thoroughly clean inside of the bell and 8 inches of the outside of the spigot end of the joining pipe to remove oil, grit, excess coating, and other foreign matter. Flex rubber gasket and insert in the gasket recess of the bell socket. Apply a thin film of gasket lubricant, supplied by pipe manufacturer, to the gasket and the spigot end of the joining pipe.
2. Start spigot end of pipe into socket with care. The joint shall then be completed by forcing the plain end to the bottom of the socket with a forked tool or jack type device. Field cut pipe shall have the end filed to match the manufactured spigot end.
3. Permissible deflection in push-on joint pipe shall not be greater than 1/2 of that listed in AWWA C600.

#### 12.3.5 Thrust Restraint

- A. Provide reaction anchors of concrete blocking at all points of tie-in to existing pressure pipe lines, Provide mechanical joint retainer glands at all fittings, valves, plugs, caps and other changes in directions or dead ends of pressure pipelines.
- B. Concrete reaction anchors shall bear against undisturbed earth and shall be of the size and shape indicated on the contract drawings.
- C. Use metal harness restraints for bell and spigot piping where as indicated on the contract drawings to be restrained.
- D. Use Mechanical Joint restraining glands for all Mechanical joint pipe as indicated on the drawings to be restrained.
- E. All pressure pipe joints at pump stations with-in the fence boundaries shall be restrained.
- F. On sewer force mains, restraint calculations shall be provided on the drawings and length of restrained joints shall be indicated on the drawings.

#### 12.3.6 Encase sewer pipe lines crossing under highways and railways in a steel casing pipe. The casing pipe shall be of the diameter and wall thickness indicated on the

Standard Drawings. Installation of the steel casing pipe shall be by jacking, boring or open cut if permitted.

- A. The installation shall meet the requirements for installation of pipelines carrying nonflammable substances under railway tracks. All permits shall be obtained prior to beginning work, from the Railway Company or VDOT. Copies of the permits shall be submitted to the County engineer for approval.
- B. Casing and carrier pipe shall be installed in accordance with the Standard Details.

12.3.7 Construct service connections from sewer main to property line as follows:

- A. Service connections shall be in accordance with the Standard Drawings.
- B. Place a wye and 45 degree fittings of the required size in accordance with the Standard Details where a service connection is to be constructed. Lay pipe from the connection to the property line on a grade of not less than 1/4 in. per foot for 4" pipe or 1/8 in. per foot for 6" pipe. Close service connection at the property line with a watertight plug.
- C. Install service connections on existing 12" and smaller sewer mains with a compression type wye cast iron saddle as manufactured by Geneco or approved equal. Secure saddle to the pipe with a 24 gauge stainless steel strap and two nickel-bronze T bolts. Make connections of this type by machine tapping or cutting the pipe. Use O-ring type gasket to ensure a watertight connection. On pipe larger than 12" a straight cast iron saddle may be used.
- D. Service connections from manholes shall be ductile iron or PVC pipe.
- E. Determine the depth of service connections by the deepest of the following:
  - 1. Provide 5 foot cover at the edge of the road paving or 15 feet from the centerline of the street.
  - 2. Provide 36 inches of cover at the bottom of highway ditches.
  - 3. Provide 5 feet of cover at the property line when property is above street.
  - 4. Where the above conditions cannot be met for a 4" pipe at 1/4" per foot slope, the line shall be changed to a 6" pipe at 1/8" per foot. If the 6" pipe cannot meet the above conditions the pipe shall be 6" ductile iron and incased in concrete where the depth of cover is less than 36 inches.



- F. Place a 2-inch x 4-inch solid piece of lumber at the end of each service connection. The 2-inch x 4-inch marker shall be set vertically and extend from the invert to six inches above grade.
- G. Provide ductile iron pipe where cover over service connections is less than 5.5 feet in public right of way and 3.5 feet in easements.

#### 12.3.8 Testing Gravity Sewer Lines and Manholes.

- A. All gauges used for testing shall be calibrated gauges with a minimum of a 4-1/2" dial with a mirrored back.
- B. Sanitary sewer lines 24 inches in diameter and smaller shall be tested after backfill using a low-pressure air test in accordance with ASTM C828. Sewer lines larger than 24 inches in diameter and manholes shall be tested by infiltration or exfiltration as hereinafter detailed. All sewer manholes shall be tested by a vacuum test in the presence of the County Inspector. Tests shall be conducted on short sections of sewer line, i.e., between manholes, or at the end of each day's work. Provide all labor, materials, tools, and equipment necessary to make the tests. All equipment and methods used shall be acceptable to the County Engineer.
- C. Testing of Gravity Sewer Pipes
  1. Testing: All structures required to be watertight and all piping and appurtenances shall be tested for leakage by CONTRACTOR under the direction of County.
  2. Gravity sewer pipes testing shall be done by air pressure test as specified herein.
  3. Air Test: CONTRACTOR shall plug the pipe and shall conduct a low pressure air test to determine the acceptability of the completed work. CONTRACTOR shall furnish all men, materials, and supplies necessary to assist in the conducting of this test. This air test shall conform to UNI-BB-6-79 or latest revision.
  4. The air testing equipment shall be Air-Lock, as manufactured by Cherne Industrial, Inc., or approved equal. All air used shall pass through a single control panel. Individual air hoses shall be used from control panel to pneumatic plugs; from control panel to sealed line for introducing low pressure air; and from sealed line to control panel for continually monitoring the air pressure rise in the sealed line.
  5. Pneumatic plugs shall have a sealing length equal to or greater than the diameter of the pipe tested. The plugs shall resist internal test pressures without requiring external bracing or blocking. Plugs shall be tested prior to installation in the pipe run. A joint of pipe

shall be sealed at both ends with the plugs to be used in the sewer test. Air shall be introduced into the plugs to 25 psi. The sealed pipe shall then be pressurized to 9 psi. The plugs shall withstand this pressure without bracing or movement. The tested line segment shall be plugged and pressurized to 4.0 psi greater than the ground water back pressure but not to exceed 9 psi. The line shall be allowed to stabilize for 2 minutes after pressurization. After the pressure has stabilized, the air pressure shall be decreased slowly to 3.5 psi (greater than ground water back pressure) and the timing shall commence. The time for the pressure to drop 1 psi from 3.5 psi shall be recorded. The minimum acceptable time durations are shown on Table I. If the elapsed time to drop 1 psi is less than that shown on Table I, then the air loss shall be considered excessive and the section of pipe has failed the test.

6. Summary of Method: Plug the section of the sewer line to be tested. Introduce low-pressure air into the plugged line. Use the quantity and rate of air loss to determine the acceptability of the section being tested.
7. Preparation of the sewer line: Flush and clean the sewer line prior to testing, thus serving to wet the pipe surface as well as clean out any debris. A wetted interior pipe surface will produce more consistent results. Plug all pipe outlets using approved pneumatic plugs with a sealing length equal to or greater than the diameter of the line being tested to resist the test pressure. Give special attention to laterals.
8. Ground Water Determination: Install a one-half inch capped galvanized pipe nipple, approximately 12 inches long, through the manhole on top of the lowest sewer line in the manhole. Immediately prior to the line acceptance test, the ground water elevation shall be determined by removing the pipe cap and blowing air through the pipe nipple into the ground so as to clear it, and then connecting a clear plastic hose to the pipe nipple. The hose shall be held vertically and a measurement of the height in feet of water over the invert of the pipe shall be taken after the water has stopped rising in the plastic hose.
9. Procedures: Determine the test duration for the section under test by computation from the applicable formulas shown in ASTM C828. The pressure-holding time is base on an average holding pressure of 3.0 psi gauge or a drop from 3.5 psi to 2.5 psi gauge.

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**TABLE I****SPECIFICATION TIME REQUIRED FOR A 1.0 PSIG PRESSURE DROP  
FOR SIZE AND LENGTH OF PIPE INDICATED Q=.0015****PART 1A**

<b>Pipe Diameter (in.)</b>	<b>Minimum Time (min:sec)</b>	<b>Length for Minimum Time (ft)</b>	<b>Time for Longer Length (sec)</b>	<b>Specification Time for Length (L) Shown (min:sec)</b>			
				<b>100'</b>	<b>150'</b>	<b>200'</b>	<b>250'</b>
4	3:46	597	.380 L	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:40	5:40
8	7:34	298	1.520 L	7:34	7:34	7:34	7:34
10	9:26	239	2.374 L	9:26	9:26	9:26	9:53
12	11:20	199	3.418 L	11:20	11:20	11:24	14:15
15	14:10	159	5.342 L	14:10	14:10	17:48	22:15
18	17:00	133	7.692 L	17:00	19:13	25:38	32:03
21	19:50	114	10.470 L	19:50	26:10	34:54	43:37
24	22:40	99	13.674 L	22:47	34:11	45:34	56:58
27	25:30	88	17.306 L	28:51	43:16	57:41	72:07
30	28:20	80	21.366 L	35:37	53:25	71:13	89:02
33	31:10	72	25.852 L	43:05	64:38	86:10	107:43
36	34:00	66	30.768 L	51:17	76:55	102:34	128:12

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**PART 1B**

Pipe Diameter (in.)	Minimum Time (min:sec)	Length for Minimum Time (ft)	Time for Longer Length (sec)	Specification Time for Length (L) Shown (min:sec)			
				300'	350'	400'	450'
4	3:46	597	.380 L	3:46	3:46	3:46	3:46
6	5:40	398	.854 L	5:40	5:40	5:42	6:24
8	7:34	298	1.520 L	7:36	8:52	10:08	11:24
10	9:26	239	2.374 L	11:52	13:51	15:49	17:48
12	11:20	199	3.418 L	17:05	19:56	22:47	25:38
15	14:10	159	5.342 L	26:42	31:09	35:36	40:04
18	17:00	133	7.692 L	38:27	44:52	51:16	57:41
21	19:50	114	10.470 L	52:21	61:00	69:48	78:31
24	22:40	99	13.674 L	68:22	79:46	91:10	102:33
27	25:30	88	17.306 L	86:32	100:57	115:22	129:48
030	28:20	80	21.366 L	106:57	124:38	142:26	160:15
33	31:10	72	25.852 L	129:16	150:43	172:21	193:53
36	34:00	66	30.768 L	153:50	179:29	205:07	230:46

10. Add air until the internal air pressure of the sewer line is raised to approximately 4.0 psi gauge. After an internal pressure of approximately 4.0 psig is obtained, allow time for the air pressure to stabilize. The pressure will normally show some drop until the temperature of the air in the test section stabilizes.
11. When the pressure has stabilized and is at or above the starting test pressure of 3.5 psi gauge, commence the test. Before starting the test, the pressure may be allowed to drop to the 3.5 psig. Record the drop in pressure for the test period. If the pressure has dropped more than 1.0 psi gauge during the test period, the line shall be presumed to have failed. The test may be discontinued when the prescribed test time has been completed even though the 1.0 psig drop has not occurred.
12. The test procedure may be used as a presumptive test which enables the installer to determine the acceptability of the line prior to backfill and subsequent construction activities.
13. If the pipe to be tested is submerged in ground water, the test pressure shall be increased to 1.0 psi for every 2.31 feet the ground water level is above the invert of the sewer.
14. Safety: The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared.

15. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts. In as much as a force of 250 lb./f. is exerted on an 8 inch plug by an internal pipe pressure of 5 psi, it should be realized that sudden expulsion of a poorly installed plug or of a plug that is partially deflated before the pipe pressure is released can be dangerous.
16. As a safety precaution, pressurized equipment shall include a regulator or relief valve set slightly over the test pressure to avoid over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.
17. Table: The air test table above has been prepared utilizing applicable formulas from ASTM C828-76T. It is based on an allowable air loss of 0.0015 cu. ft/minute per square foot of internal pipe surface, a maximum air loss per test section of 3.5 cu. ft/minute and a minimum significant air loss per test section of 1.0 cu. ft/minute. It applies when testing one pipe diameter only and for convenience ignores 4 inch and 6 inch lateral sewers, which in most instances create only insignificant differences in test time.

#### 12.3.9 Manhole Negative Air Pressure (Vacuum) Test

- A. Vacuum Test shall be in accordance with ASTM C1244.
  1. All lift holes and any pipes entering the manhole are to be plugged. A vacuum will be drawn and the vacuum drop over a specified time period is used to determine the acceptability of the manhole.
  2. The values recorded are applicable only to the manhole being tested and at the time of testing.
- B. Preparation of the Manhole.
  1. All lift holes shall be plugged.
  2. All pipes entering the manhole shall be temporarily plugged, taking care to securely brace the pipes and plugs to prevent them from being drawn into the manhole.
- C. Procedure.
  1. The test head shall be placed at the top of the manhole in accordance with the manufacturer's recommendations.
  2. A vacuum of 10 inches of mercury shall be drawn on the manhole, the valve on the vacuum line of the test head closed, and the vacuum

pump shut off. The time shall be measured for the vacuum to drop to 9 inches of mercury.

3. The manhole shall pass if the time for the vacuum reading to drop from 10 inches of mercury to 9 inches of mercury meets or exceeds the values indicated in Table 2.
4. If the manhole fails the initial test, necessary repairs shall be made by an approved method. The manhole shall then be retested until a satisfactory test is obtained.

**TABLE 2  
MINIMUM TEST TIMES FOR VARIOUS DIAMETER MANHOLES.**

Depth (ft.)	Diameter (in.)		
	48	60	72
	Time (sec.)		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	46	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89
24	59	78	97

5. For manholes less than 8 feet in depth the minimum value listed shall be used. For other manhole diameters or greater depths, refer to ASTM C1244.

- D. Test for leakage of gravity sewers using either the infiltration or exfiltration test. Allowable leakage shall be 100 gallons per inch of pipe diameter per mile per 24 hours up to a maximum of 2400 gallons per mile per 24 hours.

1. Use infiltration test when ground water is at least 4 feet above pipe crown along entire length of line to be tested. Plug the pipe at the upper manhole. Install suitable measuring device at the next lowest manhole. Measure the amount of water flowing through the outlet after flow has been stabilized.
  2. Ground water determination: Use same procedure as “low pressure air test” above.
  3. Use exfiltration test when ground water is less than 4 feet above the pipe crown. Plug the pipe at the lower manhole. Fill the line and manhole to 4 feet above pipe crown or top of manhole whichever is less. Let the water stand until pipe as reached maximum absorption and until all trapped air has escaped, 4 hours minimum. After maximum absorption is reached, refill manhole to original level. After 30 minutes, record difference in level and convert to gallons. Subtract manhole loss to obtain pipeline loss. Manhole loss is found by plugging inlet and outlet and filling manhole with water to 4 feet above pipe crown or top of manhole whichever is less. Let water stand one hour to reach maximum absorption. Refill to original level. After 30 minutes, check difference in level and convert to gallons. Manhole leakage shall not exceed 1/2 gallon per hour.
- E. All gravity sanitary sewers are to be CCTV'd prior to acceptance into the county system.

12.3.10 Force Main tests shall be as follows:

- A. Supply the pumps, water, calibrated gauges and meters, and all the necessary apparatus. Notify the Owner and County Engineer or his representatives at least 48 hours in advance of the test date and perform tests in presence of County Engineer or his representative.
- B. Hydrostatic pressure test. After the line has been backfilled and at least seven days after the last concrete anchor block was poured, a hydrostatic pressure test shall be performed. Carefully fill the system with water at a velocity of approximately 1 foot per second while necessary measures are taken to eliminate all air. After the system has been filled, raise the pressure by pump to 1-1/2 times the working pressure or 150 psi, whichever is greater. Measure the pressure at the lowest point in system with the gauge compensated for elevation. Maintain the pressure for at least two hours. If pressure cannot be maintained, determine the cause, repair and repeat the test until successful.
- C. A leakage test shall be conducted concurrently with the pressure test. Leakage shall be determined with a calibrated test meter, furnished by the Contractor. Leakage is defined as the quantity of water required to maintain

a pressure with 5 psi of the specific test pressure, after air has been expelled and the pipe filled with water. Leakage shall not exceed the amount calculated by the following formula:

$$L = \frac{SD\sqrt{P}}{133,200}$$

In which **L** is the allowable leakage, in gallons per hour; **S** is the length of pipeline tested, in feet; **D** is the nominal diameter of the pipe, in inches; and **P** is the average test pressure during the leakage test in pounds per square inch gauge.

- D. All visible leaks shall be repaired regardless of the amount of leakage.
- E. No leakage will be allowed for welded steel pipe. If leaks are revealed by test, make repair by re-welding. Peening of leaks will not be allowed.

#### 12.3.11 Manhole Connections

- A. Existing Manhole Tie-In: A flexible pipe-to-manhole connector shall be used in the connection of the sewer pipe to precast manholes, where stubs or bricked-up openings (B.U.O.) do not exist.
- B. The connector shall be installed by coring the manhole wall. Acceptable connectors shall be as specified. Connectors are to be installed in strict accordance with the manufacturer's recommendations.
- C. The connection shall be installed in the manhole wall by activating the expanding mechanism in strict accordance with the recommendation of the connection manufacturer.
- D. The connector shall be of a size specifically designed for the pipe material and size being utilized on the project.
- E. This provision shall apply to both main line and service connections.

#### 12.4 CCTV INSPECTION

12.4.1 Work included in this Section consists of all gravity sanitary sewers and all related equipment or material as indicated on the construction plans.

#### 12.4.2 Required Deliverables:

- A. Submit a letter of CCTV completion.
- B. Submit a CD of the information as discussed below.



- 12.4.3 For new installations, the Contractor shall, following construction, conduct a final video inspection of all gravity pipes and a visual inspection of all manholes and wet wells) Copies of reports of this inspection shall be submitted to the County Engineer for approval.
- 12.4.4 The Contractor shall be responsible for all traffic control related items. This shall include flagging, all applicable signage, and/or detours as designated by the more stringent authority in the design plans, the Goochland County Standards and Specifications, and the VDOT MUTCD design manual (latest editions of all.)
- 12.4.5 After cleaning, the manhole sections shall be visually inspected by means of closed-circuit television. The inspection will be done one manhole section at a time and the flow in the section being inspected will be suitably controlled as specified. All CCTV inspections shall be performed in accordance with PACP standards including the specific date and time of inspection.
- 12.4.6 The television camera used for the inspection shall be one specifically designed and constructed for such inspection. Lighting for the camera shall be suitable to allow a clear picture of the entire periphery of the pipe. The camera shall be operative in 100% humidity conditions. The camera, television monitor, and other components of the video system shall be capable of producing picture quality to the satisfaction of the Owner's Representative; and if unsatisfactory, equipment shall be removed and no payment will be made for an unsatisfactory inspection.
- 12.4.7 The camera shall be moved through the line in either direction at a moderate rate, stopping when necessary to permit proper documentation of the sewer's condition. In no case will the television camera be pulled at a speed greater than 30 feet per minute. Manual winches, power winches, TV cable, and powered rewinds or other devices that do not obstruct the camera view or interfere with proper documentation of the sewer conditions shall be used to move the camera through the sewer line. If, during the inspection operation, the television camera will not pass through the entire manhole section, the Contractor shall set up his equipment so that the inspection can be performed from the opposite manhole. If, again, the camera fails to pass through the entire manhole section, the inspection shall be considered complete noted as Survey Abandoned and no additional inspection will be required.
- 12.4.8 Camera head shall rotate at all joints and lateral connections to show a 360 degree picture.
- 12.4.9 When manually operated winches are used to pull the television camera through the line, telephones or other suitable means of communication shall be set up between the two manholes of the section being inspected to insure good communications between members of the crew.
- 12.4.10 The importance of accurate distance measurements is emphasized. Measurement for location of defects shall be above ground by means of a meter device. Marking on the cable, or the like, which would require interpolation for depth of manhole,

will not be allowed. Accuracy of the distance meter shall be checked by use of a walking meter, roll-a-tape, or other suitable device, and the accuracy shall be satisfactory to the Owner's Representative. Documentation of the television results shall be as follows:

- A. Television Inspection Logs: Electronic media location records shall be kept by the Contractor and will clearly show the location, by distance in 1/10 of a foot or nearest mm, from the manhole wall, in relation to an adjacent manhole of each infiltration point observed during inspection. In addition, other points of significance such as locations of building sewers, unusual conditions, roots, storm sewer connections, cracks, fractures, broken pipe, presence of scale and corrosion, and other discernible features, as defined in the PACP defect codes, will be recorded on electronic media and a copy of such records will be supplied to the Owner.
- B. Digital photographs of the pipe condition and all defects shall be taken by the Contractor. Photographs shall be located by distance in 1/10 of a foot or nearest mm, from the manhole wall, in relation to an adjacent manhole.
- C. Electronic media recordings: The purpose of electronic media recording shall be to supply a visual and audio record of problem areas of the lines that may be replayed by the Owner. Each original electronic media recording of conditions and defects will be delivered to the Customer upon completion of a specific line section.
- D. All CCTV Inspection be performed by CCTV personnel who are trained and certified in the use of NASSCO's Pipeline Assessment and Certification Program (PACP)©.

#### 12.4.11 Payment

- A. Only the linear foot for each existing pipe segment will be measured for payment. No additional payment will be made for measurements made from the center of manholes or by using the CCTV footage if the footage starts recording prior to entering the pipe segment or after exiting the pipe segment.

12.4.12 No reimbursement will be made by Goochland County for any delays caused by others.

END OF SECTION 12