

## **100 PIPING SYSTEMS GENERAL**

### **100.01 UNDERGROUND PIPE LOCATION SYSTEM**

100.01.01 Underground pipe locating system for all underground public utility projects shall include warning tape, tracer wire and marker balls except as noted.

#### 100.01.02 Warning Tape

100.01.02.01 Provide and install an early warning detection tape above all underground piping, excluding gravity sewer and storm drains.

100.01.02.02 Warning tape shall be laid a minimum of 8 inches above crown of pipe during installation.

100.01.02.03 If warning tape is damaged it shall be replaced prior to backfilling trench.

100.01.02.04 Tape shall be 3" wide by 4 mils thick.

100.01.02.05 Tape shall be clearly labeled "WATER" or "WASTEWATER".

100.01.02.06 Tape shall have a minimum tensile strength of 2,800 psi in accordance with ASTM D-882.

100.01.02.07 Tape color shall conform to APWA Uniform Color Code.

#### 100.01.03 Tracer Wire

100.01.03.01 All underground piping shall be electronically locatable.

100.01.03.02 A tracer wire shall be installed with all underground pipes with the following exclusions:

100.01.03.02.01 Metallic piping can be located electronically with a metal detector.

100.01.03.02.02 Piping with a straight alignment between visible structures can be electronically locatable by use of laser technology.

100.01.03.02.03 Storm drainage systems

100.01.03.03 Tracer wire shall have terminal ends accessible in tracer wire test stations located within a 3-foot radius of every fire hydrant for water lines, and within a 3-foot radius of air release valves and/or every five hundred feet in a concrete donut or mini-manhole for force mains. Other locating technologies may be approved by the Director of Engineering with input from the Public Utilities Director. Tracer wire shall be from the list of approved manufacturers included in the Appendix, or approved equal.

100.01.03.04 Wire shall be a minimum #12 AWG direct burial, high strength, 21% conductivity, annealed copper clad steel conductor wire secured to the pipe at 10' maximum spacing and rated for direct burial use at 30 volts.

100.01.03.05 Wire shall be insulated with 30 mil, high density, high molecular weight polyethylene (HDPE) complying with ASTM D-1248.

100.01.03.06 Wire break load shall be a minimum 380 lbs.

100.01.03.07 Wire color shall conform to APWA Uniform Color Code.

100.01.04 Tracer Wire Testing Station

100.01.04.01 Tracer wire testing stations shall be installed at a 500' maximum spacing.

100.01.04.02 The box shall be constructed of a rigid plastic material conforming to ASTM B-253.

100.01.04.03 The lid shall be constructed of cast iron or ductile iron.

100.01.05 Marker Balls

100.01.05.01 Pressure Piping Systems (Water mains and Force mains)

100.01.05.01.01 Marker balls shall be located at all fittings on pressurized piping systems.

100.01.05.01.02 Marker ball to be programmable. See Approved Manufacturer's List.

100.01.05.01.03 Maximum depth of the marker ball shall 3-feet.

100.01.05.02 Piping with a Straight Alignment between Structures (Gravity Sewer and Storm Drains)

100.01.05.02.01 A minimum of one marker ball shall be located along the alignment between structures at a maximum spacing of 150 feet spaced equidistant.

100.01.05.02.02 Marker balls for deep sewer services per detail 150.02

100.01.05.02.03 Marker ball to be passive. See Approved Manufacturer's List.

100.01.05.02.04 Maximum depth of the marker ball shall be 3-feet.

## 100.02 PIPING SYSTEM MATERIALS

### 100.02.01 Materials for Pipes

#### 100.02.01.01 General

100.02.01.01.01 The pipe material used for each application shall be in compliance with Table 100.09 and as specified herein.

100.02.01.01.02 Each length of pipe shall have plainly and permanently marked thereon the following information: pipe class or strength designation, manufacturer's name or trademark, nominal pipe size.

100.02.01.01.03 Ductile Iron and PVC pipe shall be manufactured in 18-foot or 20-foot lengths.

#### 100.02.01.02 Ductile Iron Pipe (DIP)

100.02.01.02.01 DIP shall be as listed in the Approved Manufacturer's List.

100.02.01.02.02 Ductile iron pipe shall be designed and manufactured in accordance with AWWA C150 and C151. The minimum required pressure ratings for ductile iron pipe installed at a Type 2 laying condition can be found in Table 100.01. For all other installations other than specified, the laying condition or the minimum pressure class rating shall be increased in accordance with AWWA C151.

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

100.02.01.02.04 All buried ductile iron pipe and fittings shall have a bituminous **exterior** coating in accordance with AWWA C151.

100.02.01.02.05 Pipe fittings shall be ductile iron designed and manufactured per AWWA C110. Fittings up to and including 12-inch shall be designed for an internal pressure of 250 psi. Fittings larger than 12-inch shall be designed for an internal pressure of 150 psi.

100.02.01.02.06 Mechanical joint compact fittings shall be ductile iron designed and manufactured per AWWA C153. Fittings up to 24-inch shall be designed for an internal pressure of 350 psi.

100.02.01.02.07 Field welding on any ductile iron pipe for any type of joint restraint is not allowed.

#### 100.02.01.02.08 Interior Coating of DIP in Potable Water Applications

100.02.01.02.08.01 All DIP and fittings used in potable water applications shall have an internal cement mortar lining with a seal coat of bituminous material in accordance with AWWA C104.

100.02.01.02.09 Interior Coating of DIP in Wastewater Applications

100.02.01.02.09.01 All DIP and fittings used in wastewater applications shall be coated with an interior ceramic epoxy lining. The lining shall be factory applied, and the pipe shall have no other interior coating prior to application of the ceramic epoxy lining.

100.02.01.02.09.02 The interior ceramic epoxy lining materials and application shall meet the following standards: ASTM E-96, ASTM G-95, ASTM B-117, ASTM G-14, ASTM D-714, SSPC-PA-2, ASTM D-1308, EPA 1311, and EN 598.

100.02.01.02.09.03 The interior of the pipe and fittings shall receive 40 mils nominal dry film thickness of ceramic epoxy lining. The ceramic epoxy material shall be an amine cured novalac epoxy containing at least 20% by volume of ceramic quartz pigment. The lining shall be applied as recommended by the lining manufacturer.

100.02.01.02.09.04 The interior lining on all DIP and fittings shall be holiday tested for integrity. Any defects found shall be repaired prior to shipment. Each pipe and fitting shall be stamped with the name of the company that applied the lining, and the date the lining was applied.

100.02.01.02.09.05 Ceramic epoxy lined pipe and fittings shall be handled only from the outside of the pipe and fittings. No forks, chains, straps, hooks, etc. shall be placed inside the pipe or fittings for lifting, positioning, or laying.

100.02.01.03 Polyvinyl Chloride (PVC) for Water Distribution

100.02.01.03.01 PVC pipe shall be as listed in the Approved Manufacturer's List and be colored blue.

100.02.01.03.02 PVC seamless pipe shall meet the requirements dimensional, chemical, and physical requirements of AWWA C-900-16 (latest revision). Polyvinyl chloride compounds shall comply with a minimum cell classification of 12454 as defined in ASTM Specification D1784. Each length of pipe shall be marked with the following information: size, company name or logo, PVC sewer pipe, manufacturer's code, and cell classification.

100.02.01.03.03 All PVC pipe used for water distribution shall have a maximum cast iron outside diameter dimension ratio of 18 (DR-18).

100.02.01.03.04 All pipe joints shall be of the bell and spigot type with elastomeric seals and conform to the requirements of ASTM D3139. Gaskets shall be factory installed and chemically bonded to the bell end of the pipe. Gasket material shall conform to the requirements of ASTM F477. Joints shall be designed to sustain an angular deflection of up to 2° without leakage or loss of joint integrity.

100.02.01.03.05 Fittings shall be ductile iron in accordance with Section 100.02.01.02 Ductile Iron Pipe.

100.02.01.04 Polyvinyl Chloride (PVC) for Sanitary Sewer

100.02.01.04.01 PVC pipe shall be as listed in the Approved Manufacturer's List and colored green.

100.02.01.04.02 PVC pipe will not be allowed in areas that have been contaminated by petroleum products.

100.02.01.04.03 PVC sewer pressure pipe (force mains) shall meet the requirements of ASTM D2241. PVC sewer pressure pipe shall have a maximum Standard Dimension Ratio (SDR) of 26. Polyvinyl compounds shall comply with a minimum cell classification of 12454B as defined in ASTM Specification D1784. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints meeting the requirements of ASTM D3139 and ASTM F477. The maximum diameter for a PVC sewer pressure pipe is 12". Each length of pipe shall be marked with the following information: size, company name or logo, PVC sewer pipe, manufacturer's code, and cell classification.

100.02.01.04.04 PVC gravity sewer pipe shall meet the requirements of ASTM D3034, Type PSM for sizes 4" to 15", and ASTM F679 for sizes 18" to 48". PVC gravity sewer pipe shall have a maximum Standard Dimension Ratio (SDR) of 35. Polyvinyl chloride compounds shall comply with a minimum cell classification of 12454 as defined in ASTM Specification D1784. The pipe shall be capable of withstanding the overburden pressures resulting from the depth of bury in the field. The pipe shall have bell and spigot ends with push-on, O-ring rubber gasket, compression type joints meeting the requirements of ASTM D3139 and ASTM F477. Each length of pipe shall be marked with the following information: size, company name or logo, PVC sewer pipe, manufacturer's code, and cell classification.

100.02.01.04.05 Where laying conditions so warrant, and in accordance with manufacturer's recommendations, lower SDR values (stronger pipe) may be required. The Town reserves the right to require the installation of SDR 26 or SDR 21 for gravity sewer pipe and SDR 21 or SDR 17 for the sewer pressure pipe at the discretion of the Engineering Director or the Public Utilities Director.

100.02.01.05 C-900 PVC for Gravity Sanitary Sewer in Lieu of DIP:

100.02.01.05.01.01 The Town requires gravity sewer installations over 12-feet of cover to be ceramic epoxy lined Ductile iron, though C-900 PVC is allowed with the following conditions.

100.02.01.05.01.01.01 C-900 shall be a maximum of DR-18.

100.02.01.05.01.01.02 When C-900 is used in lieu of epoxy lined DIP for deep sewer installations, special bedding shall be required for the main line and the sewer services. Main line bedding shall be designed per manufacturer recommendations; however, bedding of 78M or No. 5 stone shall be a minimum of 1-foot below invert and 1-foot above crown of pipe.

100.02.01.05.01.01.03 Sewer services shall also be C-900 pipe wrapped in minimum of 6-inches of stone above and below to the cleanout at ROW.

100.02.01.05.01.01.04 A geotechnical report shall be provided that certifies the absence of petroleum within the soils. If petroleum products are discovered in the area, such as due to an old leaking farm tank, then C-900 will not be allowed.

100.02.01.05.01.01.05 The entire line and sewer services shall be left exposed for visual inspection by the Town of Construction Inspector before backfill, with special attention at service taps.

100.02.01.05.01.01.06 No rocks larger than 6-inches in diameter shall be used in the first three feet of backfill over top of pipe.

100.02.01.05.01.01.07 The manholes shall be vacuum tested, the sewer lines pressure tested, and the sewer line tv'd with a tape provided to the Town with as-built plans.

100.02.01.05.01.01.08 PVC C900 fittings using AWWA C900 pipe 8" and smaller shall be gasketed joint of one piece and injection molded of PVC compound with a cell class meeting or exceeding 12454 or 13343 per ASTM D1784. Elbows and Tees shall comply with AWWA C907. Wyes shall comply with the dimensional requirements of AWWA C907 except that minimum wall thickness shall be DR 18 of like size AWWA C900 pipe and all other requirements of this specification. Gasketed joints shall be pressure rated 235 psi per ASTM D3139. Gaskets shall be SBR rubber complying with ASTM F477. All fittings for gravity sewer pipe using AWWA C900 pipe 10" and larger shall be fabricated from C900 pressure rated pipe.

100.02.01.06 High Density Polyethylene (HDPE)

100.02.01.06.01 HDPE shall be as listed in the Approved Manufacturer's List

100.02.01.06.02 HDPE pipe will not be allowed in areas that have been contaminated by petroleum products.

100.02.01.06.03 HDPE pipe used for storm drainage shall conform to AASHTO M294 "corrugated exterior/smooth interior pipe (Type S)" and shall be certified by the PPI (Plastic Pipe Institute).

100.02.01.06.04 Pipe material shall meet the product specifications of ASTM F667 and shall have a smooth interior. Pipe joints shall consist of an integral bell and spigot type joint with "O" ring rubber gasket meeting ASTM F477 placed on the spigot end. At least two (2) corrugations of the spigot end must insert in the bell end. Installation shall adhere to the specification of ASTM D2321 and certified by an engineer.

100.02.01.06.05 Transition of HDPE to RCP shall require a Dissimilar Materials Adapter incorporating a geotextile coupler with mastic coating and stainless steel straps, and a full concrete encasement around the connection.

100.02.01.06.06 HDPE pipe used for storm drainage applications shall only be installed in diameters between 15 and 48 inches.

100.02.01.06.07 Water and sewer applications shall meet product specifications of ASTM 2239, ASTM 2737 and PE 4710 with a maximum SDR of 9. Designer shall determine any impact of using HDPE with smaller inside diameters on fire flows or pump station head designs. Designer shall designate the use of ductile iron outside diameter (DIOD) in accordance with ANSI/AWWA C906-15 to match C900 outside diameters when used for water lines.

100.02.01.06.08 HDPE pipe shall not be used for installations deeper than 20 feet.

100.02.01.07 Reinforced Concrete Pipe (RCP)

100.02.01.07.01 Reinforced Concrete Pipe shall conform to ASTM C76, Table III or Table IV. Joints shall be sealed with a plastic cement putty meeting Federal Specification SS-S-00210, such as Ram-Nek or a butyl rubber sealant.

100.02.01.08 Corrugated Metal Pipe (CMP)

100.02.01.08.01 Aluminized Steel Type 2 Pipe shall be 36-inch diameter or greater and be bedded and manufactured according to ASTM A929 (Manufacturing), 760 (Coating), 796 (Structural Design) and 798 (installation). The Aluminized Steel Type 2 pipe shall meet or exceed HS20 loading requirements and NCDOT approvals.

100.02.01.08.02 Corrugated Aluminum Pipe shall conform to ASTM B744 and design standard ASTM B790. Installation and backfill shall comply with standards ASTM B788 and AASHTO M145. The Corrugated Aluminum Pipe shall meet or exceed HS20 loading requirements and NCDOT approvals.

100.02.01.09 Cast Iron Soil Pipe

100.02.01.09.01 Sewer Service connections shall be heavy weight hub and spigot meeting Federal Specifications WW-401. The joints shall be rubber type elastomeric as per ASTM C425.

100.02.02 Materials for Manholes and other Structures

100.02.02.01 General

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

100.02.02.01.02 Manhole covers shall be elevated as follows:

100.02.02.01.02.01 Manholes installed in roadways and road shoulders shall be installed with the cover flush with the top of pavement.

100.02.02.01.02.02 Manholes installed outside of roadways shall be elevated at least 1 foot above the surface grade unless otherwise noted.

100.02.02.01.02.03 All manholes installed in wooded, forested or brushy areas shall be elevated at least 2 feet above the surface elevation.

100.02.02.01.02.04 All manholes located within the 100-year flood elevation shall be elevated at least 18 inches above the 100-year flood elevation or specify watertight covers and vents that extend at least 18 inches above the 100-year flood elevation.

100.02.02.01.02.05 Manholes installed in privately maintained landscaped areas may be installed at grade provided the maintaining owner does not hide, cover, or otherwise obscure the manhole location. Manholes in these areas must be equipped with a watertight inflow dish to prevent stormwater draining into the sewer system.

100.02.02.01.03 Manholes higher than 30 inches above finished grade shall require outside steps.

100.02.02.01.04 Precast concrete manholes shall be manufactured in accordance with ASTM C478 "Precast Reinforced Concrete Manhole Sections".

100.02.02.01.05 All manhole cone sections shall be the eccentric type.

100.02.02.01.06 All structures shall have 6 inch thick, 3000-psi concrete bottoms resting on a minimum of 6 inches of # 57 stone.

100.02.02.01.07 All pipe connections on new manholes shall be precast with integral flexible watertight couplings or boots. All new pipe connections to existing manholes shall be cored with a concrete coring machine and a flexible watertight coupling or boot installed. Flexible connectors are to be manufactured of high quality rubber or synthetic rubber and all strap clamps or draw bolts shall be stainless steel. Boots are to meet standards of ASTM C923. Rings and clamps are to meet standards of ASTM A167 and/or ASTM C923.

100.02.02.01.08 In general, manholes shall be sized as shown in Table 100.02. The pipeline size, manhole depth, and number of pipes entering are essentially independent and the manhole size is based on the most restrictive factor. Manholes that house appurtenances (valves, meters, drops, etc.) or fall outside the limits of the criteria listed in Table 100.02 shall be designed on a case-by-case basis, requiring approval by the Director of Engineering, and at a minimum shall be sized to allow proper access and maintenance of the system.

100.02.02.01.09 Joint surfaces for joints between bases, risers, and cones shall be manufactured to the joint surface design and tolerance requirements on ASTM C361. The maximum slope of the vertical surface shall be 2 degrees. The maximum annular space at the base of the joint shall be 0.10-inch. The minimum



height of the joint shall be 2½-inches. Joint sealing material between manhole sections shall be rubber gasketed joints or butyl rubber. Rubber gasketed joints shall conform to ASTM C443 "Joints for Circular Concrete Sewer and Culvert Pipe, Using Rubber Gaskets". Butyl rubber sealants shall conform to Federal Specifications SS-S-210A, AASHTO M-198, Type B-Butyl Rubber with a maximum of 1% volatile matter and suitable for application at temperatures between 10 and 100 degrees F. If butyl rubber joints are used, the surface of the joint receiving the butyl rubber shall be coated with an adhesive coating to assure that a seal is established between the rubber and the concrete.

100.02.02.01.10 Precast base sections shall have the base slab cast monolithically with the walls. Manhole inverts may be cast monolithically with the base section or be formed and cast into an existing base section. Openings shall provide clearances for pipe projecting a minimum of 2-inches inside the manhole. The trough shall be formed and finished to provide a consistent slope from the pipe inlet to the outlet. The minimum fall across the manhole shall be 1-inch. The channel cross sectional profile shall be consistent and uniform from invert to invert. The bench shall be sloped to provide draining to the invert. No depressions, high spots, voids, chips, or fractures will be permitted along the trough.

100.02.02.01.11 Manholes shall have extended bases for stability and/or anti-floatation where needed.

#### 100.02.02.02 Bricks and Blocks

100.02.02.02.01 Clay brick shall be solid, rough, sound clay brick conforming to ASTM C32, Grade MS. The brick shall be laid with full shove joints, filling up the joints with mortar. The thickness of the joints shall not exceed 3/8 of an inch.

100.02.02.02.02 Concrete Block or brick shall be solid and conform to ASTM C139 as to design and manufacture. The block or brick shall be embedded in a mortar bed to form a ½-inch thick mortar joint.

#### 100.02.02.03 Precast Concrete

100.02.02.03.01 Precast concrete manholes and structures shall meet ASTM C478 as to design and manufacture. 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. The interior side of the joints and all lift holes shall be plugged and plastered smooth with non-shrinking grout after installation.

#### 100.02.02.04 Steps for Manholes and other Structures

100.02.02.04.01 Manhole steps shall be provided in bases, risers, cones, and transitions. Steps shall be furnished with the precast structures. Steps shall be of polypropylene material reinforced with a ½-inch diameter reinforcing rod. Secure steps to the wall with a compression fit in tapered holes or cast in place. Steps shall not be vibrated or driven into freshly cast concrete or grouted in place. Step pullout strength shall be a minimum of 2000 lb. when tested according to ASTM C497 (No. PS-1-PM, as manufactured by M. A. Industries, Inc., or pre-approved

equivalent). Steps shall be vertically set 16 inches on center. Holes for the installation of steps shall not project through the structure wall, but shall stop a minimum of 1 inch from the outside wall. Steps shall be at least 12 inches clear width and shall project at least 5 inches from the wall into which they are embedded. Steps shall be located along the downstream side of the structure. The eccentric cone shall be oriented so that the steps are vertical over the downstream side of the primary flow path to allow ease of access for maintenance, camera or cleaning operations.

100.02.02.05 Frames and Covers

100.02.02.05.01 All manhole frames and covers shall be domestically made with domestic Class 35 gray iron. Ring and cover shall be stamped with make and model.

100.02.02.05.02 All manhole covers shall be forged with the Town symbol and appropriate label ("WASTEWATER", "WATER", or "STORMWATER") as indicated in the Standard Details.

100.02.02.05.03 For installation in roadways, use Type 1 ring and cover and place a collar of 3000-psi concrete beneath the asphalt to sufficient depth to ensure contact with the manhole. For installation in unpaved areas, use Type 2 ring and cover. Use Type 3 ring and cover for installation necessitating watertight requirements. Locking covers shall be required in all outfall locations.

100.02.02.05.04 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. Manhole frames shall be bolted to the manhole, except in paved streets.

100.02.02.05.05 Watertight manhole rings and covers shall only be allowed upon approval by the Director of Engineering. Manholes with watertight tops shall be vented in accordance with the Standard Details. Watertight manhole frames and covers shall have neoprene gasket and machined bearing surfaces. Bolts shall be standard hexagonal-head, countersunk such that when fully tightened the bolt head is flush with the top of the cover. Only stainless steel tightening bolts shall be used.

100.02.02.06 Manhole Coatings and Sealant

100.02.02.06.01 Manholes will receive interior coatings if indicated in these Standard Specifications or as directed by the Director of Engineering. Typically, wastewater manholes that contain hydraulic jumps, wastewater entering from 12 inch or larger mains more than 12 inches above the bench, or a force main discharge, will require interior coating. Interior coatings for manholes shall be field applied after installation to allow for a monolithic holiday free coating. Factory application may be allowed on a pre-approved basis contingent upon the joints receiving a field application. The coating shall be applied to the entire manhole interior, including the bench. The epoxy shall be as listed in the Approved Manufacturer's List and shall be applied to a minimum thickness of 80 mils. Design Professional shall place a note on the plans showing the required coating for each manhole.

100.02.02.06.02 All external manhole joints shall be waterproofed by wrapping all joints with a minimum 8 inch width band of butyl joint wrap. Waterproofing shall be installed by mopping asphalt over the joint area, then wrapping butyl joint wrap around the joints, and finally mopping the wrap with another coat of asphalt. The total asphalt coat thickness shall be a minimum of 16 mils.

100.02.02.06.03 The exterior of all manholes within the 100-year flood elevation shall receive an exterior coating with bitumastic coal tar epoxy listed in the Approved Manufacturer's List or an approved epoxy coating at 40 mils to prevent weepage or attack by acidic soils.

100.02.02.06.04 All manholes subject to inundation extended above the ground surface shall receive an external frame chimney seal as listed in the Approved Manufacturer's List.

#### 100.02.02.07 Tapping Sleeves and Saddles

##### 100.02.02.07.01 Water Service Taps

100.02.02.07.01.01 Tapping sleeves shall be made of either cast iron or stainless steel. The sleeve shall be two-piece with mechanical joint to the main line and flanged to the tapping valve. Cast iron shall meet AWWA C110 specifications. Stainless steel shall meet AWWA C223 specifications. All sleeves shall require full circumferential gasket.

100.02.02.07.01.02 Tapping saddles shall be used on mains 16 inches and larger. The maximum saddle outlet shall be 12 inches. Saddles shall be made of stainless steel providing a factor of safety of 2.5 with a working pressure of 250 psi. Saddles shall be equipped with an AWWA C110 flange connection on the branch. Sealing gaskets shall be O-ring type, high quality molded rubber having an approximate 70 durometer hardness, placed into a groove on the curved surface of the saddles. Straps shall be alloy steel.

##### 100.02.02.07.02 Sewer Service Connections

100.02.02.07.02.01 PVC service saddles shall be of the same material as the main, and shall be solvent welded and fastened with double stainless steel bands.

100.02.02.07.02.02 Ductile Iron service saddles shall consist of a virgin SBR 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 SBR gasket.

100.02.02.07.03 Sewer services shall be Schedule 40 PVC for normal depth sewer, and the same material as the main from tap to right-of-way/easement cleanout per Detail 150.02 for deep sewer installations.

## **100.03 TRENCHING AND INSTALLATION**

### 100.03.01 Preparation

100.03.01.01 Prior to trenching for the construction of any piping systems the Contractor shall locate all existing utilities within the construction zone. This shall include at a minimum contacting the North Carolina One Call Center at 1-800-632-4949. In sensitive areas where utilities cannot be located by traditional means, specialized utility locating, such as vacuum excavation or ground penetrating radar (GPR) may be required to locate existing utilities before excavating.

100.03.01.02 Contractors working (excavation, boring, or other subsurface breach) within 5-feet of existing water lines 12-inches in diameter or larger shall be required to physically spot the existing line to be verified by Utility Department staff or the Construction Inspector.

100.03.01.03 The Contractor shall be responsible for implementing all required safety provisions for trenching in compliance with OSHA regulations and all other applicable safety requirements and procedures.

### 100.03.02 Trenching

100.03.02.01 Trenching for pipelines shall be excavated to the required depth to permit the installation of the pipe along the lines and grades shown on the construction drawings.

100.03.02.02 The trench shall be excavated to the alignment shown in the drawings or to the centerline staked in the field. The depth of the trench shall conform to the profile shown in the drawings. Trench width at the top of the pipe shall not exceed the nominal diameter of the pipe plus two feet without approval of the Director of Engineering.

100.03.02.03 The minimum trench width shall be one pipe (outside) diameter plus 9 inches on each side of the pipe. The minimum trench width for HDPE pipe shall be one pipe (outside) diameter plus 24 inches on each side of the pipe. Rock shall be removed to a depth of at least 6 inches below the bottom of the pipe and the trench shall be backfilled with suitable material.

100.03.02.04 A space shall be excavated at each bell to provide ample space to join the pipes with no misalignment. The bottom of the trench shall be shaped to provide uniform support along the entire length of the pipe. Depressions in the stone bedding for the pipe bells shall be provided at each joint but shall be no larger than necessary for joint assembly and assurance that the pipe barrel will lie flat on the trench bottom. The trench bottom shall be true and even in order to provide support for the full length of the pipe barrel, except that a slight depression may be provided to allow withdrawal of pipe slings or other lifting tackle.

100.03.02.05 Should the trench pass over a sewer or other previous excavation, the trench bottom shall be sufficiently compacted to provide support equal to that of the native soil. Care shall be taken to prevent damage to the existing installation.

100.03.02.06 Open trenches shall not exceed 100 feet in length.

100.03.02.07 All trenches shall be confined to the limits of the ROW or Easement. Trenches in paved areas shall not be sloped.

100.03.02.08 All trenches along roadways, and otherwise as directed by the Construction Inspector, shall be properly backfilled at the end of each working day.

100.03.02.09 Trench sheeting, shoring, or bracing shall be used where shown in the drawings, specified in the Special Conditions, or directed by the Engineer to protect the utility under construction, to allow construction to be performed according to drawings and specifications, or to prevent damage to property. The Contractor shall adhere to all OSHA requirements concerning trench sheeting, shoring, or bracing during all trench excavation. Where trench sheeting, shoring, or bracing is used, the trench width may be increased accordingly.

100.03.02.10 Excavated material shall be placed in a manner that will not obstruct the work, endanger the work or otherwise cause a threat to the welfare of the public. The trench shall be kept dewatered during the excavating, pipe laying and backfilling stages of the work. Discharge from any dewatering pumps shall be conducted to natural drainage channels, storm sewers, or an approved reservoir with appropriate erosion control measures. Wet trenches shall be stabilized with a base layer of #78M or #57 stone.

100.03.02.11 The Contractor shall take all necessary measures to prevent water from entering the trench.

100.03.02.12 All excess trench excavation shall be disposed of in an approved waste area. The ground surface shall be left in a condition such that erosion control measures can be immediately carried out.

### 100.03.03 Bedding

100.03.03.01 Classifications of bedding materials are given in Table 100.03.

100.03.03.02 The bedding (6 inch minimum below the pipe) and embedment materials shall be in accordance with ASTM D-2321. The embedment materials shall be installed from trench wall to trench wall and from the invert to a minimum of 6 inches above the crown of the pipe.

100.03.03.03 For flexible and semi-rigid pipes, bedding and embedment material shall be Class I.

100.03.03.04 Class I bedding shall be required for all pipeline installations, regardless of pipe material, when the trench bottom is unstable due to water, rock, infiltration or soil type.

100.03.03.05 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

Construction Inspector, testing shall be provided by the Contractor and a Geotechnical Design Professional to verify compliance.

100.03.03.06 In any area where the pipe is 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, whether flexible or semi-rigid.

100.03.03.07 Where the subgrade is found to be unstable or to include ashes, cinders, refuse, organic material, or other unsuitable material, such material shall be removed to a minimum of 3-inches, or to the depth ordered by the Director of Engineering, and replaced with a foundation and bedding of crushed stone, suitably graded, and acting as an impervious mat into which the unstable soil or unsuitable material will not penetrate. The depth of crushed stone used for foundation and bedding shall depend upon the severity of the condition of the trench bottom soil or material.

100.03.03.08 Surface grade the bedding stone beneath the pipe to provide a uniform and continuous support beneath the pipe at all points between bell holes or pipe joints. Densify bedding stone beneath the pipe.

100.03.03.09 After each pipe has been brought to grade, aligned, and placed in final position, deposit and densify sufficient bedding material under the pipe haunches and on each side of the pipe to hold the pipe in proper position during subsequent pipe jointing, bedding, and backfilling operations. Bedding material shall be uniformly and simultaneously deposited on each side of the pipe to prevent lateral displacement.

#### 100.03.04 Pipe Laying

100.03.04.01 All pipe shall be laid in accordance with the manufacturer's recommendations, industry standards, and all applicable Town requirements. DIP shall be installed in accordance with the Ductile Iron Pipe Handbook published by DIPRA and AWWA C500. Installation of PVC pipe shall follow the recommendations of ASTM D-2321 "Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications".

100.03.04.02 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.

100.03.04.03 Pipe laying shall be accomplished in a manner and with the required resources to provide a properly aligned and sealed pipeline and joints.

100.03.04.04 Pipe deflection limits shall not be exceeded in accordance with manufacturer requirements. The maximum allowable deflection after installation shall be less than 5% for flexible pipe and 3% for semi-rigid.

100.03.04.05 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 the pipe or fittings, it shall be removed before installation. Open ends of pipe shall be plugged or capped when pipe laying is not in progress.

100.03.04.06 For gravity pipeline systems, transitions of pipe material, pipe separations, grade changes and all angular deflection changes shall occur only at manholes or other structures.

100.03.04.07 All gravity pipeline systems shall be installed beginning with the downhill section at the lowest elevation, and advanced upgrade to the terminus of the main. All bell ends for gravity pipeline systems shall be oriented facing the uphill direction.

100.03.04.08 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, unless otherwise directed or approved by the Director of Engineering. 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.

100.03.04.09 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.

#### 100.03.05 Backfilling

100.03.05.01 Backfill material shall be free from construction material, frozen material, organic material, or unstable material. Backfill with a high clay content or high shrink-swell potential that cannot meet compaction requirements shall be deemed unsuitable and replaced.

100.03.05.02 No rocks larger than 4-inches in diameter shall be used as backfill.

100.03.05.03 Backfill materials that have been allowed to become saturated or with moisture contents non-conducive to meeting compaction requirements shall be deemed unsuitable and replaced.

100.03.05.04 When original excavated materials have been deemed unsuitable, granular material shall be imported to the site to backfill utility trenches and meet compaction requirements. The following materials shall be acceptable forms of granular backfill: aggregate base course, soil type base course, select backfill material, sand or screenings in accordance with NCDOT specifications.

100.03.05.05 In locations where backfill material is temporarily stockpiled on the roadway surface, a layer of 1½ inches of screenings shall be used between the pavement surface and the backfill material.

100.03.05.06 Backfill for utility trenches shall be placed in 8-inch lifts or less of uncompacted soil and compacted with a mechanical tamp before placing additional layers.

100.03.05.07 Under roadways and extending at a slope of 1 to 1 beyond the back of curb, measured perpendicular from centerline, backfill shall be compacted to a density of no less than 95% standard Proctor maximum dry density as measured by AASHTO method T99. Other fill material shall be compacted to a density of no less than 90% of the maximum dry density as measured by AASHTO method T99. Backfill material shall

be placed in lifts of 12 inches or less of the uncompacted soil. Suitable backfill material shall be utilized and compacted. The Contractor shall be responsible for verifying that compaction requirements have been met or exceeded by providing soils testing data from a Geotechnical Design Professional.

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

#### 100.03.06 Pavement Repairs

100.03.06.01 All trenches shall be properly backfilled at the end of each working day. All pavement cuts on Town maintained streets shall be repaired within a maximum of 3 days from the date the cut is made. If conditions do not permit a permanent repair within the given time limit, permission to make a temporary repair shall be obtained from the Construction Inspector.

100.03.06.02 Pavement repairs shall be made in accordance with the Standard Details.

100.03.06.03 All asphalt pavement utilized to repair open trenches shall comply with all applicable Town asphalt pavement material and installation specifications.

100.03.06.04 All pavement patches shall be provided in such a manner that a uniform and smooth driving surface free of depressions and/or bumps is obtained. Pavement patches not meeting this standard shall be milled and replaced.

#### 100.03.07 Thrust Restraints

100.03.07.01 All fittings or components of piping systems subject to hydrostatic thrust shall be securely anchored with some form or thrust restraint system. The standard thrust restraint system shall be reaction blocking, unless otherwise noted in these Standard Specifications. Other restraint systems, such as rodding, restrained joints, or special restraint systems (such as Mueller Aqua-Grip), may be approved by the Director of Engineering on a case-by-case basis.

100.03.07.02 Reaction blocking shall consist of 3000 psi concrete poured in place against solid, undisturbed earth. The reaction areas required for different scenarios are shown in the Standard Details. Areas given are vertical planes measured in solid material normal to the thrust line of the fitting. No concrete shall interfere with the removal of fittings. A plastic film shall be applied to the pipe to prevent concrete from bonding to the pipe material.

100.03.07.03 All steel rods and fasteners shall be COR-TEN and equivalent to ASTM A242. The number or ¾-inch steel rods required for different pipe sizes shall be in accordance with Table 100.04. The number required for any sizes not shown in Table 100.04 shall be determined by the Director of Engineering.

100.03.07.04 Restrained joints shall be as listed in the Approved Manufacturer's List.

100.03.07.05 Special restraint systems shall be as listed in the Approved Manufacturer's List. Such restraints shall be individually integral to the pipe or fitting



such that the special restraint system adequately restrains the pipe or fitting at that location without the need of additional restraints. Special restraints shall be constructed of ductile iron and provide full circumferential engagement to the ductile iron pipe. Such special restraints shall have a minimum working pressure of 250 psi with a minimum Factor of Safety of 2. Restraints shall be supplied with inspection 'break nuts' that shear upon the attainment of proper installation torque. Restraints that 'point load' around the circumference of the pipe will not be allowed without concrete reaction blocking.

100.03.08 Boring and Jacking

100.03.08.01 General

100.03.08.01.01 All utility crossings within Town streets shall be made by boring and jacking. In cases where utility conflicts, rock, or other obstructions prevent crossing by boring and jacking, the Town may consider approving other methods. Crossing of streams and/or creeks shall also be by bore and jack method. Variations with extenuating circumstances may be granted by the Director of Engineering.

100.03.08.01.02 In addition to meeting or exceeding all Town requirements, all bores shall be approved by and meet the requirements of any other controlling legal authorities, such as NCDOT, Norfolk Southern Railway and CSX Corporation.

100.03.08.01.03 All bores larger than 6 inches in diameter shall be encased as specified.

100.03.08.01.04 Encasement pipe shall be installed with a minimum cover of 4 feet between the pavement subgrade and the top of the casing pipe. Under no circumstances shall the pavement subgrade be disturbed.

100.03.08.02 Materials

100.03.08.02.01 Encasement pipe shall be manufactured of grade 'B' steel with a minimum yield strength of 35,000 psi in accordance with ASTM A139 and A283.

100.03.08.02.02 The encasement pipe shall receive an exterior bituminous protective coating at least 2 mils thickness. The coating shall be applied to the outside of all pipe and joints. The coating shall be applied in a continuous and smooth application and allowed ample time to cure prior to installation.

100.03.08.02.03 Wall thicknesses for various diameter sizes of smooth wall or spiral welded steel encasement pipe shall be as shown in Table 100.05.

100.03.08.02.04 Encasement pipe installed for railroad bores shall meet the requirements of the American Railway Engineering Association (AREA).

100.03.08.02.05 Encasement pipe shall have minimum sizes as shown in Table 100.06.

100.03.08.02.06 All carrier pipe shall be slip joint ductile iron pipe.

100.03.08.02.07 The carrier pipe shall rest on steel “spider” pipe alignment spacers. A minimum of 2 steel spiders per joint of carrier pipe shall be required. The steel spiders shall be spaced evenly along the carrier pipe alignment in such a manner that each spider supports the same unit weight of carrier main. The spacing interval of the steel spiders shall assure the necessary grade, clearance, and support of the carrier main.

100.03.08.02.08 The carrier pipe bells shall not be allowed to contact the interior of the encasement pipe under any circumstances.

100.03.08.02.09 No blocks or temporary spacers shall be wedged between the carrier pipe and the top of the encasement pipe.

#### 100.03.08.03 Installation

100.03.08.03.01 In locations where open pipe trenches are not allowed, dry bore and jack operations may be allowed. Smooth wall or spiral welded steel pipe may be jacked through dry bores slightly larger than the pipe bored progressively ahead of the leading edge of the advancing pipe. The spoil material shall be mucked by the auger back through the pipe during the boring operation.

100.03.08.03.02 As the dry boring operation progresses, each new section of encasement pipe shall be butt-welded to the section previously jacked into position.

100.03.08.03.03 If voids are encountered while installing encasement pipe 30 inches and larger, grout holes shall be installed at 10-foot centers in the top section of the encasement pipe. The grout holes shall be used to fill the void spaces with 1:3 Portland cement grout at sufficient pressure to prevent settlement of the roadway, unless NCDOT approval stipulates otherwise. Other grout mixtures may be submitted for approval.

100.03.08.03.04 In the event that an obstruction is encountered during the boring and jacking operations, the boring equipment shall be withdrawn. The pipe shall be cut off, capped, and filled with 1:3 Portland cement grout at a sufficient pressure to fill all voids before moving to another boring site.

100.03.08.03.05 See the Standard Details for further installation requirements.

## **100.04 SEPARATION DISTANCES**

### 100.04.01 General

100.04.01.01 All pipeline systems shall meet either the separation distances provided below, or the minimum separation distances as required by NCDEQ (15A NCAC 02T.305 and Recommended Standards for Water Works – Ten State Standards) or any other County, State, or Federal agency, whichever is greater.

100.04.01.02 Separation distances shall be measured from edge to edge of the pipes.

100.04.01.03 Where the required minimum separations cannot be maintained, ferrous pipe with joints equivalent to water main standards shall be used for each pipeline.

100.04.02 Horizontal Separations for Parallel Pipelines

100.04.02.01 Water system piping and wastewater system piping shall have a minimum horizontal separation distance of 10 feet. In situations where conditions or barriers prevent a 10-foot lateral separation, NCDEQ standards may allow:

100.04.02.01.01 The water main to be laid in a separate trench, with the elevation of the bottom of the water main at least 18 inches above the top of the sewer; or

100.04.02.01.02 The water main to be laid in the same trench as the sewer with the water main located at one side on a bench of undisturbed earth, and with the elevation of the bottom of the water main at least 18 inches above the top of the sewer.

100.04.02.02 Water system piping and stormwater system piping and structures shall have a minimum horizontal separation distance of 5 feet.

100.04.02.03 Wastewater system piping and stormwater system piping shall have a minimum horizontal separation distance of 5 feet.

100.04.02.04 The minimum horizontal separation between parallel pipelines of any type (including the same type) shall be 5 feet if the difference in pipeline elevation is no greater than 24 inches. If the vertical difference between the parallel pipelines exceeds 24 inches, the horizontal separation distance shall be determined on a case by case basis by the Director of Engineering. The critical factor is being able to excavate the deeper pipeline for repairs and not disturbing the shallower pipeline.

100.04.03 Vertical Separations for Pipeline Crossings or When Horizontal Separations cannot be met.

100.04.03.01 Water mains shall cross sanitary sewer mains at an approximate 90 degree angle.

100.04.03.02 Water system piping and wastewater system piping shall have a minimum vertical separation distance of 18 inches, with the water piping being above the wastewater piping. Where a water main and a sanitary sewer main cross and the vertical separation is less than 18 inches, or where the water main passes under the sanitary sewer main, the entire leg of the sanitary sewer line shall be epoxy lined ductile iron pipe with joints equivalent to water main standards. Transitions of pipe material shall not occur between manholes on sanitary sewer lines, except at inside drop manholes.

100.04.03.03 Water system piping and stormwater system piping shall have a minimum vertical separation distance of 18 inches with a minimum cover of 36-inches measured from the crown of pipe to grade in road shoulders, or minimum cover of 30-inches measured from crown of pipe to sub-grade in streets. The preference is for the water

main to be located above the stormwater system piping. Where a water main and a stormwater system piping cross and the vertical separation is less than 18 inches when the waterline crosses over the stormwater piping, the following measures are allowed:

100.04.03.03.01 If under pavement and there is 30-inches of cover to **road surface** with 6 to 12-inches of separation between pipes, use ductile iron pipe for the water main with an excavatable flowable fill cradle that meets or exceeds NCDOT specifications at the stormwater pipe crossing.

100.04.03.03.02 If cover is less than 30-inches to **road surface** and stormwater pipe is less than 24-inches in diameter the water line may be located under the stormwater piping.

100.04.03.03.03 Water lines that cross and run beneath storm drainage pipes that are greater than or equal to 24" diameter and/or streams or creeks shall be installed as restrained joint pipe and enclosed in casing pipe extending a minimum of 5-feet from the outside walls of the storm drainage pipe.

100.04.03.03.04 Other scenarios will be addressed on a case by case basis and may require steel casing pipe under stormwater piping.

100.04.03.04 Wastewater system piping and stormwater system piping shall have a minimum vertical separation distance of 24 inches, with the stormwater piping being above the wastewater piping.

100.04.03.05 Water mains and storm sewer mains shall have a minimum vertical separation of 18 inches when horizontal separation is less than 3 feet.

#### 100.04.04 Additional Horizontal Separations for Wastewater System Piping

100.04.04.01 100 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. An absolute minimum separation of 25 feet from private wells and 50 feet from sources of public water supply shall be maintained, with no exceptions.

100.04.04.02 50 feet from any waters (from normal high water) classified WS-II, WS-III, B, SA, ORW, HQW or SB.

100.04.04.03 25 feet from any other stream, lake, or impoundment

## 100.05 EASEMENTS

### 100.05.01 Sizing and Layout Requirements

100.05.01.01 All public pipeline systems shall be installed in dedicated street ROW or in dedicated utility or stormwater easements. Pipeline systems installed in Town street ROW shall be located in the center of pavement as much as feasibly possible. Pipeline systems located within easements shall be centered within the easement. Pipeline systems located within NCDOT ROW shall be placed in accordance with NCDOT standards. Private easements for public pipeline systems are not permitted.

100.05.01.02 Dedicated easements shall be recorded as “Town of Fuquay-Varina Utility Easement” or “Private Stormwater Easement”. Town utility easements shall not contain any other utilities (gas, electric, telecom, etc.).

100.05.01.03 See Tables 100.07 and 100.08 for required utility easement widths and stormwater easement widths.

100.05.01.04 All fire hydrants shall have a minimum ROW/easement width of 20 feet which shall extend a minimum of 10 feet beyond the hydrant.

100.05.01.05 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 5:1 ratio.

#### 100.05.02 Encroachments (Plantings, Fences, Structures, etc.) Within Town Utility Easements

100.05.02.01 No part of any structure, pavement, permanent equipment, private utility line (including water, irrigation, and sewer lines) or impoundment shall be placed, and no grading shall occur within any Town easement prior to either obtaining full site plan approval or obtaining an encroachment agreement from the Director of Engineering. An encroachment agreement may allow fences to cross easements provided that appropriate access gates have been installed to allow maintenance. Any application for an encroachment agreement shall include plans to facilitate access and maintenance of the utility, and shall include any documentation which the Town needs to determine that no damage will occur to the utility.

100.05.02.02 The Town shall not be liable for any damage to plantings, fences, accessory structures, or any other encroachment, located either within an easement, or in any manner restricting access to the easement. Further, the Town shall not be liable for any incidental or consequential damage caused by the Town’s removal of any structure impairing the easement. Any contractor or landowner who has impaired the easement by allowing an obstruction to be placed on the easement shall indemnify and hold harmless the Town for any resulting incidental or consequential damages. The Town shall reseed as necessary any bare or disturbed soil for erosion control purposes.

100.05.02.03 Ground covers or grasses may be planted within the center 20 feet of an easement as long as those planting do not inhibit access of the easement with required equipment by the Town and/or its agents. Small trees (under 30 feet in height at maturity) and shrubs may be planted a minimum of 10 feet from the centerline of the closest pipe within the easement or 10 feet from the center of the easement, whichever is greater. Small trees shall include redbuds, fringe tree, serviceberry, crape myrtle, golden raintree, hawthorn, hornbeam, saucer or star magnolia, sassafras, smoke tree, sourwood, and sumac. Large trees shall not be placed within any Town utility easement.

<b>Table 100.01 - Pressure Class &amp; Depth for DIP Pipes</b>		
Pipe Diameter (inches)	Depth of Cover (feet)	Pressure Class (psi)
6-8	3-20	350
10-12	3-14	350
14-20	3-10	250
24-64	3-8	150

Note: For cases not specified, consult with the Director of Engineering for further guidance.

<b>Table 100.02 - Manhole Sizing Guide</b>			
Largest Pipe Size (diameter, inches)	Depth (invert to surface)	Number of Pipes Entering*	Manhole Size (diameter, feet)
8-16	3-12	2	4
18-30	12-20	3	5
32-54	>20-30	4	6

\* - excluding services

<b>Table 100.03 – Bedding Material Classifications</b>	
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 non-cohesive, 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 are not recommended for embedment.

<b>Table 100.04 - COR-TEN Rod Requirements</b>	
Pipe Size (inches)	Number of Rods Required
4	2
6	2
8	4
12	6
16	8
24	10

<b>Table 100.05 - Minimum Wall Thickness of Steel Encasement Pipe</b>	
Encasement Pipe Outside Diameter (inches)	Minimum Wall Thickness (inches)
12-3/4	0.188
14	0.250
16	0.250
18	0.250
20	0.250
24	0.250
26	0.312
28	0.312
30	0.312
36	0.375
42	0.500
48	0.500

<b>Table 100.06 - Minimum Allowable Steel Encasement Pipe Diameter Per Carrier Size</b>		
<b>Carrier Pipe Size Ductile Iron w/Slip Joints (inside diameter, inches)</b>	<b>Carrier Pipe Outside Bell Diameter (inches)</b>	<b>Steel Encasement Nominal Diameter (inches)</b>
6	8.9	12-3/4
8	11.16	16
10	13.25	18
12	15.37	20
14	17.73	24
16	19.86	26
18	22.16	28
20	24.28	30
24	28.50	36
30	34.95	42
36	41.37	48

<b>Table 100.07 - Utility Easement Width Requirements</b>		
<b>Pipe Size (inch)</b>	<b>Pipe Depth (feet)</b>	<b>Easement Width Required (feet)</b>
0-12	0-12	20
0-12	12-17	30
0-12	17-20	40
15-24	0-8	20
15-24	8-14	30
15-24	14-20	40



Pipe Size (inch)	Easement Width Required (feet)
Open Swale	20
0-24	20
30-48	30
52-72	40
72 and above	The diameter or width plus 40 feet
Multiple culverts	The sum of the diameter plus 40 feet

Use	Material	DIP	PVC			CMP	RCP	HDPE
			SDR-21	SDR-35	C-900 DR-18			
Sewer Gravity Main (<12' depth)		X <sup>1</sup>	X	X	X <sup>2</sup>			
Deep Gravity Sewer (>12' depth)		X <sup>1</sup>			X <sup>2</sup>			
Sewer Force Main		X <sup>1</sup>	X	X	X			X
Water Main		X			X			X
Storm Drain						X	X <sup>3</sup>	X
Culvert		X				X	X <sup>3</sup>	X

<sup>1</sup> Interior Ceramic epoxy coated

<sup>2</sup> With special bedding

<sup>3</sup> Class 3 for standard installations, Class 4 for min cover installations when approved by Engineering Director