

SECTION 107
SANITARY SEWER SYSTEM

107.1 GENERAL

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.

107.1.1 Related requirements specified in other Sections of the Specifications:

- A. Section 103 - Site Clearing
- B. Section 104 - Trenching & Backfilling
- C. Section 105 - Rock Excavation
- D. Section 106 – Seeding
- E. Section 109 - Water Distribution System

107.1.2 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

107.2 PRODUCTS

107.2.1 Submit shop drawings on all products as required by City.

107.2.2 Provide certified test results of pipe testing.

107.2.3 Non-reinforced concrete pipe, fittings and specials in sizes 6 in. through 10 in. shall meet requirements of ASTM C14 Class 2. Pipe ends shall have O-ring gasket groove provided during manufacturing process.

- A. Rubber gaskets and joints of concrete pipe shall meet requirements of ASTM C361.
- B. Pipe and joints shall be tested in accordance with Section 9 of ASTM C14 and ASTM C443 with test reports submitted to the Engineers.

- 107.2.4 Reinforced concrete pipe in sizes 12 in. and larger shall meet requirements of ASTM C76 for the class shown on the Drawings. Pipe end shall have O-ring gasket groove provided during manufacturing process.
- A. Rubber gaskets and joints of concrete pipe shall meet requirements of ASTM C361.
 - B. Pipe and joints shall be tested in accordance with Section 9 of ASTM C14 and ASTM C443 with test reports submitted to the Engineers.
- 107.2.5 Polyvinylchloride (PVC) non pressure pipe and fittings shall meet requirements of ASTM D3034 type SDR-35 for 4" - 15" diameter pipe with elastomeric gasket joints. PVC Pipe 18" and larger must have prior approval from the City. All PVC pipe shall have a smooth interior and exterior wall. Fittings and saddles shall be by the same manufacturer of the pipe.
- 107.2.6 Conduits of non-ferrous material buried underground shall have a detectable tracer buried in the trench approximately 18 inches above the conduit, but no less than 24 inches below grade. Detectable tape shall have a metallic core, 14 gage or larger, protected by a plastic jacket. The tape shall be continuously marked indicating that a sewer line is buried beneath the tape. Copper wire, 14 gage or larger.
- 107.2.7 Ductile iron pipe shall meet requirement of AWWA C151 for the pressure and thickness classes shown on the Drawings. Pipe shall have cement-mortar lining and a bituminous seal coat. Thickness shall meet requirements of AWWA C150.
- 107.2.8 Cast iron and ductile iron fittings shall meet requirements of AWWA C110 or AWWA C153 for the pressure ratings indicated on Drawings. Fittings shall have cement-mortar lining and a bituminous seal coat.
- 107.2.9 Mechanical joints and jointing materials shall meet requirements of AWWA C111.
- A. Mechanical joint retainer glands shall meet requirements of AWWA C111. Retainer gland shall be fitted with set screws.
 - B. Metal harness shall be galvanized rods and clamps as detailed on Drawings.
- 107.2.10 Push-on joint and rubber gasket shall meet requirements of AWWA C111.
- 107.2.11 Flanged joints for ductile iron pipe shall meet requirements of ANSI B16.1.

- 107.2.12 Flanged joint gaskets shall be full face, made of 1/16 in. thick rubber, and shall meet requirements of ANSI B16.21.
- 107.2.13 Cement mortar lining with bituminous seal coat for cast iron pipe and fittings or ductile iron pipe shall meet requirements of AWWA C104. Cement mortar lining shall be standard thickness.
- 107.2.14 Exterior, bituminous coating for cast iron and ductile fittings and ductile iron pipe shall meet requirements of AWWA C106 or AWWA C151 as applicable.
- 107.2.15 When specified, steel casing pipe for boring or jacking or open cutting under highways and railroads shall meet the requirements of ASTM A139, Grade B. Nominal pipe diameter shall be as indicated on the Drawings. Wall thickness shall be a minimum 0.375". No protective coating or lining will be required. The carrier pipe shall be supported by full diameter, mechanically adjusted spacers, 8" on center.
- 107.2.16 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 pre-formed groove in the tongue for placement of an O-ring type round, rubber gasket.
 - (1) Gasket shall comply with requirements of ASTM C443.
 - (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 reinforce polyester or polyvinylchloride 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.
 - (1) FRP liners shall consist of 3/16 in. 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 in. 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.

- 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.
- 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 Standard Drawings. Frames and covers to be set in the street shall be set flush with the finished road surface.
- F. Flow Lines - The minimum depth of flow channel shall be equal to $\frac{3}{4}$ the diameter of the largest sewer in the manhole to which it connects. The channel shall be graded to give a smooth, uninterrupted flow through the manhole. Bench walls shall be pitched a minimum of 1 inch per foot from the inside periphery of the manhole to the edge of the flow channel.
- G. Connections to manholes shall be with boot type flexible connectors cast in the manhole. Any relocated or additional connections to a manhole will be by core drilling the manhole wall and installing the flexible boot by an approved expanding mechanism. The connector shall be the size specifically designed for the pipe material and the size being used on the project. Pipe connector shall be by Press Seal Gasket Corporation or approved equal.

107.2.17 Plug valves.

- A. Plug valves shall be the non-lubricated eccentric type with resilient faced plugs. The port area shall be at least 80 percent of the full pipe area. Bodies shall be cast iron with welded in nickel, raised seats. Valves shall have permanently lubricated corrosion resistant bearings in the bonnet and body.
- B. Packing and packing glands shall be accessible without having to disassemble valves. Packing shall be adjustable.
- C. 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.
- D. Plug valves shall be gear operated, unless otherwise shown or specified, and shall open counter-clockwise.

- E. Plug valves located inside the pumping station shall be provided with hand wheel actuators complete with valve position indicators.
- F. The maximum pull required on manual operators shall be 40 pounds.
- G. Plug valves for direct buried service shall be provided with right angle worm gear operators. Buried valves shall be provided with adjustable cast-iron valve boxed and extension stems to grade.
- H. A tee wrench shall be provided for operation of the buried valve.
- I. 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. Spec. TT-V-51a. Exterior iron or steel surfaces of other valves shall be painted as specified for the pipelines in which they are installed.
- J. Plug valves shall be Series 100 eccentric valves as manufactured by Dezurik, or equal.

107.2.18 Cleanout cover

- A. Traffic bearing cleanout covers shall be 12" diameter, Neenah Foundry R-1791-A or equivalent.

107.3 EXECUTION

- 107.3.1 Take all precautions necessary to insure that pipe, valves, fittings, and related items are not damaged in unloading, handling and placing in the 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 pipe at the end of any work period to prevent entry of animals and foreign material.
 - B. Bed pipe as specified in Section 104 - 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.

- 107.3.2 Lay gravity sewers so as to maintain a true alignment and grade as indicated on Drawings. After completion, the pipe shall be videotaped and recorded for its entire length using a self-propelled camera specifically designed for this service. Reference Section 114 "Television Inspection for Sewer Mains".
- A. Commence laying gravity sewers at the lowest point on a section of line and lay pipe with the bell ends uphill.
 - B. Pipe Joint. Preparatory to making pipe joints on gravity sewer lines, clean and dry all surfaces of joint pipe and jointing material. Use lubricants, primers, adhesives and similar materials 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 104 - Trenching and Backfilling, along each side of the pipe to resist forces that might tend to move the pipe off line and grade.

Damaged joints or pipe shall be repaired with a solid nonflexible water tight coupling.
 - C. Complete backfilling as specified under Section 104 - Trenching & Backfilling. Place backfill over the pipe immediately after the pipe has been laid.
- 107.3.3 Install force main with a minimum depth of cover of 42 in. over the top of the pipe, where no grades are shown on the Drawings.
- A. 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.
 - B. 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.
- 107.3.4 Joining Pipe
- A. Joining Mechanical Joint Pipe
 - (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 a soap solution (half cup granulated soap dissolved in one (1) gallon water). Slip the cast-iron gland on the spigot end with the lip

extension of the gland toward the end of the pipe. Paint rubber gasket with or dip into the soap solution and place it 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 are inserted and nuts screwed up finger tight; then tighten all nuts to torque listed below.

Bolts Size - Inches	Torque Foot-Pounds
5/8	40-60
3.4	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 listed in AWWA C600.

B. Joining 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 the rubber gasket and insert it in the gasket recess of the bell socket. Apply a thin film of gasket lubricant supplied by the pipe manufacturer, to either the gasket or the spigot end of the joining pipe.
- (2) Start the spigot end of the pipe into the 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 2/3 of that allowed in AWWA C600.

C. Joint reinforced concrete pipe with rubber gaskets installed as recommended by the manufacturer.

107.3.5 Provide reaction anchors of concrete blocking, metal harness or retainer gland type at all changes in direction of pressure pipelines and as shown on the Drawings.

- A. Concrete reaction anchors shall bear against undisturbed earth and shall be of the size and shape indicated on the Drawings.
- B. Use metal harness restraints as indicated on Drawings.

107.3.6 When specified encase sewer pipe lines crossing under highways and railways in a larger pipe or conduit used as a casing pipe. Joining of steel casing pipe shall meet requirements of AWWA C206. Install casing pipe by jacking, boring or open cut if permitted. The carrier pipe shall be supported by full diameter, mechanically adjusted spacers, 8' on center.

The installation shall meet AREA requirements for installation of pipe lines carrying nonflammable substances under railway tracks. Brick up casing pipe ends so as to protect against foreign matter but do not tightly seal. Prior to beginning work, notify the Railroad or Street Department.

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

- A. Place a tee fitting with 4 or 6-inch outlet in the sewer where service connection is to be constructed. Lay pipe from the tee to the property line on a grade of not less than 1/4 inch per foot. Close the service connection at the property line with a water-tight clean out plug left 2' above finished grade. Provide a water tight plug at the end of the service line.
- B. Install service connections on existing sewer mains with a compression type cast iron saddle as manufactured by Romac 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 mastic sealer type gasket to insure a water-tight connection.
- C. Service connections from manholes shall be ductile iron or PVC pipe.
- D. Determine the depth of service connection by the deepest of the following criteria:
 - (1) Provide 5-foot cover at the edge of the road paving or 15 feet from the center line of the street.
 - (2) Provide 12 inch cover at the bottom of highway ditches.
 - (3) Provide 5-foot cover at the property line when property is above street.

- (4) Provide depth necessary for a 1 percent grade if required to provide service to a property.

107.3.8 Install detectable tracer wire in utility trench above all non-metallic pipes in accordance with manufacturer's recommendations. Install tape approximately 12 to 18 inches above the pipe, not less than 24 inches nor more than 54 inches deep along the side of the trench, in such a manner as not to be broken or otherwise damaged during backfilling or compacting operations. A 14-gauge copper wire shall be installed with all non-metallic pipe and attached to fittings in addition to metallic tape installed above the pipe,

107.4 TESTING

107.4.1 Testing gravity sewer lines and manholes:

- A. Sanitary sewer lines 24-inch diameter and smaller shall be tested after backfill using a low-pressure air test in accordance with ASTM C828. Sewer lines larger than 24-inch diameter shall be tested by infiltration or exfiltration as hereinafter detailed. All sewer lines and manholes shall also be tested for final acceptance, using either the infiltration or exfiltration method as directed by and in the presence of the City Engineer. Tests shall be conducted on short sections of sewer line, i.e., between manholes, and/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 Engineer. All monitoring gauges shall be subject to City calibration, if deemed necessary by the City Engineer.
- B. All main lines shall have a television inspection performed in accordance with section 114 of the City of Staunton Design and Construction Standards, and any applicable NASSCO standards.
- C. Low-pressure air test:
 - (1) Summary of Method: Plug the sections 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.
 - (2) Preparation of the sewer line: Flush and clean the sewer line prior to testing, in order 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.

- (3) Ground Water Determination: Install a 1/2 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.
- (4) 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 based on an average holding pressure of 3 psi gauge or a drop from 3.0 psi to 2.5 psi gauge.

Add air until the internal air pressure of the sewer line is raised to approximately 3.5 psi gauge. After an internal pressure of approximately 3.5 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.

When the pressure has stabilized (5-minute minimum) and is at or above the starting test pressure of 3.0 psi gauge, commence the test. Before starting the test, the pressure may be allowed to drop to 3.0 psig. Record the drop in pressure for the test period. If the pressure has dropped more than 0.5 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 0.5 psig drop has not occurred.

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.

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.

- (5) Safety: The air test may be dangerous if, because of lack of understanding or carelessness, a line is improperly prepared. It is extremely important that the various plugs be installed and braced in such a way as to prevent blowouts.

As a safety precaution, pressurized equipment shall include a regulator or relief valve set at perhaps 10 psi or less to avoid

over-pressurizing and damaging an otherwise acceptable line. No one shall be allowed in the manholes during testing.

D. Manhole Tests

- (1) Manholes shall be tested by vacuum test, after assembly but prior to backfilling. Test shall comply with ASTM standard C1244, latest revision. Manholes shall be tested by vacuum, only if constructed of precast concrete. Testing shall include the joint between the concrete cone and spacer ring.
- (2) Stub outs, manhole boots and pipe plugs shall be secured to prevent movement while vacuum test is drawn.
- (3) Installation and operation of vacuum equipment and indicating devices shall be in accordance with equipment specifications for which performance information has been provided by the manufacturer and approved by the Virginia State Department of Health.
- (4) A measured vacuum of 10 inches of mercury shall be established in the manhole. The time for the vacuum to drop to nine inches of mercury shall be recorded.
- (5) Acceptance standards for leakage shall be established from the elapsed time for a negative pressure change from 10 to 9 inches of mercury. The maximum allowable leakage rate for a four-foot diameter manhole shall be in accordance with the following:

Manhole Depth	Minimum Elapsed Time for a Pressure Change of 1 Inch Hg
10ft. or less	60 seconds
>10ft. but <15ft.	75 seconds
>15ft. but <25ft.	90 seconds

For manholes five feet in diameter, add an additional 15 seconds and for manholes six feet in diameter, add an additional 30 seconds to the time requirements for four-foot diameter manholes.

- (6) If the manhole fails the test, necessary repairs shall be made and the test repeated one time.

- (7) If a manhole fails the second test or if the joint mastic is completely pulled out during the vacuum test, the manhole shall be disassembled and the mastic replaced
- E. 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 2,400 gallons per mile per 24 hours.
- (1) Use the 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 a 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 the 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 the manhole to 4 feet above pipe crown or top of the manhole whichever is less. Let the water stand until pipe has reached maximum absorption and until all trapped air has escaped, 4-hour minimum. After maximum absorption is reached, refill the manhole to original level. After 30 minutes, record difference in level and convert to gallons. Subtract the manhole loss to obtain pipe line loss. Manhole loss is found by plugging inlet and out let 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 the original level. After 30 minutes, check difference in the level and convert to gallons. Manhole leakage shall not exceed 1/2 gallon per hour.

107.4.2 Force Main tests shall be as follows:

- A. Supply the pumps, water, calibrated gauges and meters, and all the necessary apparatus. Notify the City Engineer at least 48 hours in advance of the test date and perform tests in presence of the City Engineer.
- 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 50 psi above working pressure indicated on Drawings. Measure pressure at lowest point in system with gauge

compensated for elevation maintain this 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 within 5 psi of the specified test pressure after air has been expelled and the pipe filled with water. Leakage shall not exceed 10 gallons per day per mile per inch of diameter. If leakage exceeds that specified, find and repair the leaks and repeat the test until successful.
- D. All visible leaks shall be repaired regardless of the amount of leakage.

107.5 MEASUREMENT AND PAYMENT

- 107.5.1 Sewer Line - Pipe measurement shall be parallel to the pipe including the lengths occupied by appurtenances. The bid price is to include all excavation, bedding and backfill as shown on the plans or standard drawings. Payment shall be per linear foot for the size and type specified. When indicated on the Bid Schedule, payment will be per linear foot for the size and type specified.
- 107.5.2 Service Line - Pipe measurement shall be parallel to the pipe including the length occupied by appurtenances. The bid price is to include excavation, bedding, backfill, and any intermediate bends and cleanouts. Payment shall be per linear foot for the size and type specified.
- 107.5.3 Service Connection - Service connections shall be paid per each for the size specified. The bid price is to include all excavation bedding, backfill, saddles, sleeves, coupling, cleanout and other appurtenances necessary for a complete service connection.
- 107.5.4 Manhole - Manhole measurement will be from the bottom of the frame and cover to the flow line. The bid price is to include the manhole, steps, invert, flexible boot and any excavation and backfill required to complete installation. Payment will be per vertical foot.
- 107.5.5 Manhole Frame and Cover - this will be measured and paid for per each for the type specified (Standard or Watertight).
- 107.5.6 Drop Manhole - Measurement and Payment will be by the vertical footage the pipe drops. This is in addition to the vertical foot cost of the manhole.

END OF SANITARY SEWER SYSTEM