

**Town of Pittsboro
Standard Specifications**

**SECTION 4
SANITARY SEWER SYSTEMS**

4.01 FORCE MAINS

4.02 GRAVITY SEWER MAINS

4.03 SEWER MAIN INSTALLATION

4.04 MANHOLES

4.05 SERVICE CONNECTIONS

4.06 TESTING AND INSPECTIONS

4.07 AERIAL CROSSINGS

4.08 REPAIRS AND MODIFICATIONS

Town of Pittsboro Standard Specifications

SECTION 4 SANITARY SEWER SYSTEMS

These Specifications apply to all sanitary sewer systems that are to be owned, operated, and maintained by the Town of Pittsboro. All aspects of the design of sanitary sewer systems and associated facilities shall, at a minimum, meet the requirements of the latest version of the NCDEQ "Minimum Design Criteria for the Fast-Track Permitting of Pump Stations and Force Mains". Requirements presented in the Town Standard Specifications hereunder that are more restrictive than the requirements of the Minimum Design Criteria are required by the Town of Pittsboro. All aspects of the design of sanitary sewer systems and associated facilities shall be submitted for review and approval to the Town Engineering Department.

4.01 FORCE MAINS

Wastewater force main interconnections shall be prohibited. In instances where this cannot be avoided, "Y" interconnections may be implemented and first approved by the Town. All wastewater force mains shall extend to the nearest gravity sewer or pump station wet well that has sufficient long-term capacity.

1. DESIGN

Force mains shall be installed with a minimum cover of 4 feet measured from the top of the pipe to the finished grade.

Force mains shall be installed in dedicated public right of way or in dedicated utility easements as follows. When wastewater force mains are constructed adjacent to gravity sewer mains or for construction of parallel wastewater force mains, the minimum horizontal clearance shall be at minimum 7-ft from pipe edge to pipe edge when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft up to installation depth of 10-ft. Clearances for pipelines greater than 10-ft depth shall be designed by Engineer of Record and approved by the Town Engineering Department. Easement widths outlined below shall be widened by at least the clearance between the pipelines when constructing a shared gravity sewer and wastewater force main corridor.

Table 4.1: Standard Easement Width for Sewer Force Mains		
Pipe Diameter	Pipe Depth	Easement Width
8-inch to 12-inch	10-ft or less	20-ft
8-inch to 12-inch	10-ft to 12.5-ft	25-ft
8-inch to 12-inch	12.5-ft to 15-ft	30-ft
8-inch to 12-inch	15-ft to 17.5-ft	35-ft
8-inch to 12-inch	17.5-ft to 20-ft	40-ft
12-inch to 24-inch	15-ft or less	30-ft
12-inch to 24-inch	15-ft to 17.5-ft	35-ft
12-inch to 24-inch	17.5-ft to 20-ft	40-ft
Greater than 24-inch	Any Depth	Specified by the Town Engineering Director
Any Size	Deeper than 20-ft	

Dedicated easements for force mains and appurtenances shall be recorded as “Town of Pittsboro Utility Easement”. Town force main easements shall contain only Town utilities unless otherwise approved by the development plan or an encroachment agreement.

Access easements to allow sufficient means of gaining entrance to proposed Utility and Pipeline Easements may be required by the Utilities Department where conventional access from the public right-of-way is limited or infeasible.

Wastewater force main discharge manholes and intermediate air release locations that require odor control shall be provided with sufficient easement area to accommodate the odor control systems as designed by the Engineer of Record, whether utilizing passive, forced-air or chemical treatment for odor control. The maintenance easement for odor control systems shall be sized based on site specific conditions and shall provide sufficient area for routine maintenance operations, such as refilling media, chemicals, replacing equipment, etc.

Force mains shall discharge at the invert of the receiving manhole and shall be as close as possible to 180 degrees from the outlet pipe.

Force main design shall facilitate cleaning and inspection. The use of 90-degree bends is prohibited.

Force mains shall be constructed with a pigging/emergency connection located within 50-ft of the pump station valve vault.

Force main minimum design velocity shall not be less than 2.5-ft per second throughout the length of the force main. As a design preference, force main systems when operating at higher flows shall reach velocities of 3 to 5 ft/s to resuspend any settled solids. Force main systems shall be of adequate sizing and design to effectively convey the ultimate peak flows as applied by the connected pump station to the discharge point.

The force main route shall be such that the number of high points requiring combination air valves is minimized to the extent possible. Combination Air Valves rated for use with raw wastewater shall be installed at all the high points or runs exceeding 3000-ft on all force mains in accordance with the

Standard Details. A high point shall be determined as any location where the vertical separation between the adjacent low point and high point in the force main is greater than or equal to 10 vertical feet.

A plug valve shall be installed at least every 3000 feet of force main length.

All air release valves, plug valves greater than 12-inches, or other appurtenances that have moving or operating parts and require maintenance and routine access shall have a manhole placed over them or over the operating portion of the device.

A. Restraint

1. **General:** All valves and fittings shall be restrained. Pipe joints shall also be restrained an adequate length away from valves and fittings in accordance with AWWA manual M41 (or the latest edition of Thrust Restraint Design for Ductile Iron Pipe as published by the Ductile Iron Pipe Research Association). In all cases, there must be a pipe restraint plan with the method of restraint to be used and the length of pipe to be restrained clearly identified on the plans at all necessary locations. The pipe restraint plan shall be included under the design responsibility of the NC Professional Engineer sealing the plan drawings.
2. **Pipe Joints:** The standard joint restraint method shall be to use manufacturer provided restrained joint pipe. Pipe up to and including 12-inches in diameter may also utilize either mechanical joint pipe with approved wedge action retainer glands (for the specified distance) or reaction blocking at fittings as an alternative. All joint restraint products that include the means of restraint within the joint gasket shall be prohibited.
3. **Valves:** Valves shall be restrained in a manner consistent with operation as a dead end. This includes restraining the valve to the pipe and restraining a sufficient number of pipe joints on both sides of the valve to accommodate dead end restraint.

B. Installation & Separation Requirements

Installation Below the Water Table

For installations below the water table, a single layer of engineering fabric shall be installed between the pipe and trench floor/trench wall. The fabric shall fully encapsulate the force main, bedding, and embedment material with a minimum of 12-inch overlap at the top of the embedment material.

Utility Coordination

Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

1. **Separation between Sewer Main and Storm Water Pipes:** Sewer mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for

water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or minimum 500-psi, quick setting, non-excavatable flowable fill that meets or exceeds NCDOT Specifications.

2. **Separation between Sanitary Sewer and Sewer Main:** There shall be a minimum 7-foot horizontal separation between parallel gravity and/or mains in outfall locations when the depth of installation is 8-ft or less. Otherwise, the minimum horizontal separation between pipelines shall be 10-ft in outfalls.

3. **Separation between Sewer Main and Water Main:**
 - Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 3-ft lateral separation, and water line at least 18-inches above sewer main measured vertically from top of sewer pipeline to bottom edge of water main. In unique cases where the sewer main and the water main are installed with at least 3-ft of lateral separation but less than 10-ft of horizontal separation, and less than 18-inches of vertical separation, both the water main and sewer main shall be constructed of ductile iron pipe with joints in full compliance with water main standards.
 - Crossings (Water Main over Sewer Main): All water main crossings of sewer mains shall be constructed in conformance with Town Specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer main. If 18-inches of clearance is not maintained, the water main and sewer main shall both be constructed of ductile iron pipe with joints in conformance with water main construction standards. The ductile iron sewer main shall extend 10-ft on both sides of the crossing. When the separation between pipelines is 18-inches or less, the void space between the pipes shall be filled with minimum 500-psi, quick setting, and non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for sewer main crossings of potable water mains.
 - Crossings (Water Main under Sewer Main): Allowed only as approved by the Town, when it is not possible to cross the water main above the sewer main. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and both the water main and sewer main shall be constructed of ductile iron in conformance with water main construction standards to a minimum of 10-ft on both sides of the crossing. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500-psi, quick setting, and non-excavatable flowable fill extending at least 3-ft on both sides of the crossing. In all cases the water main pipe shall be centered at the point of crossing with joints equally spaced from the point of crossing.

4. **Separation between Sewer Main and Reclaimed Water:** Sewer mains and reclaimed water mains shall be laid with at least 10 feet of horizontal separation, measured laterally edge to edge unless the elevation of the bottom of the reclaimed water main is at least 18 inches above the top edge of the sewer main, with a horizontal separation of at least 3 feet.

Where a reclaimed water main and a sewer main cross, the crossing shall be constructed at a 90-degree angle and the sewer main shall cross at least 18-inches below the reclaimed water line. Because all reclaimed water mains in the Town municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer main shall be provided in ductile iron pipe in full compliance with water main standard joints, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

If the sewer main crosses above the reclaimed water line, the clearance shall be at least 18-inches. Because all reclaimed water mains in the Town municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer force main shall be provided in ductile iron pipe in full compliance with water main standard joints, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing. In all cases the reclaimed water main pipe shall be centered at the point of crossing with joints equally spaced from the point of crossing.

- 5. Sanitary Sewer Force Main and Stream Crossings:** The top of the sewer force main shall be at least one foot below the stream bed. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet. Sewer force mains shall not be installed under any part of water impoundments.

The following minimum horizontal separations shall be maintained:

- 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below)
- 50 feet from any waters (from normal high water) classified WS-II, WSIII, B, SA, ORW, HQW or SB (except as noted below)
- 10 feet from any other stream, lake, or impoundment (except as noted below)
- 25 feet from private wells (with no exceptions)
- 50 feet from sources of public water supply (with no exceptions) Where the required minimum separations cannot be obtained, ductile iron sewer force main pipe with joints equivalent to water main standards shall be used.

2. MATERIALS

A. Pipe Materials

The minimum wastewater force main size shall be 4-inches in diameter. Force mains shall be ductile iron pipe or C900 PVC.

PVC pipe shall conform to AWWA C900 standards along with the following requirements:

- Outside diameter shall conform to that of ductile iron pipe.
- Pipe shall have plain end and elastomeric gasket bell ends.

Ductile iron pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table.

Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
4-8 inch	Type 1	350 psi	3-16 feet
4-8 inch	Type 4	350 psi	16-20 feet
10-12 inch	Type 1	350 psi	3-10 feet
10-12 inch	Type 4	350 psi	10-20 feet
14-20 inch	Type 4	350 psi	3-28 feet
24 inch	Type 4	350 psi	3-25 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

All ductile iron pipe shall be marked in conformance with ASTM A-746.

All ductile iron wastewater force mains and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, as manufactured by a manufacturer listed on Town’s Approved Products List. The interior coating shall be applied at a nominal dry film interior thickness of 40-mil. All DIP bells and spigots shall be lined with 8-mil of coating joint compound applied by brush to ensure full coverage. All pipe supplied with approved interior lining shall be provided free of holidays. Pipe installed with defects in the lining will be rejected. Patching of coating defects after installation shall not be approved. Lined pipe must be installed within one year of the application date on the pipe.

Pipe fittings shall be made of ductile iron designed and manufactured per AWWA C110 or C153. All fittings up to and including 24 inches in diameter shall be designed for a minimum internal pressure of 350 psi, unless otherwise approved by the Town. Fittings shall be mechanical joint or proprietary manufacturer provided restrained joint. Gaskets shall be in accordance with AWWA C111. All fittings shall be interior coated with coating listed on the Town’s Approved Products List and as specified herein for ductile iron pipe.

Restrained Joint Ductile Iron Pipe shall be the boltless type unless otherwise approved. For installations requiring welded locking rings, the rings shall be factory welded. The restrained joints shall provide a minimum of 4-degrees of deflection for pipe sizes, 4-inches through 12-inches in diameter.

All proprietary pipe restraint systems shall be approved by the Town and provided in compliance with all standards for coatings, linings, pressure classes, etc. as required for ductile iron pipe. All restrained joint pipe shall be installed based on laying conditions, pressure class, etc. as required for typical ductile iron pipe.

B. Manhole Materials:

All sewer force main manholes shall be installed according to Town Standard Specifications when design and installation criteria are not otherwise covered herein.

All force main discharge locations and other manholes for wastewater force mains (excluding those housing large diameter plug valves) shall be either epoxy coated at minimum 80-mil thickness or a polymer concrete manhole.

Force Main Manhole Epoxy Coating: Sewer force main receiver manholes, sewer force main combination air valve manholes and other concrete structures subject to high levels of hydrogen sulfide gas shall be provided with an approved monolithic epoxy coating system consisting of a 100% solids, solvent-free, two-component epoxy resin that meets the following Specifications for up to 100 mils of coating with a manufacturer approved set time of 6-hours or less.

1. Material Providers and Installers:

Approved coating manufacturers and corresponding installers are identified in the Town's Approved Product List.

2. Surface Preparation:

Concrete manholes must be well cured prior to application of the protective epoxy coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. An Elcometer pull test to determine suitability of concrete for coating may be required). Surface preparation shall be based on the requirements of the manufacturer of the epoxy coating and applicable NACE International standards.

3. Installation:

A minimum 80-mil thickness shall be applied to new manholes (120-mil for existing manholes). During application a wet film thickness gage, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

Temperature of the surface to be coated should be maintained between 40° F and 120° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising or in the early morning. The humidity should also be observed to ensure compliance with the epoxy manufacturers' recommendations. Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective epoxy coating. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

If necessary, subsequent top coating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

Force Main Receiver Manholes: Sewer force mains shall not discharge directly into existing gravity sewer lines. Sewer force mains shall discharge into a receiver manhole that has been epoxy coated as specified herein or a Polymer Concrete Manhole as specified in section 07000. The receiver manhole shall be provided in the typical eccentric tapered design at minimum 5-ft diameter. The bench shall be sloped up to 8-inches from the invert channel to the manhole wall. The invert shall be provided with a gradual upsloping alignment from the force main entry to the gravity transition point. Sufficient grade shall be placed on the invert such that wastewater falls back into the force main when the pumps are not in operation creating a vapor lock between the force main and the manhole. Drop connections into force main receiver manholes shall be prohibited.

Combination Air Valve Manholes: Manholes for combination air valve installation shall be provided in flat top configuration to accommodate the excess length of wastewater combination air valves. In cases where the combination air valve assembly shall be located in a paved area, provide typical eccentric, tapered manhole design with typical manhole frame and cover for paved areas. The minimum manhole diameter for combination air valve assemblies shall be 5-ft. Minimum 6-ft diameter manholes shall be used with force mains 20-inches and larger and when an odor control system is required. Any manholes located in NCDOT or street right-of-way shall be provided flush with finished grade.

3. VALVES AND APPURTENANCES

A. General

The rated working pressure of all valves and appurtenances shall meet the maximum design pressure of the pump station and pipeline.

B. Check Valve

Check valves shall be iron bodied, fully bronze mounted with bronze clapper disc and bronze seat ring, and shall have a spring loaded lever arm capable of being mounted on either side of the valve.

C. Plug Valve

Plug valves shall be non-lubricating, eccentric action and resilient plug facing with heavy duty Type 316 stainless steel bearings. Plug valves shall be designed for a minimum working pressure of 175 psi for valves 12" and smaller, 150 psi for valves 14" and larger. Valves shall be bi-directional and meet the pressure rating in both directions of flow. The plug valve body shall be cast iron ASTM A126 Class B with welded-in overlay of 90% nickel alloy content on all surfaces contacting the face of the plug. Sprayed, plated, nickel welded rings or seats screwed into the body are not acceptable.

All plug valves 12" and smaller shall have round port design that provides a minimum 80% port area. The valve plug shall be ductile iron ASTM A536 Grade 65-45-12 up to 20-inches in diameter, with EPDM, Buna N, or Neoprene resilient seating surface to mate with the body seat. Valves 24-inches and larger may have plugs made of cast iron in accordance with ASTM A126 class B. Large plug valves with

rectangular plugs shall provide clean passage for a solid sphere of at least 67% of the adjoining pipe diameter to facilitate pigging of the force main. Force main plug valves with rectangular port shall be "full-port" cross-sectional area perpendicular to the flow of at least 100% of the adjoining pipe.

All buried plug valves shall be provided with worm gear actuators. All plug valves shall be buried and provided with a 2-inch operator nut and valve box as shown in the details. Plug valves greater than 12-inches shall be installed such that the actuator and gearing is accessible in a manhole as shown in the details. All plug valves shall be provided with typical mechanical joint end connections and restrained with wedge action retainer glands on both ends of the valve assembly as described herein.

Valves shall be installed according to the manufacturer's recommendations. Typically for wastewater this means installing the seat side toward the pump station so that the flow is against the face of the plug in the closed position. In the open position, the plug should rotate up to the top of the pipeline which may require installing the valve on its side.

I. Rubber Seated Ball Valve

For larger diameter force mains where plug valves are not available, rubber seated ball valves shall be of the tight-closing, shaft-mounted type that fully comply with AWWA Standard C507 to provide a full port unobstructed waterway with no additional pressure drop. Design pressure ratings shall be 150 psi or greater and provide tight shutoff against flow. With the valve in the closed position, the rubber seated valve shall be bubble tight at rated pressure. All ball valves shall be provided in an epoxy coated manhole or Polymer Concrete Manhole with worm gear actuators and a handwheel.

J. Valve Box Covers

Force main plug valves or ball valves shall have valve box covers and/or manhole lids with the word "Sewer" cast into them.

K. Combination Air Valves

Combination air valves shall be provided to purge air from the system at startup, vent small pockets of air while the system is being pressurized and running and prevent critical vacuum conditions during draining. Combination air valves approved for use in wastewater force main installations shall be installed at all high points of wastewater force mains 6 inches in diameter or larger and at other locations, such as major changes in slope, as directed by the Town. A high point shall be determined as any high location where the difference between the high elevation and adjacent low elevation exceeds 10-ft unless otherwise determined by the Director of Utilities based on special circumstances. The combination air valve shall automatically exhaust large volumes of air from the system when it being filled and allow air to re-enter the pipe when the system is being drained. The wastewater force main shall be installed at a continuous grade between low and high points without intermediate high points unless an air release valve is being installed. A minimum pipe slope of 1 foot in 500 feet should be maintained. Combination air valves shall be sized by the Engineer and approved by the Town.

1. Combination air valves shall be of the single housing style with Type 304 or 316 stainless steel body that combines the operation of both an air/vacuum and air release valve. The valve must meet the requirements of AWWA C512 and be installed in accordance with the Details. The valve shall have a minimum 145-psi working pressure unless the pipeline design requires a higher pressure rating.

2. The valve shall have a minimum 2-inch male NPT inlet for a 2-inch valve assembly. Combination air valves sized from 3-inches to 8-inches shall be provided with studded inlet connectors or flanged connections. The combination air valve shall be provided with cylindrical shaped floats and anti-shock orifice made of high-density polyethylene. Combination air valves with spherical floats shall not be accepted. All combination air valves shall be installed in accordance with the Details.
3. Installation of Combination Air Valve Assembly:
 - The Engineer of Record shall provide ample depth of installation to accommodate the extended height of combination air valves for wastewater force mains. All combination air valves shall be connected to the main by an MJ x FLG tee with the branch diameter equal to at least half of the main diameter.
 - The 2-inch combination air valve shall be provided with male NPT threads and isolated with a 2-inch gate valve. The isolation valve shall be provided with NPT threads and connected with brass or bronze piping.
 - Combination air valves 3-inches and greater shall be connected by flange or studs. If needed due to a larger diameter tee, a flanged reducer shall be provided between the tee and the isolation valve. Gate valves shall be used for 3-inch assemblies. Combination air valves 4-inches and larger shall be isolated with a plug valve. In all cases the isolation valve shall be sized equal to the combination air valve.

G. Emergency Connection Assembly

On some wastewater force mains, an additional emergency connection assembly may be required. The size, criticality and proximity to a downstream manhole will be important factors in the need for this connection. The emergency connection assembly shall include either a ball valve or plug valve assembly for isolation from the primary wastewater force main. Additionally, the primary force main shall be provided with a main line plug valve or ball valve on the upstream side of the emergency connection assembly to prevent bypass flow from draining back to the pump station. The emergency connection assembly shall be brought to the final graded surface with a visible blind flange assembly for connection by an outside pumping contractor.

H. Force Main Odor Control Systems

Force main odor control shall be included in the design plans for any proposed force main at discharge locations, intermediate air release locations and otherwise as directed by the Town. In limited cases, air release valves located in isolated areas may be approved without odor control systems. The suggested odor control technology shall be designed by the Engineer of Record to achieve 95% or greater hydrogen sulfide removal. All systems, including those utilizing activated carbon, shall be manufactured specifically for addressing hydrogen sulfide gas. Forced air systems should be avoided due to the need to include provisions for electrical power to the odor control system. For all odor control systems, the Engineer of Record shall provide sufficient easement area for long term maintenance of the system.

4. INSPECTIONS, TESTING, AND TRAINING

A. Inspections

All materials and equipment used in the construction of the wastewater pumping system must be verified for compliance with the Specifications (or other approval granted by the Town) by the Inspector prior to installation. Non-conforming materials or equipment shall be immediately removed from the job site. Compliance with plans and Specifications shall be verified on a regular basis by the Inspector.

B. Testing

1. General

- The Contractor shall furnish all materials, labor, and equipment to perform all testing. Water for testing purposes may be obtained from the Town. The Contractor shall reimburse the Town for all water used at Inside Utility Rates.
- All water or wastewater used during testing of the pump station, force main, or any of the systems described in this section, must be returned to the Town's sanitary sewer system after proper coordination with the Town Engineering Department.
- All on-site testing and/or installation verification shall be performed in the presence of the Inspector or other representative authorized by the Town.

2. Force main Testing

- The force main shall be completely filled with water, all air shall be expelled from the pipe, and the discharge end of the pipeline shall be plugged and adequately blocked before the hydrostatic test begins.
- The force main shall be tested to a pressure of 150 psi or three times the rated Total Dynamic Head of the pumps in psi, whichever is larger, as measured at the lowest elevation of the pipeline, for a duration of 2 hours. The pressure gauge used in the hydrostatic test shall be calibrated in increments of 5 psi or less. At the end of the test period, the leakage shall be measured with an accurate water meter.
- All leaks shall be located and repaired regardless of the amount of leakage. If the force main does not pass the leakage test requirements, the cause of the failure shall be identified and repaired. Testing shall be repeated until the force main passes.

$$\text{Allowable Leakage, } L = \frac{S \times D \times \sqrt{P}}{133,200}$$

Where: L = leakage (gph)

S = length of pipe (feet)

D = nominal diameter of pipe segment tested (inches)

P = test pressure (pounds per square inch)

3. **Marker Ball and Marker Tape Testing:** Testing of the marker balls and marker tape shall be performed by the Contractor at the completion of the project to assure they are all working properly. It is the Contractor’s responsibility to provide the necessary equipment to test the markers. Any defective, missing, or otherwise non-locatable units shall be replaced at the contractor’s expense.

4.02 GRAVITY SEWER MAINS

1. DESIGN

A. Main Location

All public sanitary sewer mains shall be installed in dedicated street right of way or in dedicated utility easements. Mains installed in Town of Pittsboro right of way shall be located in the center of pavement. If the sewer main cannot practically be located in the center of the pavement it shall be located within the south or west side of the street. Mains within easements shall be centered within the easement. Mains located within NCDOT right of way shall be placed in accordance with NCDOT standards.

In preparing engineering design plans for sanitary sewer mains, all elevations shall be tied to NC grid system and the benchmark shall be described on the plans.

All private sewer collection mains inside the Town’s utility service area that will connect or are planning to discharge into the Town’s sewer system shall comply with all Town design, siting and installation criteria outlined herein. The Owner of the private sewer collection system shall meet all State design requirements and obtain a State permit to operate the private system. Private utilities under public roads or other public facilities shall obtain the required easements specified below. Repairs to public roads, sidewalks or other facilities resulting from access or maintenance of private utilities shall be the responsibility of the owner of the private facilities.

Gravity mains shall be installed in dedicated public right of way or in dedicated utility easements as follows:

Standard Easement Width for Sanitary Sewer Mains

Pipe Diameter	Pipe Depth	Easement Width
8-inch to 12-inch	10-ft or less	20-ft
8-inch to 12-inch	10-ft to 12.5-ft	25-ft
8-inch to 12-inch	12.5-ft to 15-ft	30-ft
8-inch to 12-inch	15-ft to 17.5-ft	35-ft
8-inch to 12-inch	17.5-ft to 20-ft	40-ft
12-inch to 24-inch	15-ft or less	30-ft
12-inch to 24-inch	15-ft to 17.5-ft	35-ft
12-inch to 24-inch	17.5-ft to 20-ft	40-ft
Greater than 24-inch	Any Depth	Specified by the Town Engineering Director
Any Size	Deeper than 20-ft	

Dedicated easements for sewer mains and appurtenances shall be recorded as “Town of Pittsboro Sewer Easement”. Town sewer easements shall contain only Town of Pittsboro utilities unless otherwise approved by the development plan or an encroachment agreement. Access easements to allow sufficient means of gaining entrance to proposed easements may be required by the Town where conventional access from the public right-of-way is limited or infeasible.

No permanent structures, equipment, retaining walls, embankments, impoundments, or other elements that would inhibit maintenance operations shall be constructed within a sewer main easement. Fences may be allowed across easements provided that appropriate access gates have been installed to allow utility maintenance. In all cases, Town Staff shall have access to secured access gates. Fill or cut slopes are not allowed to extend into easements without full development plan approval or an approved encroachment agreement from the Town. All such pre-existing or planned conditions as noted herein that would impact operations and maintenance within the noted sewer main easement shall be noted and disclosed during the development plan approval process. Pre-existing conditions that are not disclosed during the development plan review may nullify the approval and require relocating the sewer easement where there are no existing conflicts.

Sewer line easements shall be graded smooth, free from rocks, boulders, roots, stumps, and other debris, and seeded and mulched upon the completion of construction. Easements across sloped areas shall be graded uniformly across the slope to no steeper than a 5 to 1 ratio.

Mains paralleling a creek shall be of sufficient depth to allow lateral connections below the stream bed elevation. The top of the sewer main and laterals shall be at least one foot below the stream bed. Concrete encasement and ductile iron pipe shall be required when the cover between the top of the pipe and the stream bed is less than 3 feet.

Mains shall not be installed under any part of water impoundments.

B. Installation and Separation Requirements

1. The following minimum horizontal separations shall be maintained:
 - 100 feet from any private or public water supply source, including wells, WS-1 waters or Class I or Class II impounded reservoirs used as a source of drinking water (except as noted below)
 - 50 feet from wetlands and any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB (except as noted below)
 - 10 feet from any other stream, lake, or impoundment (except as noted below)
 - With approval directly from PERCS, the following separations may be acceptable when water main standards are implemented:
 - All appurtenances shall be outside the 100-foot radius of wells.
 - 25 feet from private wells (with no exceptions)
 - 50 feet from public water wells (with no exceptions)
 - Where the required minimum separations cannot be obtained, the following standards shall be used:
 - Sewer Pipe: Ductile Iron Pipe shall be used with joints equivalent to water main standards.

2. Sewer mains shall always be extended along natural drainage courses to all adjacent upstream property lines.
3. Gravity sewer mains shall be deep enough to serve the adjoining property and allow for sufficient slope in lateral lines. Gravity sewer pipe shall have the following minimum covers:
 - 4 feet from the top of pipe to finished subgrade in roadways
 - 3 feet from the top of pipe to finished grade outside roadways
4. Sewer mains over 20 feet deep require ductile iron for the entire run between manholes. Sewer mains 14 feet to 18 feet along or in roadways shall also require ductile iron pipe for the entire run between manholes. The maximum depth of sewer along or in roadways shall be 18 feet.
5. In all cases where fill material is added above existing sewer mains, the Engineer of Record shall prepare a structural analysis of the existing pipeline and determine if it is capable of supporting additional loading. If the additional fill material exceeds AWWA, DIPRA, UNIBELL and/or manufacturer standards for loading, the pipeline shall either be reinforced to adequately support the additional loading or replaced with a ductile iron pipe rated to support the added loading.
6. **Separation Between Sanitary Sewer and Storm Water Pipes:**
Sewer mains shall have a minimum vertical separation of 24 inches between storm pipes when the horizontal separation is 3 feet or less. Where sanitary and storm sewers cross with a vertical separation of less than 24 inches, the entire leg of sanitary sewer shall be made of standard ductile iron pipe with joints rated for water main service and the void space between the pipe crossing shall be backfilled with 3000-psi concrete or quick setting, minimum 500-psi, non-excavatable flowable fill that meets or exceeds NCDOT Specifications.
7. **Separation Between Sanitary Sewer and Sewer Force Main:** There shall be a minimum 7-foot horizontal separation between parallel gravity and/or force mains when the depth of installation is 8-feet or less. In cases where the depth of installation is greater than 8-feet, the minimum horizontal separation between pipelines shall be 10-ft up to 10-ft depth of installation or a project specific design shall be implemented.
8. **Separation Between Sanitary Sewer and Water Main:**
 - Parallel Installations: 10-ft lateral separation (pipe edge to pipe edge) or minimum 3-ft lateral separation, and water line at least 18-inches above sanitary sewer line measured vertically from top of sewer pipeline to bottom edge of water main. In unique cases where the sanitary sewer and the water main are installed with at least 3-ft of lateral separation but less than 10-ft of horizontal separation, and less than 18-inches of vertical separation, both the water main and sanitary sewer shall be constructed of ductile iron pipe with joints in full compliance with water main standards.
 - Crossings (Water Main Over Sewer): All water main crossings of sewer lines shall be constructed over the sewer line in conformance with Town Specifications. At a minimum, 18-inches of clearance shall be maintained between the bottom edge of the water main and the top edge of the sewer main. If 18-inches of clearance is not maintained, the water main and sanitary sewer main shall:

- Both lines shall be constructed of ductile iron pipe with joints in conformance with water main construction standards.
- The sanitary sewer pipe shall be ductile iron the entire run from manhole to manhole.
- The void space between the pipes shall be filled with minimum 500-psi, quick setting non-excavatable flowable fill extending 3-ft on both sides of the crossing. Regardless of pipe material, at least 12-inches of vertical separation is required for sanitary sewer crossings of potable water mains.
- Crossings (Water Main Under Sewer Line): Allowed only as approved by the Town, when it is not possible to cross the water main above the sewer line. At a minimum, 18-inches of separation shall be maintained, (measured from pipe edge to pipe edge) and the sanitary sewer shall be constructed of ductile iron in conformance with water main construction standards the entire run from manhole to manhole. If local conditions prevent providing 18-inches of clearance, then at least 12-inches of clearance shall be provided and the void space between the pipes shall be filled with minimum 500- psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

9. Separation Between Sanitary Sewer and Reclaimed Water:

- Sanitary sewer and reclaimed water mains shall be laid with at least 10 feet of horizontal separation, measured laterally edge to edge unless the elevation of the bottom of the reclaimed water main is at least 18 inches above the top edge of the sanitary sewer, with a horizontal separation of at least 3 feet.
- Where a reclaimed water main and a sanitary sewer main cross, the crossing shall be constructed at a 90-degree angle and the sanitary sewer main shall cross at least 18- inches below the reclaimed water line. Because all reclaimed water mains in the Town’s municipal system are constructed to fully comply with water system testing and integrity standards, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer main shall be provided in ductile iron pipe in full compliance with water main standards, and the void space between the pipes shall be filled with minimum 500-psi, quick setting, non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.
- If the sanitary sewer crosses above the reclaimed water line, the clearance shall be at least 18-inches. Because all reclaimed water mains in the Town’s municipal system are constructed to fully comply with water system testing and integrity standards as described by 15A NCAC 18C, when the minimum separation cannot be met, at least 12-inches of clearance shall be maintained, the sewer main shall be provided in ductile iron pipe in full compliance with water main standards, and the void space between the pipes shall be filled with minimum 500-psi, quick setting non-excavatable flowable fill extending at least 3-ft on both sides of the crossing.

C. Main Size, Slope and Design Criteria

Public gravity mains shall be a minimum of 8 inches in diameter.

Major interceptors shall be sized in accordance with the most current Town of Pittsboro Utility Master Plan. In areas not included in the master plan, interceptors shall be designed based on the proposed

land use, using the following flow factors. At a minimum, all gravity sewer mains shall be designed and sized to serve the ultimate tributary buildout of the drainage basin.

Use flow factors as required by the North Carolina Department of Environmental Quality (NCAC 02T .0114). Sanitary sewers shall be designed to carry the projected peak flow at no more than 2/3 full. The minimum velocity for sanitary sewer lines shall be 3-fps.

Sanitary sewers shall be sized based on the Manning’s Equation with Manning’s roughness coefficient “n” = 0.013 or greater. Pipe diameter sizes used in the calculation of Manning’s Equation shall be nominal pipe sizes.

The minimum grades for public sanitary sewers shall be as follows:

Table 4.4: Minimum Slopes for Gravity Sewer Mains	
Main Size (diameter in inches)	Minimum Slope V=3.0ft/s, depth 2/3 full (feet per 100 feet) {standard required velocity}
8	0.61
10	0.46
12	0.36
14	0.29
15	0.27
16	0.25
18	0.21
21	0.17
24	0.14
27	0.13
30	0.11
36	0.09

Note1: All minimum slopes based on Manning’s Equation

Note2: Manning’s coefficient n = 0.013 used for all computations

The minimum grade for the uppermost reach of a sanitary sewer line shall be 1% regardless of sewer line size.

The maximum grade for sanitary sewers is 10%. The maximum velocity in sanitary sewers is 15 ft/sec. These limits may only be exceeded with the approval of the Director of Utilities and the incorporation of the following provisions, which apply to all sewers either designed or installed at grades equal to or exceeding 10%:

1. All sewers with a grade of 10% or higher must have the downstream run of pipe installed with ductile iron pipe.
2. High velocity manholes shall be used on all sewers with a grade of 10% or higher. High velocity lines cannot tie directly to an existing line and must proceed 180 degrees through the invert into the downstream line.

3. Concrete thrust collars shall be installed on all sewers designed at grades of 10% or higher. The anchors shall be installed at the following spacing:
 - Not over 36' center to center on grades from 10% to 25%
 - Not over 24' center to center on grades from 25% to 40%
 - Not over 16' center to center on grades exceeding 40%
4. Town reserves the right to require all high velocity requirements outlined herein for sewer lines either designed or installed at grades of 10% or greater, regardless of the flow velocity. In cases where the design grade established on the sewer design plan is exceeded during construction and the 10% threshold is exceeded, all high velocity requirements shall apply without waiver.

Sewer extensions shall be designed for projected flows, even when the diameter of the receiving sewer is less than the diameter of the proposed extension.

All pipe diameter changes shall occur only in manholes, with the invert of the larger pipe lowered sufficiently to maintain the same energy gradient. An approximate method of obtaining this result is to place the 0.8 depth point of both sewers at the same elevation. As an alternative, the crown of the incoming pipes may be designed for an elevation at or above the crown of the outgoing pipe.

All transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes.

Pipe trench excavation and backfilling shall be performed in accordance with Section 2 of these Specifications.

2. MATERIALS

Materials specified herein are acceptable for sewer service as described. See Standard Procedure 120 for instructions on requesting new product approval.

A. Ductile Iron Pipe

Ductile Iron Pipe shall be designed and manufactured in accordance with AWWA C150 and C151 and provided in nominal 20-ft lengths. The minimum requirements for ductile iron pipe and required laying conditions are tabulated below. For all other installations other than specified, the laying condition, bedding requirements or the minimum pressure class rating and/or thickness class shall be increased in accordance with AWWA C151. A pipe thickness design shall be submitted for external loading in all cases where the pipe depth exceeds the specified range of depths outlined in the following table:

Table 4.5: Pressure Class, Max. Depth and Laying Condition for DI Sewer Mains			
Pipe Diameter	AWWA C-150, Laying Condition	Pressure Class	Maximum Depth of Cover
8 -inch	type 1	350 psi	3-16 feet
8 -inch	type 4	350 psi	16-34 feet
10-12 -inch	type 1	350 psi	3-10 feet
10-12 -inch	type 4	350 psi	10-28 feet
10-12 -inch	type 5	350 psi	28-44 feet
14-20 -inch	type 4	250 psi	3-22 feet
14-20 -inch	type 5	250 psi	22-30 feet

14-20 -inch	type 5	350 psi	30-38 feet
24-30 -inch	type 4	250 psi	3-19 feet
24-30 -inch	type 5	300 psi	19-29 feet
24-30 -inch	type 5	350 psi	29-33 feet
36-42 -inch	type 4	300 psi	3-20 feet
36-42 -inch	type 5	350 psi	20-32 feet

Note: For cases not specified, a ductile iron pipe and bedding design certified by a Professional Engineer licensed in the State of North Carolina shall be required in compliance with AWWA C150 and the Ductile Iron Pipe Research Association.

In cases where thickness class designation of ductile iron pipe is specified, the corresponding thickness class designations are as outlined in the following table:

Pipe Diameter	Pressure Class	Nominal Thickness (inches)	Minimum Corresponding Thickness Class
4	350	0.25	51
6	350	0.25	50
8	350	0.25	50
10	350	0.26	50
12	350	0.28	50
14	250	0.28	50
16	250	0.3	50
18	250	0.31	50
20	250	0.33	50
24	250	0.37	50
24	300	0.40	51
30	250	0.42	51
30	300	0.45	52
36	300	0.51	52
36	350	0.56	53
42	300	0.57	52
42	350	0.63	53

Pipe joints shall be of the push-on type as per AWWA C111.

For 10-inch diameter and smaller gravity sewer mains, pipe lining shall be cement mortar with a seal coat of bituminous material, all in accordance with AWWA C104 except a minimum thickness of 1/8" shall be provided (double thickness).

For 12-inch diameter and larger gravity sewer mains, all ductile iron pipe and fittings for sewer construction shall receive an interior ceramic epoxy coating, consisting of an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment, from a Town approved manufacturer. The interior coating shall be applied at a nominal dry film interior thickness of 40-mil. All DIP bells and spigots shall be lined with 8-mil of approved joint compound listed on the Town's Approved Products List applied by brush to ensure full coverage. All pipe supplied with approved interior lining shall be

provided free of holidays. Pipe installed with defects in the lining will be rejected and required to be replaced. Patching of coating defects after installation shall not be approved. Lined pipe must be installed by date required by lining manufacturer.

All buried DIP and fittings shall have bituminous coating on the exterior surface in accordance with AWWA C151. Pipe shall be supplied in minimum 20-ft lengths.

All ductile iron pipes shall be marked in conformance with ASTM A746.

B. Solid Wall PVC Pipe

PVC Pipe shall be solid wall and made of PVC plastic having a cell classification of 12454 or 12364 (with minimum tensile modulus of 400,000 psi) as defined in Specification D1784. PVC pipe shall have integral wall bell and spigot joints for the conveyance of domestic sewage and shall be supplied in minimum 14 or 20 ft lengths. Fittings shall be made of PVC plastic having a cell classification of 12454-B, as defined in ASTM D1784.

All PVC gravity sewer pipe and PVC fittings up to 15-inches in diameter shall be manufactured in accordance with the latest version of ASTM D3034. All solid wall PVC pipe installed at diameters from 18-inches to 27-inches in diameter shall be manufactured in conformance with ASTM F679 and provided at minimum pipe stiffness of 115-psi. Fittings must be manufactured by pipe supplier or approved equal, and have bell and/or spigot configurations compatible with that of the pipe. PVC pipe shall be installed in accordance with the requirements of this Specifications manual and ASTM D2321.

All PVC pipe up to and including 15 inches in diameter shall have a maximum Standard Dimension Ratio (SDR) of 35 for depth of installation no shallower than 4-ft of cover from the pipe crown and no deeper than 14-ft measured from the bottom of the pipe. All solid wall PVC pipe for depth of installation greater than 14-ft shall have a maximum Standard Dimension Ratio (SDR) of 26. Solid wall PVC pipe shall not be approved for depths of installation greater than 20-ft. All solid wall PVC pipe shall be marked and certified in conformance with ASTM D3034 or ASTM F679.

Nominal Pipe Diameter (inches)	Outside Diameter (inches)	Minimum Wall Thickness SDR 35 (inches)	Minimum Wall Thickness SDR 26 (inches)
8	8.400	0.240	0.323
10	10.500	0.300	0.404
12	12.500	0.360	0.481
15	15.300	0.437	0.588
18	18.701	-----	0.720
21	22.047	-----	0.849
24	24.803	-----	0.956
27	27.953	-----	1.077

Note: SDR 35 not approved for pipe diameters greater than 15-inches and for depths greater than 14-ft.

4.03 SEWER MAIN INSTALLATION

1. GENERAL REQUIREMENTS

Pipe trench excavation and backfilling shall be performed in accordance with Section 2 of these Specifications.

Transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes.

All sewer mains installed with less than 3 ft of cover or deeper than 18- ft shall be ductile iron pipe.

Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be covered and protected when pipe laying is not in progress to prevent debris from entering the pipe.

All sewer cleanouts shall be protected during construction by installation of tree protection fencing or another Town approved material. Material will be adequately maintained throughout the construction period to prevent damage and contamination of the sewer system.

All pipes shall be constructed with at least 48 inches of cover below the finished grade. Pipe shall be laid on true lines as directed by the Engineer. Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of joint selected.

Prior to beginning construction, the Contractor shall contact local utility companies and verify the location of existing utilities. The Contractor shall be completely and solely responsible for locating all existing buried utilities inside the construction zone before beginning excavation. The Contractor shall be solely responsible for scheduling and coordinating the utility location work. When an existing utility is in conflict with construction, it shall be exposed prior to beginning construction to prevent damage to the existing utility.

2. EMBEDMENT MATERIAL BEDDING

Embedment Material Bedding and embedment material classifications shall be defined as follows:

- **CLASS I** - Angular, (1/4 to 1-1/2 inch) graded stone, including a number of fill materials that have regional significance such as coral, slag, cinders, crushed stone, crushed gravel, and crushed shells.
- **CLASS II** - Coarse sands and gravels with maximum particle size of 1-1/2 inch, including variously graded sands and gravels containing small percentages of fines, generally granular and noncohesive, either wet or dry. Soil types GW, GP, SW and SP are included in this class.

- **CLASS III** - Fine sand and clayey gravels, including fine sands, sand-clay mixtures, and gravel-clay mixtures, Soil Types GM, GC, SM, and SC are included in this class.
- **CLASS IV** - Silt, silty clays, and clays, including inorganic clays and silts of medium to high plasticity and liquid limits. Soil Types MH, ML, CH and CL are included in this class. These materials shall not be used for embedment.

Class I foundation material consisting of ¼-inch to 1½ -inch graded stone shall be required in addition to standard bedding and embedment for all sewer installations, regardless of pipe material, when the trench bottom is unstable due to water, rock, infiltration or soil type.

All bedding, embedment and backfill materials shall be compacted to a minimum of 95% Standard Proctor density regardless of material. In instances where compliance with compaction requirements is questionable as determined by the Town inspector, testing shall be provided by the Contractor and a reputable licensed Geotechnical Engineer to verify compliance.

The minimum trench width shall be one pipe diameter plus 12 inches on each side of the pipe.

In any area where the pipe will be installed below existing or future ground water levels or where the trench could be subject to inundation, additional Class I material shall be used for bedding.

If hydraulic jack shoring is utilized for trench walls, it shall be restricted to the area just above the top of the pipe. This will ensure the embedment materials and pipe will not be disturbed when the shoring is removed.

3. DUCTILE IRON PIPE INSTALLATION REQUIREMENTS

Ductile iron pipe shall be installed in accordance with the requirements of AWWA C600 and the Ductile Iron Pipe Handbook published by the Ductile Iron Pipe Research Association. Materials at all times shall be handled with mechanical equipment or in such a manner to protect them from damage. At no time shall pipe and fittings be dropped or pushed into ditches.

Pipe trench excavation and backfilling shall be performed in accordance with Town standard specifications. Pipe and fitting interiors shall be protected from foreign matter and shall be inspected for damage and defects prior to installation. In the event foreign matter is present in pipe and fittings, it shall be removed before installation. Open ends of pipe shall be plugged or capped when pipe laying is not in progress.

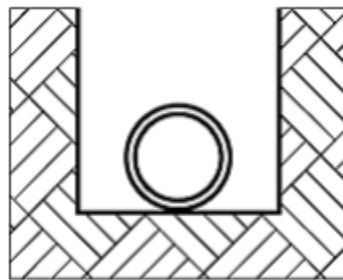
All pipe shall be constructed with at least 48 inches of cover below the finished surface grade. Pipe shall be laid on true lines as directed by the Engineer. The wastewater force main shall be installed at a grade which will allow air to migrate to a high point where the air can be released through an air valve. A minimum pipe slope of 1 foot in 500 feet should be maintained and there shall be no intermediate high points in the line.

Trenches shall be sufficiently wide to adjust the alignment. Bell holes shall be dug at each joint to permit proper joint assembly. The pipe shall be laid and adjusted so that the alignment with the next succeeding joint will be centered in the joint and the entire pipeline will be in continuous alignment both horizontally and vertically. Pipe joints shall be fitted so that a thoroughly watertight joint will result. All joints will be made in conformance with the manufacturer's recommendations for the type of

joint selected. All transition joints between different types of pipe shall be made with transition couplings approved on shop drawings showing the complete assembly to scale.

Pipe shall be installed at laying conditions as specified herein and identified by the plan drawings. Laying conditions for ductile iron pipe shall be as described in AWWA C151 and the Ductile Iron Pipe Research Association. Laying conditions shall be defined as follows:

Type 1: Flat Bottom Trench with Pipe Resting on Stable Undisturbed Earth. Unstable conditions such as wet trench bottoms, intermediate rock layering, partially weathered rock, and other unsuitable soil conditions shall require utilizing more stringent laying conditions. At a minimum, Type 4 laying condition shall be utilized with a minimum of 4- inches of bedding to overcome unstable conditions. For severe unstable soil conditions, undercut excavation and an engineer designed foundation plan shall be provided prior to pipeline installation.



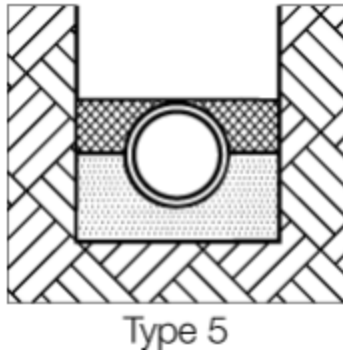
Type 1*

Type 4: Pipe bedded in Class 1 material, No. 67 or No. 78 crushed stone to a depth of 1/8 pipe diameter or a minimum of 4-inches. Embedment material consisting of Class 1, Class 2 or Class 3 materials shall be compacted to the top of the pipe greater than 95% Proctor. Careful attention must be allocated to compacting embedment material under the bottom edges of the pipe.



Type 4

Type 5: Pipe bedded in Class 1 material, No. 67 or No. 78 crushed stone to the center of the pipe and extending a minimum of 4-inches under the pipe. Granular or select embedment, consisting of Class 1 or Class 2 materials, compacted to greater than 95% Proctor installed to the top of the pipe.



4. PVC PIPE INSTALLATION REQUIREMENTS

The installation of PVC Pipe shall satisfy the requirements of the manufacturer, and/or the following, whichever is more stringent:

For PVC pipe, the pipe shall be produced with bell and spigot end construction. Joining shall be accomplished by rubber gasket in accordance with manufacturer's recommendation. Flexible watertight elastomeric seals in accordance with ASTM D3212-1 may also be used. Each pipe length shall be clearly marked with information including pipe size, profile number and class number.

Installation of PVC pipe shall follow the recommendations of ASTM D2321 "Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications". For PVC pipe installation, bedding and embedment material shall be Class I, typically No. 67 or No. 78 washed stone. Bedding and embedment materials for PVC gravity sewers other than No. 67 or No. 78 washed stone shall be approved by prior to use.

Typical Bedding and Embedment for SDR35 PVC Gravity Sewers, 4-ft to 14-ft in Depth.

- Bedding shall consist of minimum 4-inches of No. 67 or No. 78 stone installed under the pipe. Embedment shall extend to the top of the pipe. Bedding and embedment shall be compacted to 95% standard proctor density. Careful attention shall be placed on compacting embedment under the haunches of the pipe to prevent any potential voids.

Typical Bedding and Embedment for SDR26 PVC Gravity Sewers, 14- ft to 20-ft in Depth.

- Bedding shall consist of minimum 6-inches of No. 67 or No. 78 stone installed under the pipe. The embedment, consisting of the same material, shall extend 6-inches above the crown of the pipe. Bedding and embedment shall be compacted to 95% standard proctor density. Careful attention shall be placed on compacting embedment under the haunches to prevent any potential voids.

The bedding and embedment materials shall be in accordance with ASTM D-2321. The embedment materials shall be installed from trench wall to trench wall. The maximum allowable deflection after installation shall BE LESS THAN 5% for PVC pipe.

All PVC pipe shall be stored properly to prevent UV damage prior to installation. Any PVC pipe with visible fading caused by UV radiation from sunlight shall be rejected. All PVC pipe shall be free from

nicks, scratches and gouges at the time of installation. Such defects can impact the strength of PVC pipe and all pipes with visible gouges shall be rejected.

5. PIPE IDENTIFICATION AND MARKING

A. Marking Tape

1. **Installation:** Marking tape shall be installed continuously and longitudinally along all sanitary sewer mains for new construction and for any repair or retrofit construction using open trench methods. For service connections, the marking tape shall extend from the main line to the cleanout at the right-of-way/easement. Marking tape shall be installed directly above the center of the pipe and at least 24-inches deep from final grade to a maximum depth of 36-inches below final grade.
2. **Specifications:** The sanitary sewer main marking tape shall be an approved product identified in the Town's Approved Products List. The marking tape shall be made of polyethylene (or approved equivalent) material, 6-inches wide and a minimum of 6 millimeters thick. The marking tape shall have detectable markers embedded in the tape and spaced adequately to provide continuous detection along the tape from above the buried pipe at final grade. The tape shall be green in color and shall be marked with words "CAUTION SEWER LINE BURIED BELOW" (or an approved equivalent wording). The wording shall be repetitive along the full length of the tape.

B. Marker Balls

1. **Installation:** Non-programmable marker balls are required at the ends of all casing pipe and at reducers. They shall also be installed along and directly above all water mains in conditions where marking tape cannot be installed due to restrictions or conflicts. In these conditions, non-programmable marker balls shall be placed at all vertical and horizontal deflection points, at all tees and crosses and at a spacing along the main no greater than 100 feet apart. Each marker ball shall be installed directly above the center of the pipe and at least 24-inches deep from final grade to a maximum depth of 36- inches below final grade.
2. **Specifications:** The Marker Ball is a non-programmable ball and shall be an approved product identified in the Town's Approved Products List. The marker ball shall be green in color for wastewater and conform to APWA standards. It shall have a minimum detectable depth of 5 feet.

4.04 MANHOLES

1. DESIGN

A. Manhole Location, Siting and Design

Manholes shall be spaced at a maximum distance of 400 feet. Manholes shall be installed at each deflection of line and/or grade. The flow channel through manholes shall have a uniform and smooth

finish free of irregularities or obstructions. The invert channel shall conform to the shape and slope of the entering/exiting sewer line. Either pre-cast or brick and mortar inverts may be used.

When sewers of uniform slope pass through a manhole, the slope shall be maintained and the invert at the center of the manhole shall be provided. When sewers change slope at a manhole, the incoming and outgoing invert elevations will be given on the plan drawings.

The maximum flow deflection angle in a manhole shall be dependent upon pipe size as shown in the following table. Sufficient drop shall be provided in the manhole to compensate for energy loss caused by the change of alignment. A minimum drop of 0.1-ft is required for a change of alignment greater than 30-degrees.

Pipe Size (largest pipe controls)	Maximum Deflection Angle per Manhole
8-10 inch diameter	<90 degrees
12-20-inch diameter	75 degrees
>20-inch diameter	60 degrees

Free falls of wastewater flow into the manhole invert from incoming sewer mains shall not be allowed, except under limited circumstances approved by the Town Engineering Department. In certain isolated circumstances standard free drops may be allowed, not exceeding 20-inches, when pipe diameter changes occur at a manhole. In these cases, the smaller diameter pipe crown shall be positioned no higher than the larger diameter pipe crown to limit the drop. When free drops are necessary due to pipe size changes, the Contractor shall take preventive measures to prevent free drops into the manhole invert, such as building a flume or trough up to the incoming invert or piping the flow to the primary invert flow channel.

Drop manholes are not allowed without the written approval of the Town Engineering Director. While certain physical constraints may dictate the need for drop manholes, they may not be used merely to decrease trenching depth. Upstream slope changes shall be used to avoid the need for drop manholes.

When there is an unavoidable elevation change from invert to outlet greater than 20-inches, drop manholes shall be constructed with an outside drop connection. The entire incoming sewer leading to the drop shall be made of ductile iron pipe. Drops shall be concrete encased and constructed in accordance with the Standard Details. Inside drop manholes shall only be allowed in unique circumstances on a limited basis and must be approved by the Town Engineering Director.

Manholes shall not be obstructed from view or access. It is illegal to bury or obstruct access to manholes.

Manhole covers shall be elevated as follows:

- Roadways: Manholes installed in roadways and road shoulders shall be installed with the cover flush with the top of pavement.
- Outside of Roadways: Manholes installed outside of roadways shall be elevated at least 1-ft above the surface grade unless otherwise noted.

- **Wooded Outfalls:** All manholes installed in wooded, forested or brushy areas shall be elevated at least 2-ft above the surface elevation.
- **100-Year Flood Zone:** All manholes located within the 100-year flood elevation shall be elevated at least 24 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 24 inches above the 100-year flood elevation.
- **Well Maintained Areas:** All manholes installed in well maintained areas, such as yards, sidewalks or otherwise inside an improved right-of-way shall be installed flush with the finished surface.

Manholes higher than 30 inches above finished grade shall be constructed with a flat top and outside steps. When connecting a new sewer main to an existing main, the connection shall be established with a “Doghouse” type of manhole inserted over the existing main.

B. Manhole Sizing

Manholes shall be sized as shown in the following table. The next larger size shall be required if the pipe size, depth, drop connection or number of main line connections warrants a larger size. In consideration of main line connections, all will be considered regardless of type, whether inside drop, outside drop, force main or standard connection.

Table 4.9: Manhole Sizing Guide					
Manhole Size	Maximum Allowable Pipe Size	Maximum Depth of Cover	Maximum Depth with Extended Base	Frame and Cover Size (outside of paved areas)	Maximum Sewer Main Connections
(diameter)	(diameter)	(invert to surface)	(invert to surface)	(diameter)	(quantity)
4-ft	8-12 inches	12-ft	25-ft ¹	24-inches	3 ²
5-ft ⁴	14-24 inches	12-ft	35-ft	24-inches	2 ³
6-ft ⁴	27-42 inches	12-ft	35-ft	36-inches	2 ³
8-ft ⁴	48 inches	12-ft	35-ft	36-inches	2 ³
10-ft ⁴	54 inches	12-ft	35-ft	36-inches	2 ³

¹ Depths beyond 14-ft in roadways shall require a 5-ft diameter manhole with extended base.

² Four connections may be permitted in a 4-ft diameter manhole when the separation between each incoming connection is at least 85°.

³ Additional smaller diameter connections that meet the spacing requirements of Section 4.3 “Installation”, may be approved by the Town Engineering Department.

⁴ Due to the limited manhole wall area that could exist between the invert in and out, some manholes may require upsizing as directed by the Town Engineering Department.

All manholes 5-ft in diameter shall be extended to surface elevation with no further reduction in diameter until the eccentric cone section. Manhole transitions for 6-ft and larger diameter manholes are only allowed in the top 5-ft of the manhole. In no case shall the smallest barrel size be less than 5-ft diameter. At least 5-ft of vertical clearance shall be maintained above the pipe crown before transitioning to a smaller diameter riser, or transition shall not be utilized. An eccentric flat slab reducer from 6-ft diameter or larger manhole base sections to 5-ft diameter risers (non-paved areas) or eccentric cones (paved areas) shall be used to make any transition.

Manholes outside of paved areas that are 6-ft in diameter and greater and are too shallow to maintain 5-ft of vertical clearance above the crown of the pipe shall maintain the full manhole diameter up to the design surface elevation and be provided with a flat top slab cover with eccentric hole. Manholes inside of paved areas that are 6-ft in diameter and greater shall be constructed with an eccentric, flat top reducer to 5-ft diameter and provided with a 5-ft diameter eccentric, tapered cone at the finished grade. When the depth of the manhole is too shallow to maintain 5-ft of vertical clearance above the crown of the pipe a 3-ft tall eccentric, tapered cone shall be used without any additional 5-ft diameter risers.

2. MATERIALS

A. Concrete Manholes

Manholes shall be precast concrete with a minimum compressive strength of 4000-psi and utilize minimum grade 60 rebar in compliance with ASTM C478. All 4-ft and 5-ft diameter manholes and all 6-ft diameter manholes in paved areas shall be provided with eccentric cone sections. Flat top manholes are required in outfall areas for 6-ft and larger diameter manholes.

Precast concrete manholes shall meet all design and manufacturing requirements of ASTM C478 and all H-20 loading requirements. Minimum wall thickness shall be 5-inches and shall increase with depth and diameter in accordance with ASTM standards. The standard joint shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant. All lift holes must be plugged with non-shrinking grout after installation.

All manholes greater than 5-ft diameter shall have minimum 8-inch (6-inch for 4-ft diameter manholes), 4,000-psi concrete bottoms resting on a minimum of 12 inches of #57 stone. Sewer mains shall enter and exit radially through the manhole. Inverts shall be constructed with a width equal to the effluent pipe and a height equal to 1/2 that of the effluent pipe. Inverts shall be so finished with sufficient drop across the manhole to compensate for all resulting energy loss across the invert. Flat invert channels shall not be allowed. At each inlet and outlet of 8 inches or greater, resilient connectors or manhole boots shall be provided in conformance with ASTM C923. Rings and clamps are to meet standards of ASTM A167 and/or ASTM C923.

Precast manhole components shall not be installed, transported, or removed from the casting yard prior to reaching the minimum compressive strength of 4,000-psi and at least 7 days have elapsed since casting.

Manhole flat slab, eccentric reducers provided for 6-ft diameter and larger manholes shall be provided with minimum slab thickness of 12-inches. Flat slab, eccentric reducers shall not be allowed for manhole diameters less than 6-ft. Manhole flat top slab covers for outfall manholes 6-ft diameter and greater shall be designed and manufactured for H-20 loading and provided in minimum slab thickness of 8-inches. Manhole flat top covers shall be provided with a minimum clear opening of 36-inches when utilized with a 36-inch clear span manhole frame and cover.

Manhole benches shall slope upwards from the spring line of the pipe to the projected level of the pipe crown at the manhole wall, or 8-inches above the spring line, whichever is less. Bowl type inverts recessed inside of precast benches shall not be accepted.

B. Polymer Concrete Manholes

Polymer concrete manhole sections, monolithic base sections and related components shall meet the requirements of ASTM C 478. ASTM C 478 material and manufacturing is allowed compositional and dimensional differences required by a polymer concrete product. Polymer Concrete Manholes shall be domestically manufactured.

Base riser section shall be provided with monolithic floors, unless shown otherwise. Riser sections shall be provided joined with bell and spigot / ship-lap design seamed with butyl mastic and or rubber gaskets (ASTM C 990) so that on assembly, manhole base, riser and top section make a continuous and uniform manhole structure. Riser sections for polymer concrete manholes shall be constructed from standard polymer concrete manhole sections of the diameter indicated on drawings. Use various lengths of polymer concrete manhole sections in combination to provide correct height with the fewest joints.

Wall sections shall be designed for depth and loading conditions with wall thickness as designed by polymer concrete manufacturer.

Manhole tops shall support AASHTO HS-20 loading or loads as required and receiving cast iron frame covers or hatches, as indicated on drawings Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet the intent of ASTM C 478 with allowable compositional and sizing differences as designed by the polymer concrete manufacturer.

Covers shall be designed to meet AASHTO HS-20 design or as required by drawings, shall be domestically manufactured and listed on the Town's Approved Products List. Polymer manholes shall be designed based upon live and dead load criteria in ASTM C 857 and ACI 350-06.

Polymer Concrete Manhole risers, cones, flat lids, grade rings and manhole base sections shall be designed by manufacturer to meet loading requirements of ASTM C 478, ASTM C 857 and ACI 350-06 as modified for polymer concrete manhole design as follows:

1. **Polymer Concrete Mix Design** - Shall consist of thermosetting resin, sand, and aggregate. No Portland cement shall be allowed as part of the mix design matrix. All sand and aggregate shall be inert in an acidic environment.
2. **Reinforcement** – Shall use acid resistant reinforcement (FRP Bar) in accordance with ACI 440.1R-06 as applicable for polymer concrete design. The wall thickness of polymer concrete structures shall not be less than that prescribed by the manufacturer's design by less than 95% of stated design thickness.
3. **Thermosetting Resin** - The resin shall have a minimum deflection temperature of 158° F when tested at 264 psi (1.820 mPa) following Test Method D 648. The resin content shall not be less than 7% of the weight of the sample as determined by test method D 2584. Resin selection shall be suitable for applications in the corrosive conditions to which the polymer concrete manhole structures will be exposed.
4. **Components** - Each polymer concrete manhole component shall be free of all defects, including indentations, cracks, foreign inclusions and resin starved areas that, due to their nature and degree or extent, detrimentally affect the strength and serviceability of the component part. Cosmetic defect shall not be cause for rejection. The nominal internal diameter of manhole components shall not vary more than 2%. Variations in height of two opposite sides of risers and

cones shall not be more the 5/8 inch. The under-run in height of a riser or cone shall not be more than ¼ in/ft of height with a maximum of ½ inch in any one section.

5. **Marking and Identification** - Each manhole shall be marked with the following information - Manufacturer's name or trademark, Manufacturer's location and Production Date.

Manhole joints shall be assembled with a bell/spigot or shiplap butyl mastic and/or gasketed joint so that on assembly, manhole base, riser and top section make a continuous and uniform manhole. Joint sealing surfaces shall be free of dents, gouges and other surface irregularities that would affect joint integrity. Minimum clearance between wall penetrations and joints shall meet the requirements laid out in the Town standard specifications and details.

Construct invert channels in accordance with Town standard details to provide smooth flow transition with minimal disruption of flow at pipemanhole connections. Invert slope through manhole is as indicated on drawings. All precast base sections to be cast monolithically. Polymer bench and channel are to be constructed with all polymer concrete material. Extended ballast slab requirements for buoyancy concerns can be addressed with cementitious concrete material.

Provide resilient connectors conforming to requirements of ASTM C 923 or other options as available. All connectors shall be watertight. Install approved resilient connectors at each pipe entering and exiting manholes in accordance with manufacturer's instructions.

All materials needed for grouting and patching shall be a polyester mortar compound provided by the manufacturer or an approved equal by the manufacturer.

MANUFACTURER shall be included on the Town's Approved Products List.

C. Manhole Frame and Cover Materials

Manhole Frames and Covers shall be Class 35 gray iron with "Sanitary Sewer" and the Town of Pittsboro symbol forged into the cover as indicated in the details. Ring and cover shall be stamped with make and model. All manhole frames and covers shall be domestically made and manufactured in the USA from domestic iron.

1. Types:

- Manhole Frames and Covers in Paved Areas and some Unpaved Areas: For all installations in roadways or within the right of way, use Type 1 ring and cover, and place sufficient depth of concrete below the pavement around the ring to ensure contact with manhole. Type 1 covers shall be provided with 1 vent hole. Type 1 covers shall be designed for a proof load of 40,000 lbs. and be provided in Class 35B gray iron in conformance with ASTM A48. At a minimum, Type 1 manhole rings shall weigh 190 lbs. and the cover shall weigh 120 lbs.
- Manhole Frames and Covers for Outfalls: For installation in outfall areas, with 4-ft and 5-ft diameter manholes use Type 2 ring and covers. Type 2 covers shall not be installed in areas subject to traffic loading. Type 2 covers shall be provided with an integrated frame and cover assembly in which the cover rotates away from the frame for access. The rotating assembly shall be provided with a cast in stainless steel rod assembly. Type 2 covers shall be provided with a minimum 24-inch clear span opening along the axis with the stainless steel rod assembly. Security shall be provided by 3 exterior cast lugs at ¾-inch thickness that allow padlock installation or bolting with 3 stainless steel bolts with stainless steel zinc plated nuts. Type 2 covers shall be made of Class 35B iron in conformance with ASTM A48

and designed for a proof load of 12,000 lbs. The frame and cover weight shall not be less than 60-lbs for the cover and 80-lbs for the ring. The Type 2A frame and cover assembly shall be provided with a gasket that makes the cover assembly watertight when bolted at all three lugs. Type 2A covers shall be provided inside the 100-year flood elevation or other areas subject to flooding, if the manhole lid is less than 24 inches above the 100-year flood elevation. Type 2B covers are not watertight and are not required to have a gasket.

3. All castings shall be machined to give even and continuous bearing on the full length of the frame. Castings shall be free of porosity and blow holes. All manhole frames shall be bolted to the manhole, except in paved streets.

3. INSTALLATION

A. General Requirements

1. The upstream side of the last manhole(s) of a sanitary sewer line extension under construction shall be plugged by constructing a brick/block wall to prevent the passage of groundwater, runoff and sediment into the sanitary sewer system. All water upstream of the wall shall be pumped out of the sanitary sewer line and all sediment and solids shall be removed and properly disposed of by the Contractor. The wall shall not be removed until the line has been inspected by the Town to ensure that all possible points of inflow or infiltration have been eliminated. Failure to meet these requirements may be deemed a violation of the Ordinance with fines up to \$1,000.00 per day.
2. Manholes shall not be buried or hidden, which is a violation of the sewer use ordinance and subject to penalty by fines. All manhole penetrations, whether sewer main or service lateral, shall be cored with a concrete coring machine. All pipe connections must be made with flexible watertight couplings or boots.
3. For new manholes, there shall be a minimum of 9-inches or $\frac{1}{2}$ the pipe outside diameter (OD), whichever is greater, between the pipe hole openings. (Pipe hole opening is typically 4" greater than the pipe OD.) When the adjacent pipes are different sizes, the OD of the smaller pipe shall be used to determine the spacing requirement but shall never be less than 9-inches.
4. For connections to existing manholes, there shall be a minimum of 9- inches or 3.5-inches plus $\frac{1}{2}$ the OD of the existing pipe, whichever is greater, between the pipe hole openings. All external manhole joints shall be wrapped with an approved joint seal material.

B. Manholes Subject to Inundation

1. Manholes subject to flooding shall be watertight and vented 24 inches above the 100-year flood elevation. In flood prone areas, the manholes shall be vented at least every 1000-ft or every other manhole, whichever is greater.
2. The exterior of all manholes within the 100-year flood elevation and in wetland areas shall receive an exterior coating of an approved bitumastic coal tar epoxy at 40-mil to prevent

weepage or attack by acidic soils. In lieu of epoxy coated concrete manholes, approved polymer concrete manholes may be installed. Manufacturer of polymer concrete manholes shall be listed on the Town's Approved Products List. Anti-flotation design measures shall be implemented as required in flood prone areas.

C. Manholes Located on Large Collection Mains

The Town reserves the right to require all manholes located on interceptor or outfall mains 24-inches in diameter and larger to have the manhole interior and bench coated with an approved epoxy coating at 80-mil thickness. The epoxy coating shall be field applied and tested as described herein. An approved polymer concrete manhole may be installed in lieu of epoxy coating the manholes.

D. Force Main Discharge Manholes

All manholes located on gravity mains that serve or will serve as discharge points for sanitary sewer force mains shall receive an interior epoxy coating at 80-mil thickness. In addition to the receiver manhole, the Town reserves the right to require epoxy coating of the next two consecutive manholes downstream of the receiver manhole or all downstream manholes within 1500-LF of the receiver manhole. An approved polymer concrete manhole may be installed in lieu of epoxy coating the manholes.

E. Epoxy Coating

1. **Material Providers and Installers:** Approved coating manufacturers and corresponding installers are identified in the Town's Approved Product List.
2. **Surface Preparation:** Concrete manholes must be well cured prior to application of the protective epoxy coating. Generally, 28 days is adequate cure time for standard Portland cement. If earlier application is desired, compressive or tensile strength of the concrete can be tested to determine if acceptable cure has occurred. (Note: Bond strength of the coating to the concrete surface is generally limited to the tensile strength of the concrete itself. An Elcometer pull test to determine suitability of concrete for coating may be required).

Surface preparation shall be based on the requirements of the manufacturer of the epoxy coating and applicable NACE International standards.

3. **Installation:** A minimum 80-mil thickness shall be field applied to new manholes (120-mil for existing manholes). During application a wet film thickness gage, meeting ASTM D4414 - Standard Practice for Measurement of Wet Film Thickness of Organic Coatings by Notched Gages, shall be used to ensure a monolithic coating and uniform thickness during application.

Temperature of the surface to be coated should be maintained between 40° F and 120° F during application. Prior to and during application, care should be taken to avoid exposure of direct sunlight or other intense heat source to the structure being coated. Where varying surface temperatures do exist, care should be taken to apply the coating when the temperature is falling versus rising or in the early morning. The humidity should also be observed to ensure compliance with the epoxy manufacturers' recommendations.

Manufacturer approved heated plural component spray equipment shall be used in the application of the specified protective epoxy coating. The spray equipment shall be specifically designed to accurately ratio and apply the specified protective coating materials and shall be regularly maintained and in proper working order.

If necessary, subsequent top coating or additional coats of the protective coating should occur as soon as the basecoat becomes tack free, ideally within 12 hours but no later than the recoat window for the specified products. Additional surface preparation procedures will be required if this recoat window is exceeded.

F. Adjusting Manhole and Valve Covers with Adjustment Rings

Adjusting rings may be used to raise manhole covers in asphalt pavements when deemed acceptable by the Engineer. The amount of adjustment, thickness of seal or overlay, and cross slope will be considered when using adjusting rings. Each location where an adjusting ring is used must have a sufficient depth of asphalt to assure the proper installation and operation of the ring. The rings shall be made of a concrete, non-metallic, polypropylene or fiberglass material and installed per the manufacturer's specifications. The rings shall be approved by Town Engineering Department.

The concrete collar ring around the frame or valve box shall be circular, and shall be a minimum of eight (8) inches thick, placed flush with the adjacent new pavement surface. Concrete shall be a minimum of Class AA on all paved streets. All concrete shall be obtained from plants approved by the Town or Engineer.

If required by the Town of Pittsboro, a single No. 4 rebar hoop will be placed in each adjustment collar. The hoop diameter shall be such that its placement is centered between the edge of the manhole frame or valve box, and the outer edge of the concrete collar, the depth of the hoop shall be centered in the thickness of the collar. Each concrete ring shall be scored radially at quarter-circle points. Score lines shall be ¼ -inch wide by ½ - inch deep. The concrete collar surface shall be rough broom finished.

Traffic shall not be allowed on the concrete collars until the concrete has cured enough to allow traffic to drive on. On major streets the contractor shall use "high-early" in the concrete mix, approved by the Town of Pittsboro, to minimize delay in reopening the street(s) to traffic.

4.05 SERVICE CONNECTIONS

1. DESIGN

A. General Requirements

Direct sewer service taps shall not be allowed on sewer interceptor or outfall mains 15-inches in diameter or larger, except by manhole connection.

All residential subdivision lots shall be served by gravity unless otherwise approved. If a pump is approved, it shall be privately maintained and must pump into either a service connection placed on the lot or through a private force main to a manhole. The pump and force main (if needed) must have a note on the recorded plat indicating the following: "Privately maintained sewer pump and force main is required to serve this lot".

Service connections to the main lines shall be perpendicular to the main line and shall extend to the edge of the right of way or easement line. In addition, within townhouse developments, sewer service connections shall be located within 4-feet of driveways, or under driveways, in order to minimize conflicts between service lines and trees.

Cleanouts are required on all services with a maximum spacing of 75 feet on 4-inch services and 100 feet on 6-inch services, and at the right of way line or edge of easement. All cleanouts shall extend a minimum of 6-inches above finished grade with brass caps or meet the optional cleanout method requirements in accordance with the Standard Details.

Sewer cleanouts located in or within 24-inches of a paved areas, which bear vehicle loading, must have ductile iron risers, ductile iron fittings and a traffic rated cast iron or ductile iron cover assembly. Refer to standard detail for mini manhole for sewer service cleanout assembly in traffic areas.

All 6-inch service connections shall be into a manhole.

Service lines connected to manholes shall not be through the cone section or manhole joints. Service lines shall be installed 6" above, but no more than 30 inches above the invert or shall be installed with a standard drop. Multiple service connections shall not be maintained by the Town. For 6-ft diameter and larger manholes no service is allowed in the reduced diameter riser sections of the manhole.

The use of in-line wyes for service connections shall be required for all new construction. When connecting to existing sewer mains, service saddle taps will be allowable. Taps shall be at the 10 or 2 o'clock position and shall not be top taps.

Service connections to mains at depths of 18-ft and greater shall utilize ductile iron pipe between the main and the cleanout, including a ductile iron wye for the cleanout stack. Location and angle of fittings shall be as shown in the standard detail drawings.

Where the flood level rims of plumbing fixtures are below the elevation of the manhole cover of the next upstream manhole in the public sewer, such fixtures shall be protected by a backwater valve installed in the building drain, branch of the building drain or horizontal branch serving such fixtures. Plumbing fixtures having flood level rims above the elevation of the manhole cover of the next upstream manhole in the public sewer shall not discharge through a backwater valve.

2. MATERIALS

A. Pipe Materials

1. PVC Pipe shall be schedule 40 or greater supplied in minimum 18-ft lengths. Schedule 40 PVC pipe shall be manufactured with a cell classification of 12454 in conformance with ASTM D1784. Schedule 40 pipes shall be manufactured to dimensional tolerances as specified in ASTM D1785 and rated for service conditions up to temperatures of 140-degrees Fahrenheit. The pipe may be joined by solvent weld in conformance with ASTM D2564.

Nominal Pipe Diameter (inches)	Outside Diameter (inches)	Inside Diameter (inches)	Thickness (inches)
4	4.50	4.02	0.24
6	6.62	6.03	0.28

PVC pipe for sewer services shall require bedding based upon depth as follows:

- 3-14-ft Depth – 4-inches of stone bedding extended to springline
- 8-20-ft Depth – 6-inches of stone bedding extended 6-inches above pipe crown

2. Ductile Iron Pipe shall be used for sanitary sewer services with less than 3 feet of cover or in excess of 18 feet of cover. Ductile iron services shall also be used in all cases where a well is located within 100-ft of the sewer service line. Ductile iron service piping shall be provided in conformance with the ductile iron piping standards outlined herein including cement mortar lining.

Nominal Pipe Diameter (inches)	Outside Diameter (inches)	Inside Diameter (inches)	Thickness (inches)
4	4.80	4.30	0.25
6	6.90	6.40	0.25

B. Sewer Service Fittings, New Construction

All sewer service connections for new construction shall be provided with in-line wye fittings.

1. DIP Main with DIP Service

In-line wye fittings for ductile iron main lines joined with ductile iron service lines shall be typical ductile iron mechanical joint fittings as specified herein. In this case all fitting sizes shall conform to AWWA C153. Wye fittings through 10-inches in diameter shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Wye fittings for lines larger than 10- inches in diameter shall be provided with Town approved lining as specified herein for ductile iron pipe of the same sizing.

2. DIP Main with PVC Service

For ductile iron sewer mains to be joined with PVC service lines, the inline wye fittings shall be slip joint ductile iron with an IPS sized branch for PVC schedule 40 service lines. Ductile iron fittings for connecting PVC service lines shall be deep bell, gasketed joint and air test rated. Gasket grooves shall be machined. Bell depths shall meet the minimum socket depth requirements of ASTM D3034 and ASTM F1336. Wall thickness shall meet the requirements of AWWA C153. Ductile iron wye fittings through 10-inches in diameter with IPS connections shall be provided with cement mortar lining in accordance with AWWA C104 and provided with exterior asphaltic coating per AWWA C151. Ductile iron wye fittings for PVC lines larger than 10- inches in diameter shall be provided with Town approved lining as specified herein.

3. PVC Main with PVC Service

For PVC sewer mains to be joined with PVC service lines, PVC in-line wye fittings shall be provided. Typical Schedule 40 PVC fittings shall be provided at the cleanout wye and stack.

4. PVC Main with DIP Service

A ductile iron tee/wye shall be provided when the service line is required to be ductile iron due to a crossing or other obstruction. The fitting shall be specifically manufactured for ASTM 3034

PVC pipe such that a smooth flow way exists on the main line through the fitting. The branch shall be gasketed to receive the 4-inch DIP service line without additional fittings. The ductile iron tee/wye fitting shall be provided with Town approved lining.

C. Service Saddle Connections, Existing Sewer Mains

1. PVC service saddles shall be of the same material as the main and shall be solvent welded and fastened with double stainless steel bands.
2. For existing DIP main lines, ductile iron service saddles shall be used. The saddle assembly shall consist of a virgin SBR or NBR gasket compounded for sewer service, a ductile iron saddle casting, a 304 stainless steel adjustable strap for fastening the gasket and the saddle casting to the sewer main and a 304 stainless steel adjustable circle clamp for securing the service line into the rubber gasket.

3. INSTALLATION

Sewer laterals shall not be located in easements when gravity service can be provided to the property frontage at the street. Each separately owned structure requires a separate tap to a public sewer.

All service lines with less than 3-ft of cover or deeper than 18-ft shall be made of ductile iron pipe.

Four-inch lines shall have a minimum slope of 1.0-ft/100 feet and a maximum slope of 10.0-ft/100 feet. Six-inch lines shall have a minimum slope of 0.60-ft/100 feet and a maximum slope of 6.0-ft/100 feet.

All service connections to existing sanitary sewer mains shall be made by the Town. Service connections to new mains may be made by the Contractor but shall include the use of wye (not tee) connections. Saddle taps onto new lines shall not be allowed.

Saddle taps into existing PVC mains shall be made at the 10 o'clock or 2 o'clock position of the main with the wye saddle angled 45-degrees towards the direction of flow in the main. Taps shall only be made by a mechanical circular cutting saw providing a smooth and uniform cut for the saddle installation.

Service connections shall be made using an approved sewer saddle when the existing sewer line is 8", 10", or 12" in diameter. This service connection shall not be used when the sewer main material is truss sewer pipe. The opening in the sewer main for the sewer saddle shall be cut with a hydraulically or pneumatically driven circular tapping saw of the same nominal diameter as the sewer service line.

4.06 TESTING AND INSPECTIONS

The Contractor shall furnish all materials, labor, and equipment to perform all testing. The Contractor may arrange to obtain water for testing purposes from the Town. The Contractor shall reimburse the Town for all water used for construction at current inside utility rates.

1. SEWER MAIN AND SERVICE CONNECTION TESTING

A. Visual Testing and Observation

All materials used must be approved by the Town inspector prior to installation. Rejected materials shall be immediately removed from the job.

Gravity sanitary sewer lines shall be clean and free from obstructions and shall be visually inspected from every manhole. Lines which do not exhibit a true line and grade or which have structural defects shall be corrected. Sanitary sewer service connections shall be visually inspected prior to backfilling.

B. Air Testing

Low-pressure air testing in accordance with ASTM F1417 shall be performed on all sewer mains before the laterals or stubs are installed on the line, and after the trench has been backfilled to finished grade. Plugs shall be installed at each manhole to seal off the test section. The line will be pressurized with a single hose and monitored by a separate hose connection from the plug. Air then shall be slowly introduced into the sealed line until the internal air pressure reaches 4.0 psig. The air pressure shall then be allowed to stabilize for a minimum of 2 minutes at no less than 3.5 psig (plus groundwater pressure, if any). When the pressure reaches 3.5, the time required for the pressure to drop 1.0 psi will be observed and recorded. The line shall be "acceptable" if the pressure does not drop more than 1.0 psi in the time prescribed for the test in the Sanitary Sewer Air Test table found in Standard Detail SS-04-026. An abbreviated version of the air test table is shown below:

Table 4.12: Sanitary Sewer Air Test (abbreviated)												
NOMINAL PIPE DIAMETER (INCHES)												
LENGTH OF TEST SECTION		8	12	15	16	18	21	24	27	30	36	42
	50	7:33	11:20	14:10	15:11	17:00	19:48	22:40	25:30	28:19	34:00	39:40
	100	7:33	11:20	14:10	15:11	17:00	19:48	22:47	28:51	35:37	51:17	69:48
	150	7:33	11:20	14:10	15:12	19:14	26:10	34:11	43:16	53:25	76:55	104:42
	200	7:33	11:24	17:48	20:16	25:39	34:54	45:35	57:42	71:13	102:36	139:36
	250	7:33	14:15	22:16	25:20	32:03	43:37	56:58	72:07	89:02	128:12	174:30
	300	7:35	17:06	26:43	30:23	38:28	52:21	68:22	86:32	106:48	153:54	209:25
	350	8:52	19:57	31:10	35:37	44:52	61:05	79:46	101:00	124:42	179:30	244:19
	400	10:07	22:48	35:37	40:31	51:17	69:48	91:10	115:24	142:30	205:06	279:13
	450	11:23	25:39	40:04	45:35	57:42	78:31	102:36	129:48	160:18	230:48	314:07
500	12:39	28:30	44:31	50:39	64:06	87:15	114:00	144:12	178:06	256:24	349:02	

If the section fails to meet these requirements, the source of leakage shall be repaired and the pipe section re-inspected. The Town inspector may require that an infiltration test be performed that shall not exceed 100 GPD/inch/mile.

C. Deflection Testing for Flexible Pipe

The mandrel (go/no-go) deflection test shall be performed on each line prior to acceptance and no sooner than 30 days after installation. The pipeline shall be thoroughly clean and free of debris and/or sediment prior to testing. The Contractor shall supply the mandrel used for this performance test. The mandrel device shall be cylindrical in shape having 9 possible contact points with the pipe. The mandrel's length and diameter (ID of proving ring) shall be in accordance with the following tables, and shall be subject to the Town inspector's approval.

For flexible pipes (such as PVC), the following shall apply:

Table 4.13: Deflection for Flexible Pipe

Nominal Diameter (inches)	Pipe Class	Average Inside Pipe Diameter (inches)	5% Deflection Mandrel Diameter (inches)	Length of Mandrel (inches)	Minimum Fins Included with Mandrel
8	SDR 26	7.715	7.329	10	9
8	SDR 35	7.891	7.496	10	9
10	SDR 26	9.644	9.162	10	9
10	SDR 35	9.864	9.371	10	9
12	SDR 26	11.480	10.906	10	9
12	SDR 35	11.737	11.150	10	9
15	SDR 26	14.053	13.350	10	9
15	SDR 35	14.374	13.655	10	9
18	SDR 26	17.261	16.398	24	9
21	SDR 26	20.349	19.332	24	9
24	SDR 26	22.891	21.746	24	9
27	SDR 26	25.799	24.509	24	9

Note: Calculated 5% deflection allowance does not include additional manufacturing tolerances provided by pipe manufacturers. For the purposes of testing, 5% deflection shall be calculated from standard pipe inside diameter as published in ASTM D3034 and ASTM F679.

The mandrel shall be advanced through the pipeline to determine if bedding and embedment has been provided in compliance with ASTM D2321 to assure joint deflection of less than 5%. If the mandrel becomes obstructed for any reason while being pulled through the line with less than 100-lbs of force, the location of the defect shall be noted and the mandrel shall be removed from the pipeline. Under no circumstances shall heavy equipment be utilized to force the mandrel through the pipeline. Deflection testing may be done concurrently with sewer televising inspections, provided the mandrel is kept within visible range of the camera.

D. Video Assessment and Cleaning

As a final measure required for acceptance, the Contractor shall clean and televise all newly installed sewer mains and laterals from the demarcation cleanout to the main and shall be clearly identifiable as to the lot of building serviced prior to acceptance by the Town. The Contractor shall televise the sewer main and all lateral connections installed from the upstream to downstream manhole with no reverse setups or cutaways. Throughout shooting, the camera shall be panned and tilted for a complete view of the main and laterals. Lighting shall be adequate to view the entire sewer main and service connections from beginning to end. The video inspection shall be submitted to the Town on approved media type. IT Pipe files shall be included with the submission. The Town shall not be responsible for purchasing additional software necessary to view the submission.

The camera shall be advanced at a uniform rate not to exceed 20 feet per minute that allows a full and thorough inspection of the new sewer main. The camera shall be a color, pan and tilt camera capable of producing a five hundred line resolution picture. Lighting for the camera shall be sufficient to yield a clear picture of the entire periphery of the pipe. The picture quality shall be acceptable and sufficient to allow a complete inspection with no lapses in coverage. The length of the sewer main shall be measured and recorded on the video screen. The distance counter shall be calibrated before shooting the inspection video.

The Contractor shall clean the sewer mains and laterals ahead of video inspection with a high-velocity water jet. The video inspection shall take place within 2-hours of cleaning operations as witnessed by the Town inspector. All construction debris shall be collected in the downstream manhole and shall not be released into the sewer system.

The Town inspector shall be present throughout the cleaning and televising of the sewer mains and laterals to verify that the video work complies with the Specifications.

Prior to providing the inspection media to the Town inspector, the Contractor shall label the submission with the following information:

- Name of the Project/Development.
- Name and contact information of responsible party.
- Date of televising.
- Manhole identification as shown on the design plans.

E. Marker Tape Testing

Testing of the marker tape shall be performed by the Contractor at the completion of the project to assure it is working properly and completely detectable. It is the Contractor’s responsibility to provide the necessary equipment to test the markers. Any defective, missing, or otherwise nonlocatable segments shall be replaced at the Contractor’s expense.

2. MANHOLE TESTING

A. Vacuum Testing

All newly installed manholes, shall pass a vacuum test in accordance with ASTM C 1244. The Contractor shall supply all equipment and materials necessary to vacuum test the manholes. Vacuum Testing shall be completed prior to any specified coating and lining materials being installed. For manholes in roadways, vacuum testing shall occur after stone has been proof-rolled.

The Town inspector shall be present and witness all vacuum testing. The following vacuum testing criteria shall apply for compliance with the testing procedure.

- A vacuum of 10-inches of mercury shall be drawn with an approved vacuum testing unit.
- The testing time shall not be measured until after the vacuum pump has been shut off.
- The time required for the vacuum to drop from 10-inches to 9- inches of mercury shall meet or exceed the values listed in the following table.

Table 4.14: Manhole Vacuum Testing Time			
Depth (feet)	Manhole Diameter (inches)		
	48	60	72
	Time (seconds)		
8	20	26	33
10	25	33	41
12	30	39	49
14	35	48	57
16	40	52	67
18	45	59	73
20	50	65	81
22	55	72	89

24	59	78	97
26	64	85	105
28	69	91	113
30	74	98	121

B. Holiday Testing of Lined Manholes

All manholes that require an epoxy coating shall undergo discontinuity testing. This shall be a high-voltage spark test conducted in accordance with NACE International Standard Practice 0188. All areas of the manhole coated shall be tested. The spark tester shall be set at a minimum of 100 volts per mil of coating thickness applied. The Contractor shall supply the spark tester and all testing equipment and labor needed to perform this test.

All holidays identified must be repaired. The epoxy coating must be abraded and cleaned prior to re-coating. All touch-up work shall be in accordance with the epoxy manufacturers guidelines.

4.07 AERIAL CROSSINGS

1. DESIGN

Aerial crossings shall only be utilized in cases where buried crossings are prohibited due to stream crossings, compliance with riparian buffer standards, minimizing impacts to wetlands, preventing excessive depth of installation, or as otherwise directed by the Town.

In cases where aerial crossings are utilized to cross streams, the bottom of the pipe shall be installed above the 25-year flood elevation of the stream. Piers shall generally be located at a uniform spacing of 20-ft or 1 pier for every joint of pipe. Piers shall be provided in accordance with the standard details or as otherwise designed by a licensed NC Professional Engineer. Aerial crossing with greater than 50 acres of drainage area are subject to Town floodplain regulations.

All pier footings shall be designed by a licensed NC Professional Engineer and the assumptions provided in the footing design shall be included on the plans. At a minimum, the footing design shall include:

- the allowable soil bearing capacity
- design concrete compressive strength
- plan for reinforcing steel with sizing and location of bars
- force diagram including buoyant forces, stream velocity impacts
- depth of installation to prevent frost heaving
- bedding design to prevent differential settlement and subbase scour
- factors of safety for unanticipated loads such as trees falling across the aerial crossing.

At locations inundated by the 100-year design storm shall include foundation anchor design.

At a minimum all pier foundations shall be constructed on a base of 12- inches of washed stone. The soil conditions under the pier shall be evaluated by a licensed NC Geotechnical Engineer to determine if the allowable soil bearing capacity meets or exceeds the design assumptions included in the structural design and subbase stability. If the soil conditions fail to meet the specified bearing capacity and stability requirements, a pile foundation shall be provided, or the soils shall be undercut and replaced in conformance with the recommendations of the geotechnical engineer of record.

Piers installed in stream beds shall be avoided in lieu of spanned crossings. Spanned pipe crossings greater than 20-ft shall be provided in accordance with the pipe manufacturer's specifications and shall not exceed 40-ft for ductile iron pipe. Spanned pipe crossings shall be designed such that all flanges and exterior pipe connections are located above the 25-year flood elevation.

Each pier exposed to the 100-year design storm shall be protected by the appropriately size rip rap and extends 6-feet beyond the pier radially. Stream bank slopes beneath the aerial crossing shall be protected by appropriately sized rip rap and extend a minimum of 6-feet beyond the centerline of the pipe up and downstream. Rip rap shall not be allowed in the stream. Spanned crossings greater than 40-ft without piers shall be provided in a steel encasement pipe and the entire crossing including piers, foundation, truss and/or beam supports and pipe thickness design shall be provided by a licensed NC Structural Engineer.

2. PIPE MATERIALS

PVC pipe shall not be approved for aerial crossings.

Ductile iron pipe for aerial crossings shall be interior lined with approved liner listed on the Town Approved Products List at 40- mil regardless of pipe diameter from manhole to manhole. All joints for ductile iron pipe utilized in aerial crossings shall be restrained with a US Pipe Mech-Lok joint, American MJ Coupled joint, or other as approved by the pipe manufacturer, the Utilities Department and the Engineer of Record. Ductile iron pipe utilized for spanned crossings greater than 20-ft without a pier shall typically be provided with flanged connections. All bolts and fasteners for flanged or bolt locking restraining systems shall be provided in stainless steel and installed in a manner to prevent seizing.

Steel pipe provided for aerial crossings shall be fabricated with grade B steel that has minimum yield strength of 35 KSI in accordance with ASTM A139. Steel pipe for aerial crossings shall be provided with minimum wall thickness consistent with a pressure class of 200-psi or greater. Steel pipe for aerial sewer crossings shall be provided with 40-mil of interior ceramic coating, such as Ceramaline and provided with an exterior tape wrap approved by the manufacturer. All steel pipe joints shall be welded in conformance with manufacturers' specifications.

3. INSTALLATION

Aerial crossings are often utilized to span sensitive environmental areas and installation shall be consistent with plans to preserve the sensitive areas.

Joints of bolt lock or coupled restrained pipe shall be located within 2-ft of each pier as outlined by the detail drawings. Contractor shall ensure the length of pipe joints allows for this spacing.

Pipe shall be secured to each pier with 1/4-inch by 2-inch width steel straps fastened to 4; 1/2-inch stainless steel lugs anchored and adhered with epoxy to the concrete pier. The steel straps shall receive a weather resistant painted finish to prevent long term corrosion.

Precast piers may be submitted for approval provided the footing and foundation designs are completed by licensed structural and geotechnical engineers.

In cases where soil conditions cannot be sufficiently stabilized to provide an adequate foundation for concrete piers, a pile foundation designed by a licensed NC structural engineer and approved by the Town shall be provided.

Reinforcing steel for concrete piers shall be grade 40 and shall be constructed in conformance with the latest edition of the "Recommended Practice for Placing Reinforcing Bars" or other documentation as published by the Concrete Reinforcing Steel Institute.

In cases where rock exists at the foundation or potential scour elevation, the footing shall be drilled and connected with dowels into the rock layer.

4.08 REPAIRS AND MODIFICATIONS

1. SEWER MAIN REPAIRS

A. Vitrified Clay Pipe

Replace damaged section with D.I.P. and install a Fernco coupling at each end encased in concrete.

B. PVC Pipe

Replace damaged section with PVC Pipe and install a Fernco coupling at each end encased in concrete.

C. ABS/PVC Truss Pipe

Replace damaged section with D.I.P. and install a Fernco coupling at each end encased in concrete.

D. Asbestos Cement Pipe

Replace damaged section with DIP and couplings encased in concrete.

2. INSTALLATION

All repairs to damaged sanitary sewer lines in paved areas shall be backfilled with ABC stone (crusher run) to a density of 95 percent Standard Proctor.

All repairs to damaged sanitary sewer lines shall be bedded with 6- inches of washed stone and compacted to a minimum of 95% Standard Proctor density before installing the new joint of ductile iron or PVC pipe.

3. ABANDONMENT

Sewer service laterals shall be abandoned by removing and replacing the saddle with a 360-degree stainless steel sleeve. At in-line wyes the service lateral shall be cut within 12" of the wye and a mechanical cap installed on DIP/cast services or glued to PVC services and the abandoned wye encased with 1 cubic foot of concrete.

4. DRAINING SEWER MAINS

A detailed pumping and emergency plan shall be required for any sewer line draining event.

All sanitary sewer mains and sewer force mains 20-inches and larger, active, inactive, or abandoned shall begin to be drained by tapping the bottom half of the pipe. A corporation stop or other valve shall be

provided to control flow. All effluent shall be pumped to a downstream manhole (when available) or other containment tank utilizing continuous piping. The use of a sump pit on lines 20-inches and larger is not allowed.

In sensitive environmental areas and in other various scenarios the Utilities Department may require lines less than 20-inches also be tapped in order to be drained.

END OF SECTION 4.